

The Benefits of Flood and Coastal Risk Management: A Handbook of Assessment Techniques

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Foreword

This Handbook has been produced by the Flood Hazard Research Centre at Middlesex University, under the Policy Development theme of the joint Defra and Environment Agency R&D programme.

The final text is the result of collaboration between the Centre, Defra, the Agency and other stakeholders, and we recommend use of this Handbook and its accompanying data CD for benefit assessment of flood and coastal erosion risk management in all levels of appraisal.

The aim of this research has been to *improve efficiency and consistency* in benefit assessment within flood and coastal erosion risk management appraisal. To this aim, the purpose of the Handbook has been to provide readers with:

- Easier access to the techniques and information needed to undertake evaluation of the benefits for most straightforward risk management projects (probably 75% to 85% of all cases);
- A greater understanding of the principle that for most cases appraisal effort should be proportional to the scale and scope of the decisions required.
- Techniques that fully support sustainable development principles.

Importantly, the Handbook provides approaches to implementing the policies set out in the HM Treasury 'Green Book' (HM Treasury, 2003) and Defra Flood and Coastal Management project appraisal guidance (the FCDPAG series), and it offers a useful step-wise 'how to do it' style.

The Handbook's development has faced challenges set by the emerging policy agenda and the government strategy, Making Space for Water (see: <http://defraweb/environ/fcd/policy/strategy/1stres.pdf>). It is likely that this new strategy will lead to further developments in appraisal methodology that will, for example, better identify gains and losses to individuals and different sectors, and make more use of approaches such as Multi-Criteria Analysis.

The Handbook touches on these areas in Chapter 2, but formal guidance will advise on the recommended adoption of these and any other new approaches in the future. For details, please look out for further information on new appraisal guidance, at: www.defra.gov.uk/environ/fcd/default.htm.

We hope that you find this Handbook and CD useful.

Defra Flood Management Division
December 2005

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A full set of acknowledgements for their contribution to the research leading to and the production of this Handbook and its associated Manual is contained in that Manual. A special mention should be made here, however, to the following for their contribution to this Handbook:

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1 Introduction: the purpose and contents of this Handbook

Aim and purpose of the Handbook

This Handbook is intended to be a stand-alone “How to do it” guide to assessing the benefits of flood and coastal risk management. When put together with knowledge of the costs of the plans and schemes required in that risk management, the user can assess the relationship between the benefits and the cost of investment decisions. This comparison should enable the users to identify those risk management plans and schemes which maximise the economic return to the nation (England and Wales) and therefore represent “best value for money” by being economically efficient.

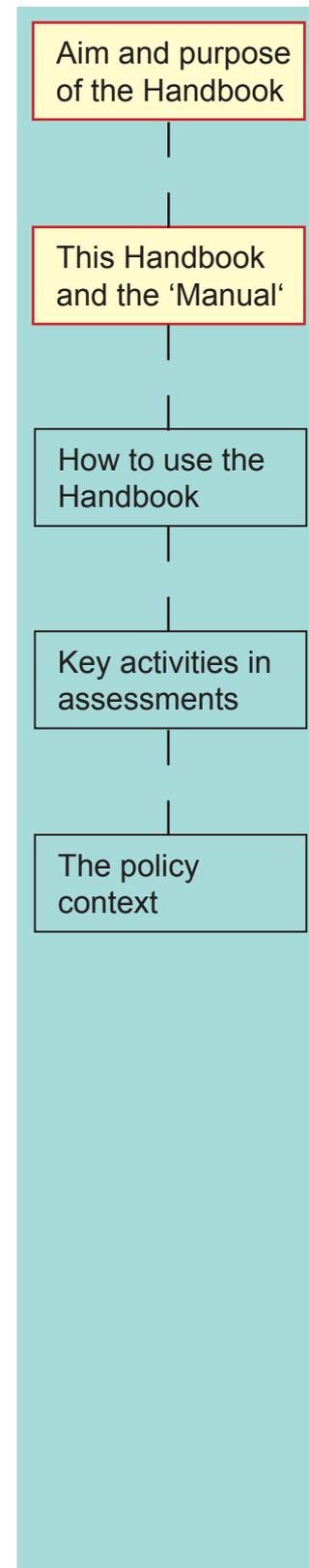
The term ‘**scheme**’ here is not meant to imply an engineering scheme but includes both structural engineering ways to reduce flood or erosion risk and non-structural alternatives (flood warning; emergency response; land use planning; etc). The term ‘scheme’ is used hereafter for simplicity.

This Handbook and the ‘Manual’

This Handbook will allow the user to carry out economic appraisal with the minimum of effort for the majority of flood and coastal erosion risk management schemes to be assessed. However, assessments are not always straightforward and therefore this Handbook is complemented by a much more extensive Manual, colloquially termed the *Multi-Coloured Manual* or, hereinafter, as the MCM (Penning-Rowell *et al.*, 2005) (Table 1.1).

The Handbook is designed to be more straightforward to use than the Manual, because that also reports the research undertaken at Middlesex University on which this Handbook and the MCM are based. The Manual also discusses the kind of complications in the appraisal of flood risk management options that can occur when the assessment is not straightforward, and provides suggestions and methods to apply in those circumstances

Those using this Handbook should therefore appreciate the connection with the full MCM. To help this, the MCM chapters correspond with those in the Handbook and, additionally, the MCM provides further detail on the rationale behind our approaches described here. **All values in this Handbook and Manual are at mid-2005 prices.**



How to use the Handbook

This Handbook is aimed at guiding those undertaking Flood and Coastal Erosion Risk Management (FCERM) project appraisals. It offers a step-by-step 'how-to do-it' commentary on the many types of benefits to be assessed, which are a feature of FCERM appraisal.

The Handbook seeks to develop and improve existing approaches, without compromising the principles that underpin current Defra and HM Treasury guidance. Defra, however, is currently reviewing its economic appraisal policy for FCERM, in line with the HM Treasury 'Green Book' (HM Treasury, 2003). This may lead to future changes in approach, which may go beyond the scope of this Handbook.

In the meantime, we believe that the majority (say 75%) of flood and coastal erosion risk management schemes can have their economic benefit assessments undertaken using the guidance provided here. In particular, the Handbook applies to:

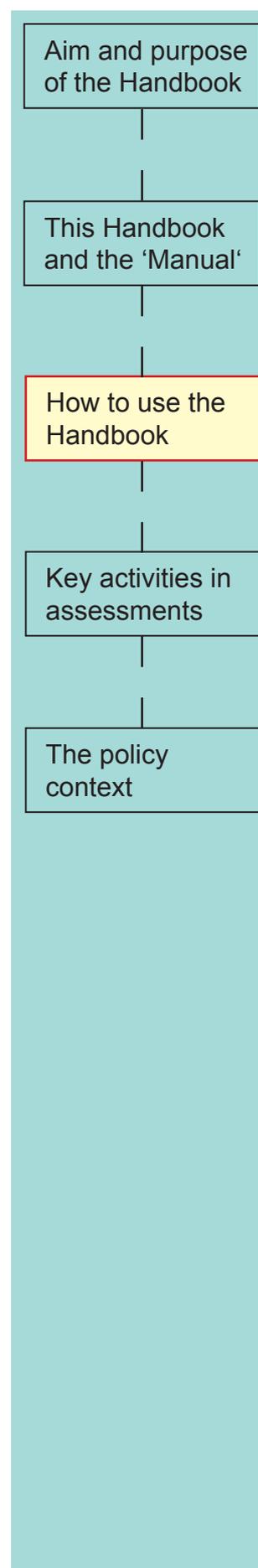
- Those undertaking strategy studies who want a 'first cut' assessment of potential benefits;
- Those undertaking pre-feasibility studies, who should use the methods described for this level of analysis, as covered herein;
- Those undertaking scheme feasibility studies, who should generally use the more detailed methods described here and in the MCM.

Importantly, appraisers should always, in cases of doubt, seek guidance or refer to the over-riding policy framework in the Treasury 'Green Book' and the associated Defra guidance.

Handbook structure

The Handbook is structured to reflect three considerations:

1. The type of scheme, that is to say whether it is aimed at:
 - Flood alleviation (**Chapters 2, 3, 4, 5 and 6**)
 - Delaying erosion at the coast (**Chapter 7**)
 - Providing an enhanced flooding and drainage regime for agriculture (**Chapter 9**)
2. In the case of flood alleviation, which economic sectors are under consideration, e.g.:
 - Residential and non-residential properties (**Chapters 4 and 5**)
 - Road disruption (**Chapter 6**)
 - Emergency services (**Chapter 6**)



3. Some chapters address both coastal erosion and flood risk management:
- Recreational impacts (**Chapter 8**)
 - Environmental impacts (**Chapter 10**)

This structure is also followed in the MCM, thereby assisting cross-referencing.

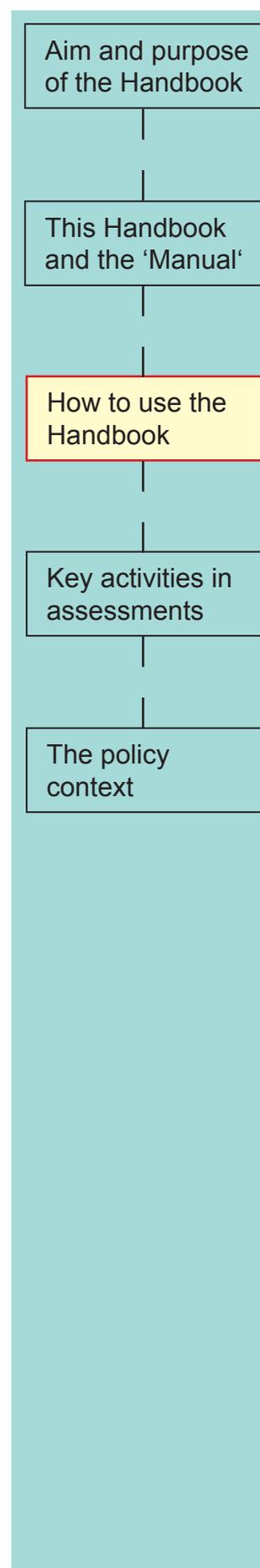
Handbook contents

The chapters of this Handbook each generally contain:

1. Step-by-step guidance on benefit assessments: “How to do it”
2. Data collection needs, methods and key issues
3. Methods of benefit calculation, including the relevant formulae, separated in some instances into strategic methods, pre-feasibility and full feasibility appraisals
4. Guidance as to interpreting the results
5. Details of other relevant aspects to benefit assessment *not* discussed in the Handbook but outlined in the MCM

Because it is designed for ‘work-a-day’ situations, the Handbook includes no consideration of the complexity of the economic theory behind benefit-cost analysis (which is dealt with in the MCM, Chapter 2), or of the theory of risk management. But the MC CD included with the Handbook contains the MCM database on flood impacts and other relevant data.

Table 1.1 Sources of guidance on appraising flood and coastal erosion risk management schemes and plans		
Source	Document	Purpose
HM Treasury	‘Green Book’	Identifies the preferred approach to public sector investment appraisal
Defra	PAG series, particularly PAG3, plus addendums	How a project appraisal and CBA should be completed for flood and coastal erosion risk management projects
Middlesex University FHRC	The ‘Multi-Coloured Manual ’ (MCM)	Gives details of relevant research and detailed guidance on benefit assessment methods and data
Middlesex University FHRC	The ‘Multi-Coloured Handbook ’ (MCH)	Summarises the guidance in the MCM for easier access



Key activities in assessments

This Handbook is intended to allow appraisals of flood and coastal erosion risk management schemes to be undertaken with the minimum of effort. One important dimension of this is judging the time and resources allocated to those parts of the benefit assessment process that are most important. This importance is gauged in two ways:

- Concentrating on those components of total benefits which are the largest compared with the effort expended on assessing them (e.g. non-residential property where there is a mix of non-residential and residential property at risk, because non-residential damage per unit area is generally far higher than residential damages)
- Ensuring that the data on which the benefit assessment depends is most accurate (or least inaccurate) where it has most effect on the final results (e.g. for coastal erosion, making sure projected erosion rates are as soundly based as possible; in the flooding field ensuring flood probability and depth are accurately assessed)

Applying these two principles will be different for different scheme types and in different economic sectors, so that each chapter of this Handbook addresses this issue in its own subject area.

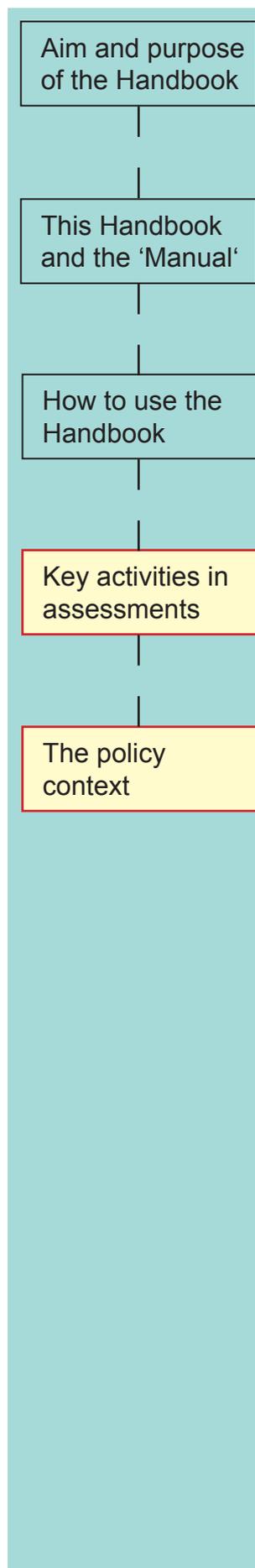
In general, applying such judgement will mean ignoring sources of small amounts of benefit (e.g. road traffic disruption on minor roads) and accepting that some data will be less accurate than others. Sensitivity analysis can be used to test how the decisions that flow from these principles affect particular appraisals.

The policy context

This Handbook and the MCM are designed to support the Defra/ODPM/HM Treasury policy on “Making Space for Water” (Defra, 2004; 2005). This stresses holistic policies and integrated appraisal, commensurate with sustainable development. It also supports the Water Framework Directive and other EU and UK government policies (Table 1.1).

Neither the Handbook nor the MCM explicitly includes the appraisal of urban drainage but could be used in this field. Both recognise the current moves away from narrow benefit-cost analysis (BCA) towards Multi-Criteria Analysis (MCA): see Chapter 10.

Both this Handbook and the MCM build on the latest Treasury ‘Green Book’ guidance on investment in public sector projects including, for example, the use of weightings to assess and



correct for distributional impacts, optimism bias considerations when assessing project costs, and variable discount rates for projects with long lives.

They also build on Defra's series of Project Appraisal Guidance series (e.g. PAG3). References here are therefore to 'Defra appraisal guidance' but the PAG series may shortly be replaced: 'Making Space for Water' (Defra, 2005) commits to updating this guidance, separating policy guidelines/statements issued by Defra from Environment Agency best practice implementation guidance.

In this respect appraisers of FCERM schemes should be aware of the types of risk management expenditure that Defra currently funds, not least because some benefits might not be supported in this way. Those benefits (e.g. major recreational benefits) might currently need the support of other funding streams where they are not incidental to the relevant scheme.

Notwithstanding the above, the contents of both the Handbook and the Manual remain the responsibility of Middlesex University (FHRC).

2

Using appraisals to make better choices

This chapter presents key points on how to improve decisions through project appraisal, and is structured to consider six key questions covering the project appraisal process:

- What is project appraisal?
- Why do project appraisals?
- Why involve stakeholders?
- What is value?
- How to compare options?
- How to make the decision?

A much more detailed discussion of these points is contained in Chapter 2 of the Multi-Coloured Manual (Penning-Rowsell *et al.*, 2005).

What is project appraisal?

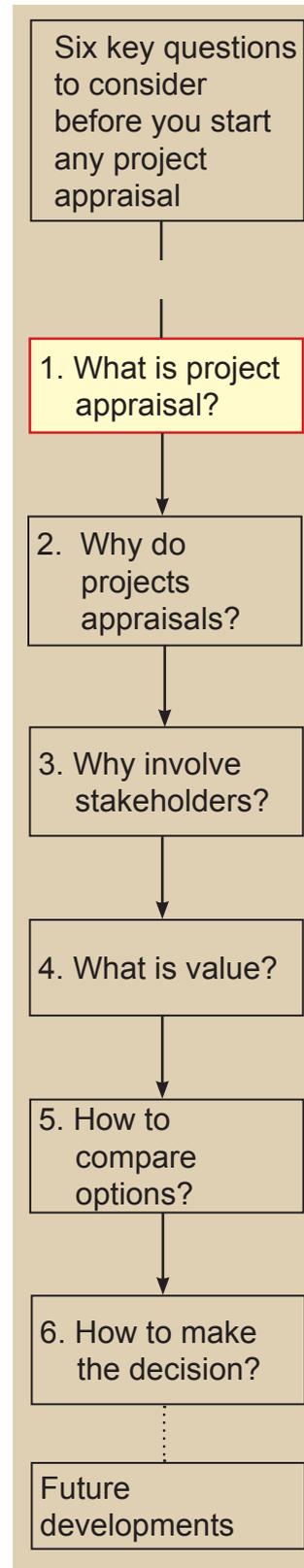
Defra's project appraisal guidance outlines that project appraisal is the process of identifying and then evaluating options in order to select the one that most likely satisfies the defined project objectives. The purpose of the project appraisal process is to improve decision making towards making the 'best' choice. Good decisions and the 'best' choice are most likely to result from considering all economic, social, environmental and technical issues for a full range of options.

The methods used in project appraisal are aimed at:

1. Simplifying the complexity of choice;
2. Understanding what choice involves; and
3. Enabling this understanding to be shared by stakeholders.

To ensure that project appraisal is not a mechanical exercise, appraisal led design is essential. Appraisals should drive the design process, with the identification and specification of project options evolving through this appraisal process.

To be useful appraisal methods should ensure best value and hence the highest rate of return for public monies. They must also provide accountability, transparency of the basis for choice, and result in a rational comparison of the available options and the consequences of these options.



Why do project appraisals?

If we want to make better decisions in flood and coastal erosion risk management, we need to start by understanding why we have to make the particular decision in the first place. This commences with identifying the problem and defining our objective/s.

In the simplest terms, a choice is required when there is conflict (i.e. disagreement) and uncertainty about a course of action to meet the defined objective/s. Uncertainty arises because of initial limited knowledge of an option's pros and cons (benefits and costs), and whether the 'best' choice to be made will be the most sustainable.

Economic appraisal enables the comparison of widely differing options, with careful consideration applied to how options are appraised as to their 'value' to arrive at the 'best' choice.

Why involve stakeholders?

A better decision is one that is both a 'just' decision and one that turns out to be 'correct' in the long run. For a decision to be 'just', it is not only the outcome that must be seen to be fair but so too must the process by which the decision is made. Critical to the achievement of a 'just' process and a better decision is therefore appropriate stakeholder involvement.

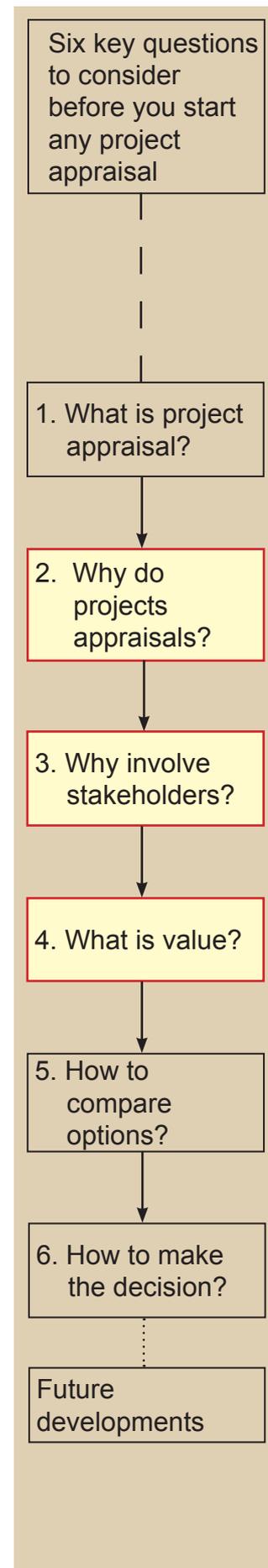
Project appraisal therefore has two roles:

1. Stakeholders need informed involvement, with information available to all: the project appraisal technique itself can contribute to creating a shared knowledge base;
2. The project appraisal method must serve as a framework through which stakeholders can explore, argue and negotiate their concerns and explore different options.

Also, new techniques are being developed, including Multi-Criteria Analysis (MCA) which, when appropriately applied, could lead to improved stakeholder involvement in decision making.

What is value?

Value is central to benefit-cost analysis and, in economics, all values are subjective: the value of some 'good' is given by the individual and reflects his or her subjective preference for that 'good'. Value does not have to be measured in monetary terms, only, although the Treasury Green Book, suggests that '*real or estimated market prices provide the first point of reference for the value of benefits*', and that '*benefits should be valued unless*



it is clearly not practicable to do so'.

In this respect, the shorthand term 'good' is used to denote any commodity, resource or item which an individual prefers or desires (for example, a coastal protection project, a flood alleviation scheme, a beach, a river, or a recreational experience). The values assigned to any such good then reflect the relative contribution that this good makes to an individual's 'utility' or wellbeing.

Value is also 'sacrificial'. This means it quantifies or reflects the degree to which the individual would be willing to give up an amount of that 'good' in order to have more of another: more flood alleviation means fewer hospitals. Values are, therefore, not absolute but reflect the basis upon which choices are made between enjoying these different goods (which the economist calls 'consumption').

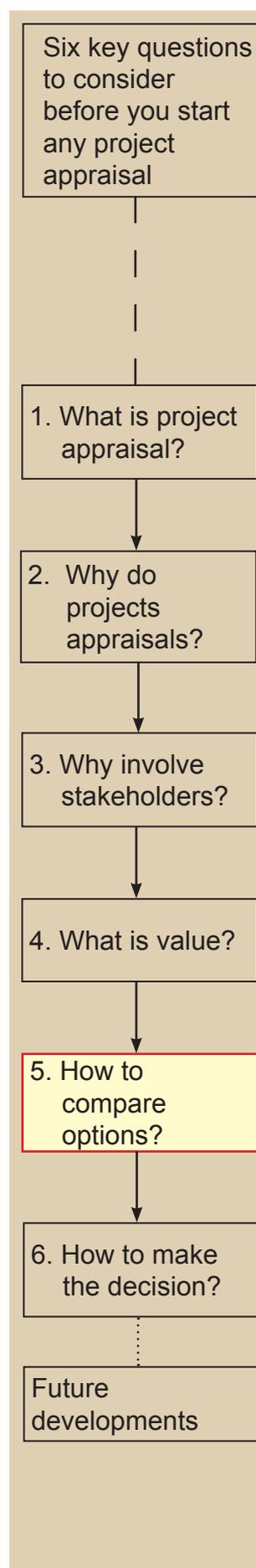
There are three general strategies for deriving values for use in benefit-costs analysis:

1. Using market prices (e.g. the cost of repairing flood damage)
2. Using 'inferential' methods, which use statistical techniques to infer the value of something that does not have an observable market price (e.g. valuing a recreation resource by the distance people are prepared to travel to enjoy that resource)
3. Using 'expressed preference' methods which usually involve questionnaires to elicit a value (e.g. asking people what choices they would make between different recreation venues)

Further information on these techniques and on the issues covering non-use values is provided in Chapter 10 and in the Multi-Coloured Manual. New Multi-Criteria Analysis could facilitate better comparison of certain monetary and non-monetary values.

How to compare options?

Option appraisal should provide an assessment of whether a proposal is worthwhile. However, the steps outlined in the Treasury Green Book involving *Justifying Action* (e.g. identifying need) and Setting Objectives should take place before *Option Appraisal*. Once options are developed, the appraisal process assesses option performance, usually by comparing the consequences of 'do something' options against some baseline option (usually 'do nothing'). Appraisers should only be interested in these differences. Benefit-cost analysis is normally used to make comparison and judgments on these differences, whilst other techniques such as MCA can improve this compar-



ison stage.

An initial **sensitivity analysis** should ideally be undertaken at the start of the project appraisal process, and not at the end, in order to understand how sensitive the choice is to the accuracy of data or methods being used. An experienced appraiser should be able to anticipate those parameters to which the estimated benefits and costs are most sensitive. It is those parameters that should be progressively refined as the analysis progresses.

The consequences of the different options often differ in terms of:

- Who is affected
- What is affected
- How they are affected, and
- When this effect occurs

Thus, all appraisals should identify these effects, and any comparison between options will involve judgments about how these different consequences can be brought to a common base.

How to make the decision?

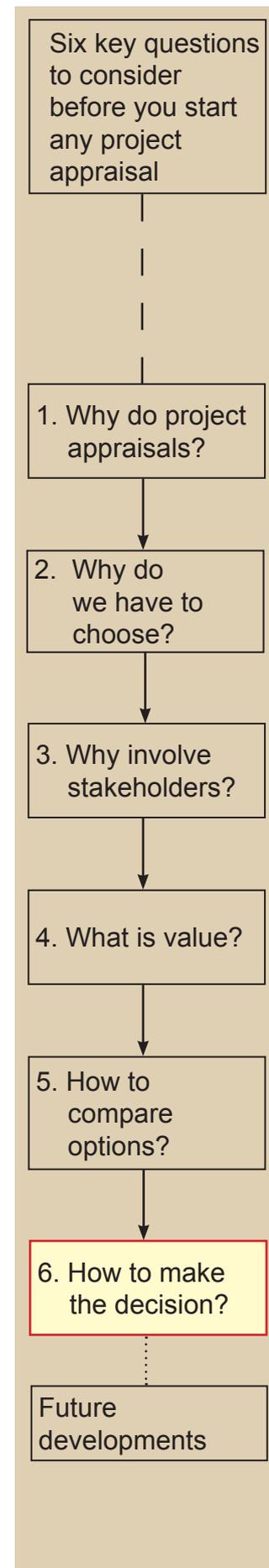
According to the Treasury Green Book, the purpose of an appraisal is to indicate that no policy, programme or project is adopted without first having the answer to these questions:

- (a) Are there better ways of achieving a given objective (e.g. reduced flood risk)?
- (b) Could the resources be put to better use (e.g. building a hospital)?

The appraisal also should explore how confident we can be that one option is better than a range of other options. Two criteria frequently used in comparing the different options are:

- The **benefit-cost ratio**: the ratio of the present value of all of the streams of benefits over the present value of all of the streams of costs; and
- The **net present value**: the difference between the present value of all of the streams of benefits and the present value of all of the streams of costs.

Projects are only economically viable if the benefits exceed the costs (i.e the ratio of benefits to costs is greater than 1.0). Where benefits marginally exceed costs, there is often high uncertainty as to whether an option is justified, because only a small change or error in either the benefits or costs would tilt



the balance the other way. So when comparing a 'do something' option to the baseline option, confidence is needed that a 'do something' option is clearly preferable.

In this regard, the decision process explores whether the best value for money is provided while achieving the most appropriate standard of risk management defence. This is undertaken by assessing the incremental benefit-cost ratio of each economically viable option. The full mechanics of this decision process can be found in Defra Flood Management's PAG3 appraisal guidance.

The Defra guidance explicitly notes that the decision should be modified as necessary to take account of factors that are not fully counted in the economic analysis. New techniques which incorporate these other factors into the decision making process in a more consistent and transparent way, such as Multi-Criteria Analysis, are being tested and developed (see below).

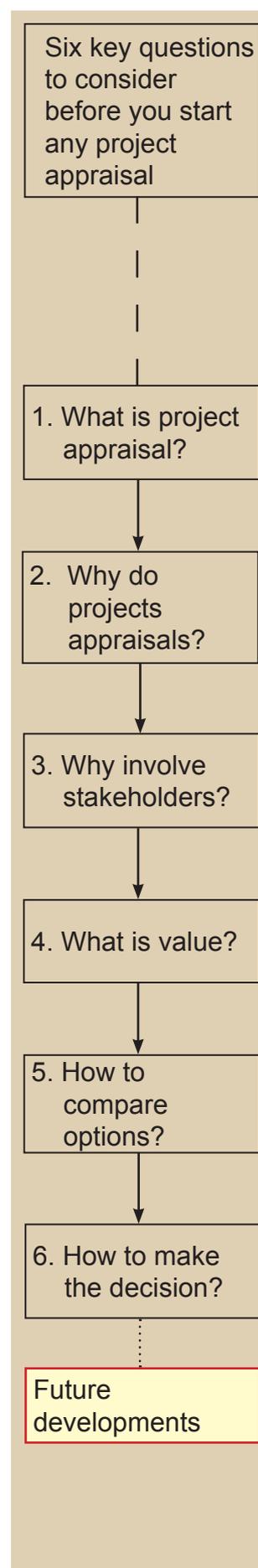
Future developments

The Treasury's Supplementary Guidance Note to their Green Book (HM Treasury, 2005), sets out five principles that Government will apply to managing risks to social, environmental and economic aspects of sustainability:

1. Openness and transparency
2. Involvement
3. Proportionality and consistency
4. Evidence
5. Responsibility

Future guidance on project appraisal and decision making will draw on a number of techniques that will contribute to underpinning these principles, as shown below:

- Improved transparency, openness, proportionality and greater consistency of appraisal policy with the 'Green Book' (HM Treasury, 2003) should emerge through the adoption of Willingness to Pay economic approaches. Amongst other changes, these approaches seek to disaggregate benefits and present how project and programmes impact on different economic interest groups and financial budgets.
- Improved evidence, involvement, responsibility and transparency should emerge through the application of Multi-Criteria Analysis (MCA). MCA aims to establish preferences between options with reference to an explicit set of objectives and associated criteria for assessing the extent to which objectives have been achieved. Two of the key advantages of MCA are that, when appropriately applied, it can allow greater stakeholder involvement and provide greater transparency to the decisions being made at all levels of appraisal.



These areas have been the subject of some research and theoretical development. But more work is required to test their feasibility and practical application before recommendations can be made for wider adoption in flood and coastal erosion risk management applications. Future policy statements and guidance will be produced by Defra and the Environment Agency by the end of 2007.

Remaining Issues

Key definitions:

'Private', 'public', 'collective' and 'individual' goods

- ◆ Those goods that are bought and consumed by individuals such that they are then not available to others are termed **private goods**. The assumption here is that individuals make their own purchasing decisions for their own purposes. This applies to most marketed goods, although some goods can be shared between individuals without being used-up (e.g. newspapers and books).
- ◆ **Public goods**, by contrast, occur when the provision of a good by one individual necessarily means that it is also provided for others without diminishing its value. The assumption here is that there is no way of excluding others from receiving the benefits of the goods provided (e.g. a lighthouse, or a ring flood embankment around a town).
- ◆ There are some goods that any individual, given sufficient resources, can acquire for him/herself and these are termed **individual goods** (e.g. flood proofing a house).
- ◆ **Collective goods**, by contrast, can either only, or only efficiently, be provided collectively (e.g. a public flood warning system).

3 Flood alleviation benefits: theory and practice

In this chapter we provide pointers as to how a flood risk management benefit assessment should be conducted. This draws on the theory that should guide this and the sources of data that will be necessary. These are not presented as step-by-step guidance, as in other chapters, but as matters that need consideration before and during the work. More detail is provided in Chapter 3 of the MCM.

Types of flood damage and flood loss

The benefits of flood alleviation comprise the flood damage averted in the future as a result of schemes to reduce the frequency of flooding or reduce the impact of that flooding on the property and economic activity affected, or a combination of both.

Direct damages result from the physical contact of flood water with damageable property and its contents. Many items of flood damage loss are a function of the nature and extent of the flooding, including its duration, velocity and the contamination of the flood waters by sewage and other contaminants. All these affect damages and losses, and the location of the flood will affect the networks and social activities disrupted, causing indirect losses.

This situation is summarised in Table 3.1. It is important to ensure that for the purposes of benefit-cost analysis we assess only the national economic losses caused by floods and coastal erosion, and their indirect consequences, rather than the financial losses to individuals and organisations which are affected (Table 3.2; see also Chapter 2).

Table 3.1 Direct, indirect, tangible and intangible flood impacts

		Measurement	
		Tangible	Intangible (i.e. difficult to quantify)
Form of loss	Direct	Damage to building and contents	Loss of an archaeological site
	Indirect	Loss of industrial production	Inconvenience of post-flood recovery

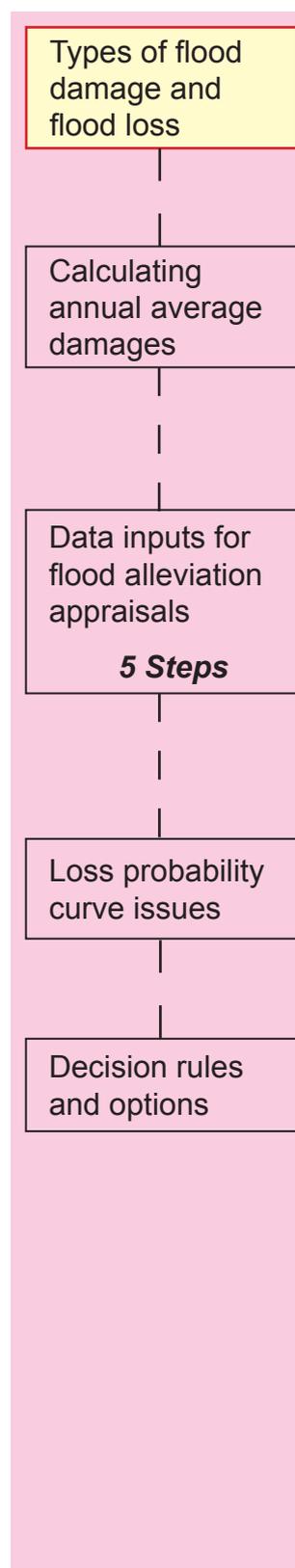


Table 3.2 Financial and economic residential flood damages
Financial
Takes the standpoint of the individual household or organisation involved
Uses the actual money transfer involved to evaluate the loss or gain (e.g. if a household has a new-for-old insurance policy and they claim for a ten year old television, the loss is counted as the market price of a new television)
VAT is included as are other indirect taxes as they affect the individual household or organisation involved
Economic
Takes the standpoint of the nation as a whole – one person's loss can be another person's gain
Corrects the actual money transfer in order to calculate the real opportunity cost (e.g. in the case of the ten year old television, the real loss to the country is a ten year old television; the depreciated value of that ten year old television is taken as the loss)
VAT is excluded, as are other indirect taxes, because they are money transfers within the economy rather than real losses or gains

It is also important to ensure that benefits are not double-counted, such as counting the loss of trade of a factory as well as the consequent loss of business of the factory's retail outlets.

Calculating annual average damages

The methodology for assessing the benefits of flood alleviation combines:

- An assessment of risk, in terms of the probability or likelihood of future floods to be averted, and
- A vulnerability assessment in terms of the damage that would be caused by those floods and therefore the economic saving to be gained by their reduction.

Figure 3.1 provides the classic four-part diagram summarising the inter-relation of hydrology, hydraulics and economics as the basis of calculating the benefits of flood alleviation. The annual average flood damage is the area under the graph of flood losses plotted against exceedance probability (the reciprocal of the return period in years).

Figure 3.2 gives a simplified flow chart of the stages that need to be followed in order to calculate the benefits of flood alleviation (or, put another way, the stages for calculating the present value of flood damages/losses (PVD) that will occur in the future if a "do nothing" option is adopted).

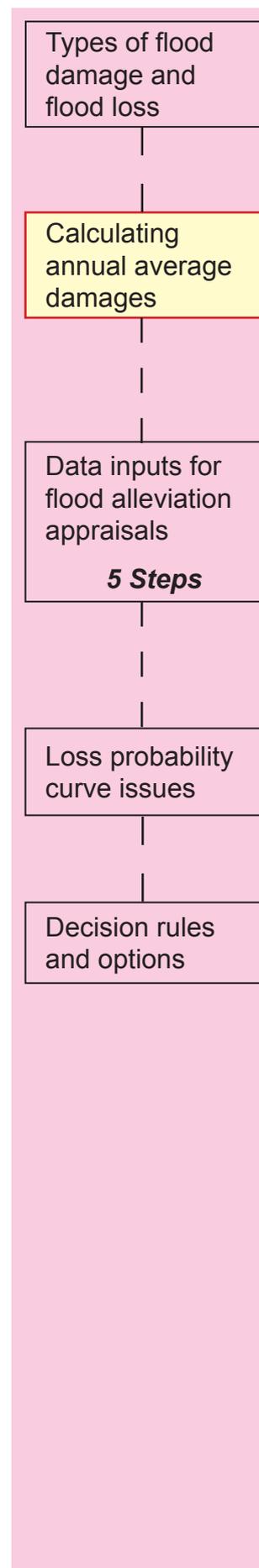


Figure 3.1 The classic 4-part diagram summarising the calculation of annual average flood losses

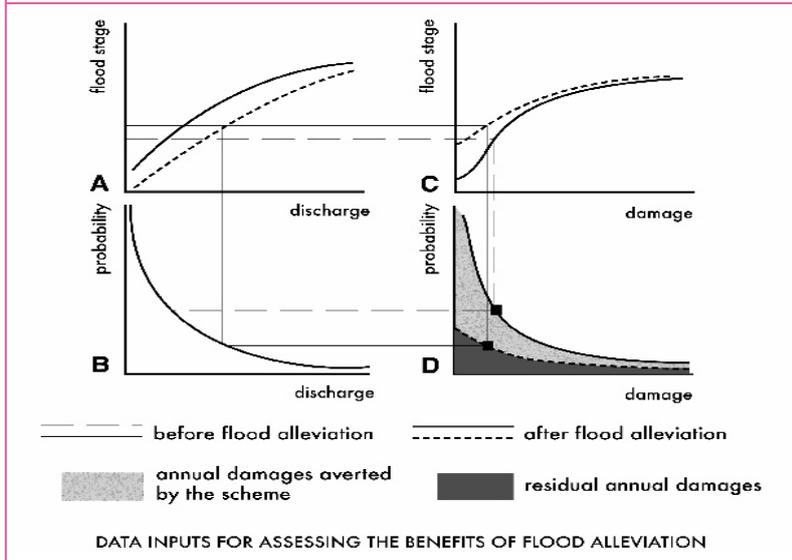
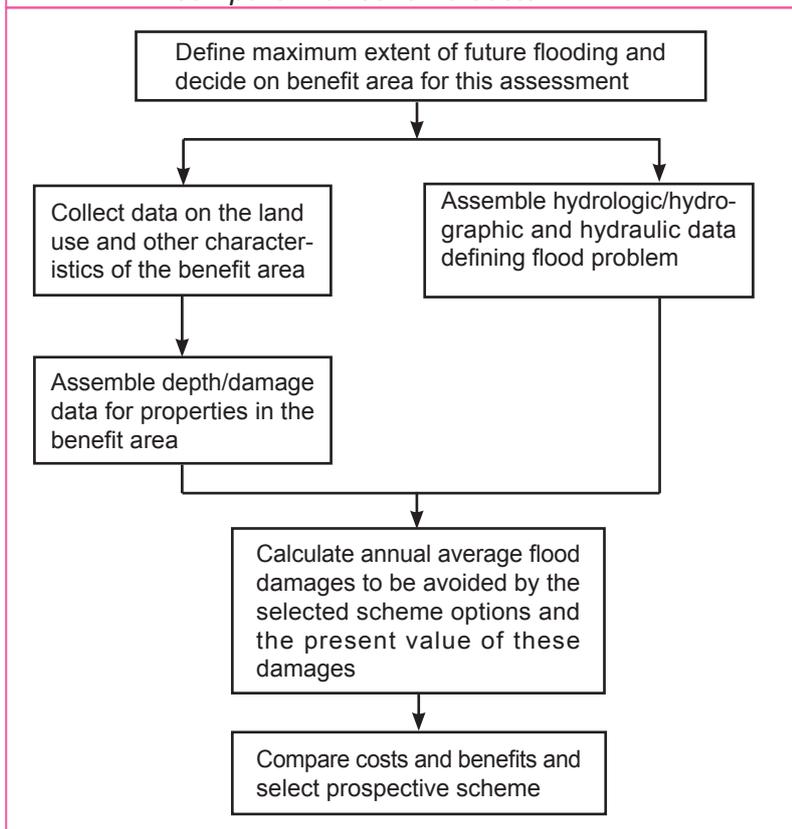
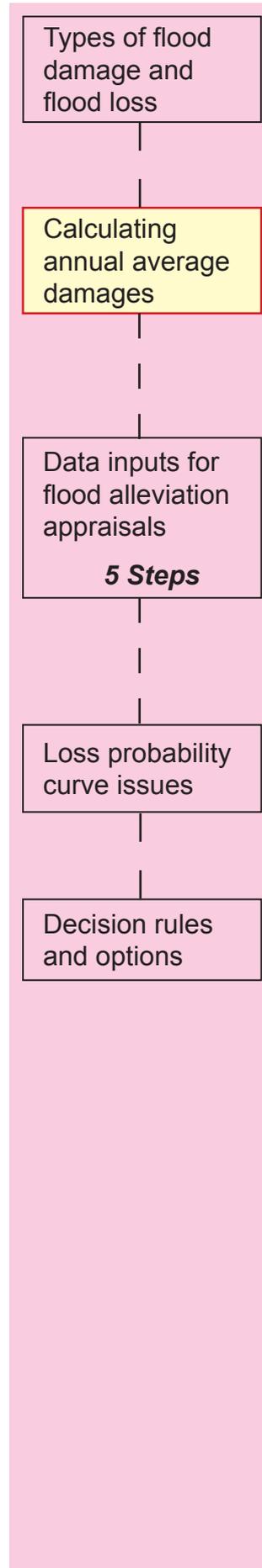


Figure 3.2 The stages that need to be followed in order to calculate the benefits of flood alleviation to compare with scheme costs



Adding emergency costs

Research has shown that flood incidents are accompanied by significant emergency costs:



- Police, fire and ambulance service costs
- Local Authority costs
- Environment Agency costs

These costs have been quantified at 10.7% of property damages (see Chapter 6 and the detailed research in the MCM). In any benefit assessment all property damages should therefore be multiplied by 1.107 to allow for these costs.

Data inputs: *Defining the benefit area*

The benefit area is the starting point for assessing the benefits of flood alleviation; it is the area affected by the flood problem, both directly and indirectly.

Usually the benefit area will be the maximum known extent of flooding in the area or catchment involved. However, it may also be necessary to extend the benefit area beyond the flood plain as conventionally defined by, say, the 1 per cent probability event. This is because the calculation of Above Design Standard benefits generally requires the assessment of the impacts of reducing more extreme flood events beyond any anticipated 'design flood'.

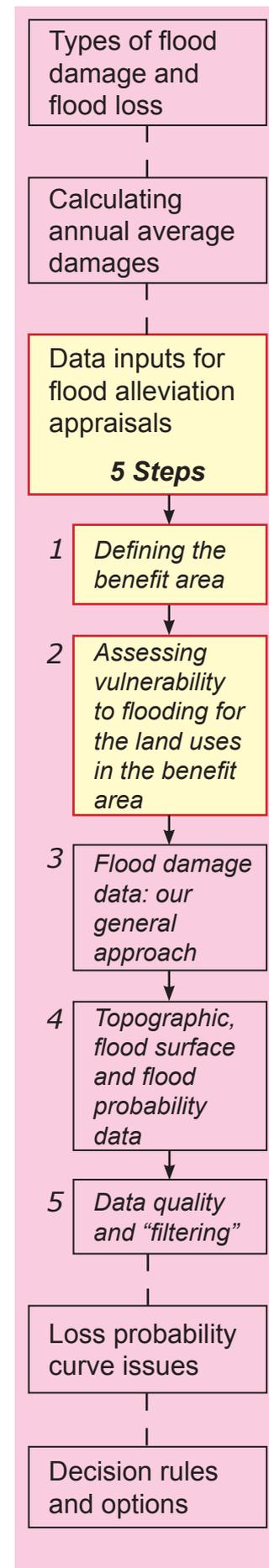
The indirect effects of flooding can also extend well beyond the flood plain. Telecommunications, road and rail traffic disruption can occur many kilometres from the flood plain, as a flood can cause disruption to those communication and economic linkages and that disruption 'spills over' to communication links not themselves flooded.

In coastal situations it will generally be necessary to assess the flood plain as the area subject to flooding if current defences are breached.

Data inputs: *Assessing vulnerability to flooding for the land uses in the benefit area*

The approach to assessing the benefits of flood alleviation is through investigating the potential damage to a variety of land uses in the areas to be affected.

A classification of land use is in the MC CD Appendix 3.1. It is customary within benefit-cost analysis of flood alleviation investment to consider only the land use as currently is existing (except where the future flood regime is likely to make current use untenable and property is assumed to be written off or



subject to change of use, or when agricultural land becomes suitable only for less productive uses).

For a fully comprehensive assessment of benefits it will be necessary to determine:

- The geo-reference of each property (the grid reference);
- The altitude of the threshold of flooding at that property; and
- The area of the property in square metres if the property is non-residential.

Field surveys can identify land uses in the benefit area. Otherwise, the EA's National Property Dataset is the first source of data that should be consulted, but field surveys will also be necessary to determine the type of non-residential property in the area and its size.

Research evidence indicates that the social grouping of occupants of residential properties is a good indicator of damage potential and these differences are reflected in the standard damage tables provided with the MC CD. This data allows the application of equity multipliers in a structured and transparent way to better reflect the impact of investment decisions on different groups within society (see Chapter 4).

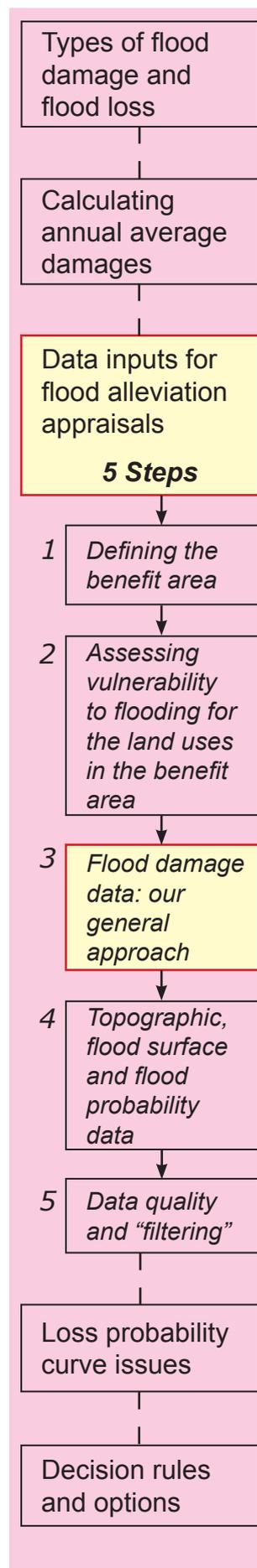
Data inputs:

Flood damage data¹: our general approach

The general approach here to assessing the benefits of protecting properties from flooding encapsulates the following principles:

- We assess the potential damage in the future from a range of severities of flooding, resulting from different depths of flood waters within the property. Only in this way will the shape of the loss-probability curve be accurately determined.
- Much of the flood damage data presented here is “synthetic” (i.e. from a synthesis of many data items). It is therefore not directly derived from an analysis of properties which have been flooded in the recent past, because evidence suggests that post-flood surveys can be very inaccurate.
- The losses to individual properties must represent national economic losses. Therefore, the damage to property components (i.e. inventory items), is based on their assumed pre-flood value – their depreciated value - rather than the

¹ The Dundee flood damage data (Black *et al.* 1999) is a collation of data from insurance companies, inclusive of VAT and not counting flood damages as loss of depreciated values. Values are therefore approximately double those in the MCM dataset and this Dundee data should not be used in economic project appraisals.



cost of their replacement with new items at current market prices.

- Any taxation element within potential flood losses is subtracted, because these are transfer payments within the economy rather than real resource costs. Therefore the VAT element in repair costs is not counted.
- For indirect flood losses, it is necessary to separate financial and economic losses by not including, for example, the loss of income in one particular retail shop if the trade this represents is likely to be deferred in time or transfer to another retail outlet.

Future approaches may seek to identify gains and losses to individuals and different sectors.

Data inputs:

Topographic, flood surface and flood probability data

Experience with many project appraisals has indicated that one of the most important inputs to benefit assessments is the topographic data describing the flood plain and the accuracy of the hydraulic profiles that intersect this surface.

In Britain, many floods are relatively shallow, slow-moving, and represent water accumulating towards the lower end of catchments. In these circumstances, accurate delineation of the area liable to flooding and the precise depth of flood waters on that flood plain are both essential to accurate benefit assessments.

Sources of topographic data (and hence the threshold of flooding for each property in the benefit area) are:

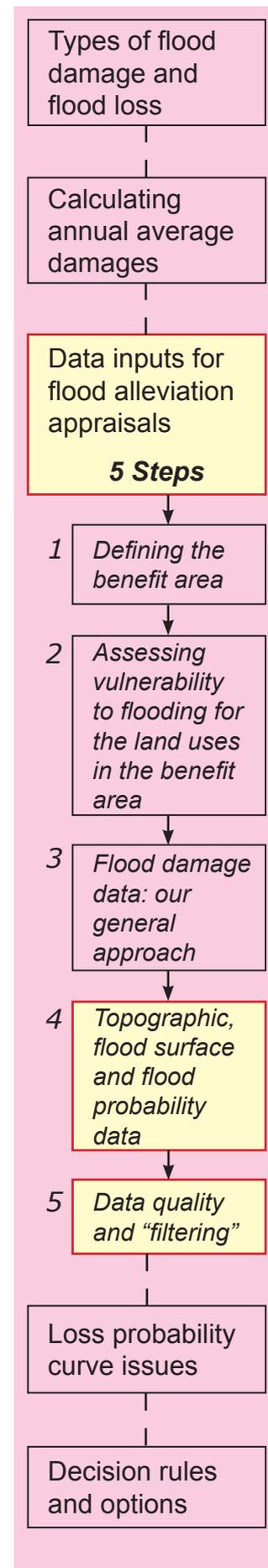
- LIDAR data
- Field levelling data
- Digital terrain model data
- Simpler methods as appropriate (e.g. topographic maps)

The estimation of the probability of flood events contributing to appraisals is also critical, particularly the probability of the threshold of flooding.

Data inputs:

Data quality and “filtering”

Experience indicates that the different data elements have different qualities. Our recommended objective is to improve the quality of the data that makes most contribution to calculated benefits, using a system that is transparent and auditable. The description below is for calculating the benefits of flood risk



management; see MCM Ch. 3 for other situations.

A. Data assembly and DQS scores

Assemble the following for each property in the benefit area. The National Property Dataset (NPD) is a useful source of land use data.

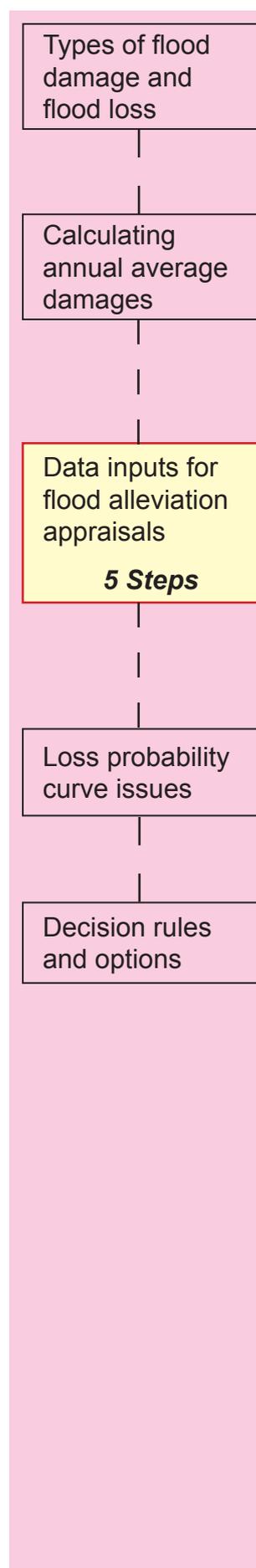
- 1 The land use category
- 2 The floor area (NRPs only: see Ch. 5)
- 3 The threshold height of the property
- 4 The most appropriate level of detail for depth/damage data (from the MC CD)
- 5 The hydrologic/hydraulic profile data (or similar) for each return period analysed

Assign Data Quality Scores (DQS) for each of the five elements of dataset above: "1" = good; "4" = poor (Table 3.3).

Table 3.3 The system of Data Quality Scores (DQS) (MCM Table 3.5)		
DQS	Description	Explanation
1	'Best of Breed'	No better available; unlikely to be improved on in near future
2	Data with known deficiencies	To be replaced as soon as third parties re-issue
3	Gross assumptions	Not invented but deduced by the project team from experience or related literature/data sources
4	Heroic assumptions	No data sources available or yet found; data based on educated guesses

B. Procedure

1. Calculate the Present Value of damages (PVd) for each property and rank all properties by PVd;
2. 'Cap' PVd at each property's market value. Market value data sources include:
 - a) Residential: Land Registry website, etc, for the property's post code;
 - b) Non-residential: from NPD (rateable value) or from www.voa.gov.uk (rateable value); NPD indicates the yield factor to convert rateable value (NRP) to an approximate market or capital value.
3. Consider the scores assigned to each of the five types of data. If the scores are at levels 2 or 3, or (particularly) level 4, and there is evidence to suggest that data can be improved without disproportionate cost, then clearly there is cause for concern with the existing data-set;
4. Attempt to explore the impact of the lower quality of data and whether improvement will affect the final decision.



Appraisers need to question, on a case-by-case basis, whether improving data will affect decision making, using standard sensitivity testing techniques.

Sensitivity tests may demonstrate that improved data quality will not have an effect on the outcome of the appraisal decision. Whether data improvement is achieved or not, the debate raised will be seen in the audit trail, with reviews/actions documented to support any decision on data and its use.

The route to improved data quality will be different for each data item. For example, better quality property area data can come from GIS-based measurement from maps or OS Mastermap, or from field surveys.

Loss probability curve issues

Residual flooding and dis-benefits

Defra's Project Appraisal Guidance (PAG3) decision rules seek the lowest acceptable standard of protection commensurate with maximising the difference between costs and benefits. Schemes therefore may not protect wholly or even significantly against the more major floods.

This leaves residual flooding after the scheme has been implemented, and this damage from residual flooding should not be counted towards the benefits of the scheme.

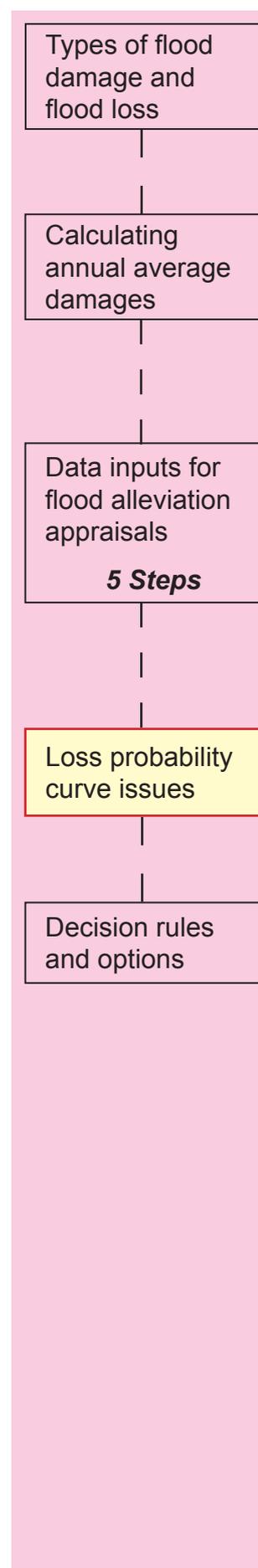
To assess these residual 'dis-benefits' requires the assessment of the impact and damage of the major floods not avoided. Such assessments will often be time-consuming, particularly for the very low probability floods which may cover large areas.

Above Design Standard benefits

Above Design Standard (ADS) benefits accrue where engineered flood alleviation schemes result in water levels changing for the whole range of floods experienced on a flood plain, not just the events with annual probabilities up to and including a 'design event'.

These ADS benefits will be most important where there is significant urban development at the outer edges of the flood plain, only affected by the most substantial floods, and where modest schemes can reduce flood water levels and therefore extents at these locations, even if only marginally.

However only certain types of scheme have this hydraulic effect; for example raised defences do not. The most obvious schemes where ADS benefits accrue are by-pass channels and, in most circumstances, flood storage reservoirs.



These benefits can be large. For example, in the case of the Datchet to Walton Bridge reach of the Thames, appraisal results showed that the ADS benefits could amount to some 31.5 per cent of total benefits.

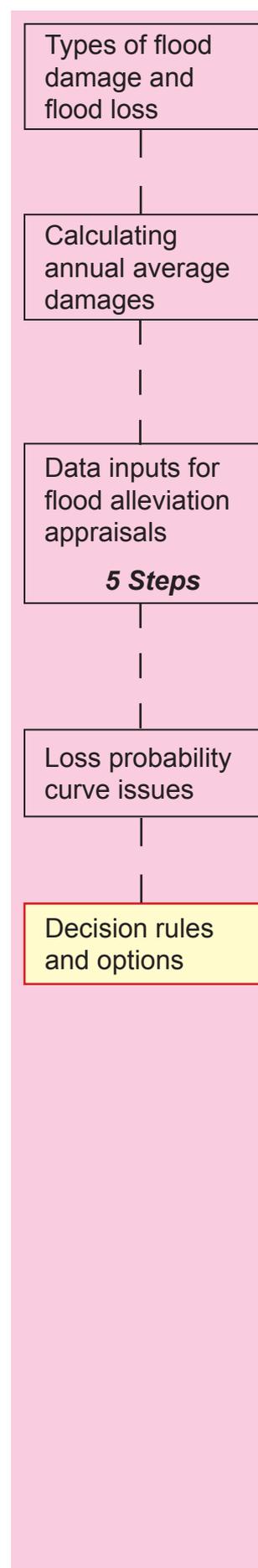
Decision rules and options

Defra appraisal guidance provides a logical decision making approach with regard to the standards of flood protection to be implemented.

This approach requires:

1. First, identifying the scheme with the highest benefit:cost ratio. This may be below, within or above the indicative standard of protection set out in Defra guidance: there should be no presumption that the 'best' standard will necessarily be within the indicative range.
2. Secondly, where the scheme with the highest benefit:cost ratio falls below or within the indicative range, PAG3 has a range of tests for the incremental benefit:cost ratios which allow higher standards to be considered, up to the top of the indicative range. Sufficient analysis will be required to ensure that the highest justifiable standard has been reached.

Flood risk management options should be appraised against these rules, so as to seek the best value for public money. When a mix or 'portfolio' of option elements is being appraised, this can be a complex operation.



Remaining Issues

- ◆ In locations where there is an efficient flood warning system which results in significantly lower damage and loss values (e.g. from the kind of sandbagging operations as reported in Chapter 6), the assessment of flood damages must reflect those lower values. The flood damage data on the accompanying CD represent the maximum potential damage, ignoring the damage-reducing effects of action taken after flood warnings. Data on this can be found in the full MCM.
- ◆ Sufficient potential floods should be appraised so that an accurate picture can be developed of the shape of the loss-probability curve including, where appropriate, such events needed to define and quantify any Above Design Standard benefits. Usually this means that at least 5 floods need to be appraised (e.g. the 5, 10, 25, 75 and 100+ year floods).
- ◆ Appraisers should not assume that the public necessarily wants the standard of flood protection that is identified as being optimal by the benefit-cost analyses that are undertaken.

4 Flood damage to residential properties and related social impacts

Residential flood damage is significant in almost all cases of serious flooding in the UK, and remains an area of public and government concern. This damage includes both direct damages and indirect losses, measured as the tangible and intangible impacts of flooding on residential properties and householders.

This chapter addresses the appraisal of the direct damages and tangible impacts of flood waters on household inventory and building fabric items. In addition, information is provided for incorporating new government guidance on the appraisal of the indirect and intangible impacts of flooding.

The assessment of direct residential property flood damage potential should utilise the standard data (on the MC CD). The most detailed standard data provided is for:

- Five house types;
- Seven building ages; and
- Four different social classes of the dwellings' occupants.

Underlying assumptions

The residential potential flood damage data for household inventory and building fabric items is based on economic values not financial values (Table 3.2). The difference between the Dundee University and the Middlesex University flood damage information is due to the former being financial data and the latter being economic data. In compiling the standard flood damage data (on the MC CD), the total inventory damage is dependent on the average remaining values (ARV - to depreciate prices), the house type, social class and the ownership of household items for each social class (Table 4.1; Table 4.2). This data can be used at several scales, including pre-feasibility and full feasibility studies (Table 4.3).

The 'intangible' effects of flooding

The 'intangible' effects of flooding are now recognised to be significant. Recently, Defra and the EA have funded research to establish an economic valuation of the intangible health impacts of flooding. This research confirmed the significance of the health impacts of flooding and led to the publication of interim guidance (Defra, 2004).

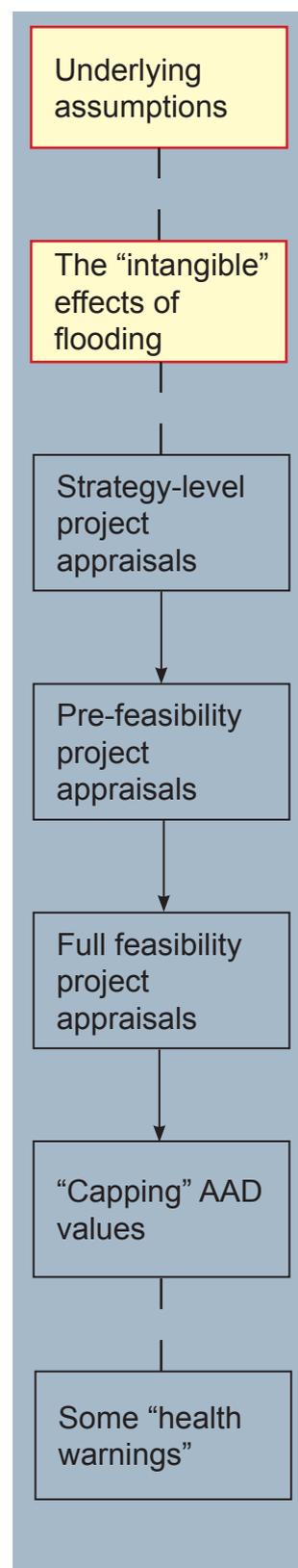


Table 4.1 The range of possible flood impacts on households

Direct tangible losses for flooded households	Intangible losses for flooded households	Indirect losses for flooded households (summary)	Indirect losses for non-flooded households
<ul style="list-style-type: none"> ▪ Damage to building fabric ▪ Damage to household inventory items ▪ Clean-up costs 	<ul style="list-style-type: none"> ▪ Worry about future flooding ▪ Loss of memorabilia and irreplaceable items and pets ▪ Damage to physical and/or mental health, death or injury ▪ Loss of community ▪ Loss of confidence in authorities and services 	<ul style="list-style-type: none"> ▪ Permanent evacuation ▪ Evacuation costs ▪ Disruption due to flood warnings or alarms ▪ Loss of utility services ▪ Loss of income ▪ Loss of leisure and recreational opportunities ▪ Additional communication costs ▪ Increased travel costs 	<ul style="list-style-type: none"> ▪ Increased travel costs ▪ Loss of income/ earnings ▪ Loss of utility services ▪ Loss of other services ▪ Loss of leisure and recreational opportunities ▪ Increased cost of shopping and recreational opportunities

Table 4.2 Social class categorisation by occupation (*MCM Table 4.8*)

Social Class AB	Upper middle and middle class: higher and intermediate managerial, administrative or professional
Social Class C1	Lower middle class: supervisory or clerical and junior managerial, administrative or professional
Social Class C2	Skilled working class: skilled manual workers
Social Class DE	Working class and those at the lowest level of subsistence: semi-skilled and unskilled manual workers. Unemployed and those with no other earnings (e.g. state pensioners)

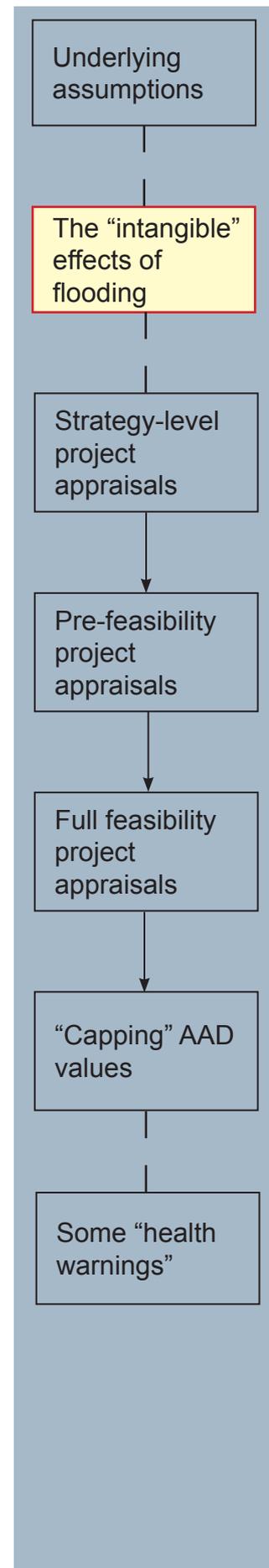
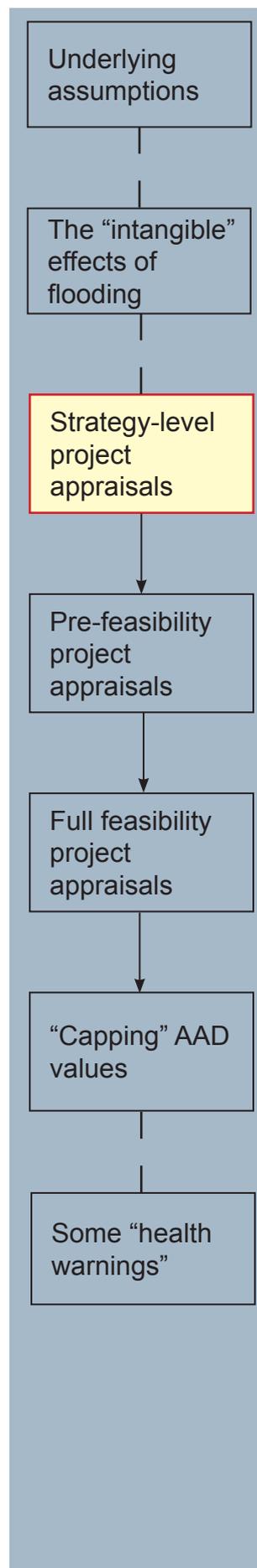


Table 4.3 Strategic, pre-feasibility and full feasibility methods (MCM Table 4.16)

Scale of analysis	Strategy	Pre-feasibility	Feasibility
Guidance	For rapid MDSF ¹ and similar desktop type appraisals: first approximations to identify areas where more detailed work is required	For more detailed appraisals where further assessment of household loss potential is warranted	For the detailed study of potential benefits using the most detailed of the standard data sets
Data requirements for the benefit area	<ul style="list-style-type: none"> Number of properties at risk 	<ul style="list-style-type: none"> Number, type and age of houses at risk Standard of protection (pre and post scheme) for intangible values 	<ul style="list-style-type: none"> Number, type, age and social class of houses and householders at risk Standard of protection (pre and post scheme) for intangible values Government Weighting Factors for distributional Impact analysis
Direct/tangible method of assessment	<ul style="list-style-type: none"> Annual average direct damages: sector average 	<ul style="list-style-type: none"> Generalised standard residential depth/damage data for type and age of houses 	<ul style="list-style-type: none"> Detailed standard data for type, age and social class of houses and householders Vulnerability analysis where feasible
Indirect/intangible method of assessment	<ul style="list-style-type: none"> Surrogate values for average indirect losses Health: £200 per property per year for intangibles 	<ul style="list-style-type: none"> Surrogate values for indirect losses and Vulnerability analysis where feasible Health: £200 per property per year for intangibles 	<ul style="list-style-type: none"> Surrogate values for indirect losses and Vulnerability analysis Health: £200 per property per year for intangibles



Strategy-level project appraisals

Where only the number of properties in the benefit area is known, approximate flood alleviation benefits can be derived by making some assumptions about the depth of flooding expected from floods with different return periods. Then use weighted Annual Average Damage (AAD) figures as initial estimates of potential direct damages (Table 4.4).

¹ Modelling and Decision Support Framework

Table 4.4 Weighted Annual Average Damages (AAD) assuming variable threshold Standards of Protection (SoP) and different flood warning lead times (*MCM Table 4.17*)

Existing SoP	No warning (£)	< 8 hour warning (£)	> 8 hour warning (£)
No protection	6027	5511	4901
2 years	6027	5511	4901
5 years	3254	2975	2646
10 years	1606	1469	1306
25 years	719	657	585
50 years	303	277	246
100 years	76	69	62
200 years	38	35	31

With a basic understanding of the depths of flooding, appraisers can use the data provided in Appendix 4.1 (on the MC CD). However, during a strategy-level study, only the sector average figures should be used.

To employ both these methods, the appraiser needs to determine the size of the benefit area, the number of properties at risk there and, where available, the depth of potential flooding:

- The size of the benefit area is determined by the flood problem being appraised.
- The number of properties can be obtained from the National Property Dataset, from the Environment Agency.
- The depth of flooding is determined from the ground level data and the results of hydraulic modeling or, more likely at this stage, from field-based assessments or historical records.

Weighted Annual Average Damages (AADs)

Where the appraiser has little or no understanding of the potential flood depths and return periods, use the weighted annual average damage (AAD) approach, broken down by warning lead time and the standard of protection (Table 4.4).

The annual average damage to the average house with no flood warning and no flood protection is £6,027. Table 4.4 gives the reduced values provided by different standards of protection and different levels of flood warning (to which householders are assumed to respond effectively).

However, where this value is used in pre-feasibility studies, as the weighted AAD per residential property within a defined benefit area (say, 1 in 200 year flood plain), the number of properties affected by successively more frequent return period floods should be reduced as in Table 4.5:

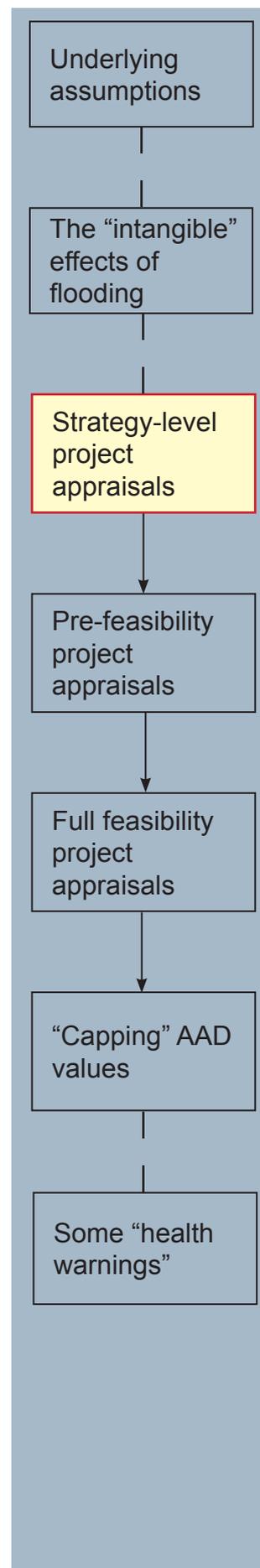


Table 4.5 Estimates of the number of properties affected by different floods

Return period	No. of properties as % of 200 year No.
100	93
50	80
25	25
10	10
5	5

Sector average damages

To provide a more refined estimate of direct damages, the depth of flooding across a range of flood events must be known. The absolute minimum number of flood events that can be considered is three:

- The threshold flood event (the most extreme flood event which does not cause any losses)
- An event larger than the possible design standard of protection
- An intermediate flood

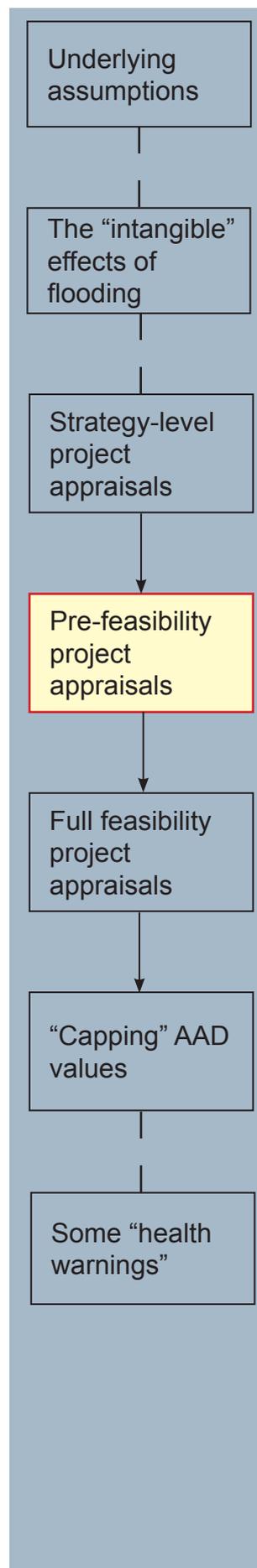
Pre-feasibility project appraisals

These appraisals require information on flood depths for each flood event being considered, and a more detailed understanding of the properties in the benefit area. In particular, the appraiser will need to know the following:

- The depth of flooding for a range of flood events
- The type and age of houses in the benefit area, obtained from a more detailed field survey (rather than obtaining the data solely from OS MasterMap and the National Property Dataset)

With this information, the appraiser can then evaluate potential direct damages using the generalised standard residential depth/damage data in MC CD Appendix 4.1.

However, unlike a strategy study, a more detailed analysis of intangible benefits is required at a pre-feasibility scale of analysis. Rather than simply applying the weighted average figure of £200 per property per year, the intangible benefits need to be determined using Defra’s risk reduction matrix (Defra, 2004). In addition, it is also recommended that a more detailed vulnerability analysis is conducted (see below).



Generalised standard residential depth/damage data

Identifying the variables used to classify dwellings should be a routine procedure in the field. Firstly, identifying the type of dwelling can be done from OS MasterMap and from direct observation. By contrast, secondly, assessing the age of any dwelling may involve a small degree of subjectivity unless planning departments can provide mapped information.

Intangible benefits and level of risk

Government guidance now requires appraisers to consider how the level of exposure to household flood risk varies with and without the proposed scheme. This requires the appraiser to determine the level of risk, such that:

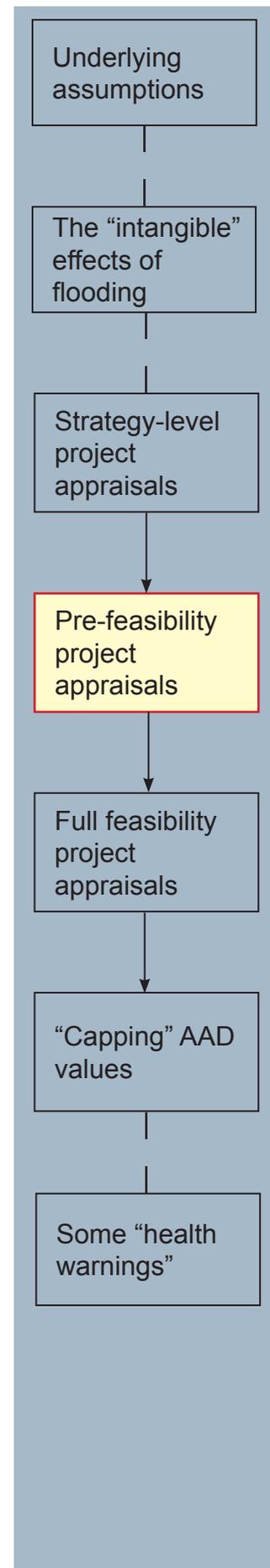
- For areas of uniform risk (such as housing on level ground behind a flood defence), damages are based on common standards of defence of an area
- For areas of greatly varying risk (sloping ground away from a river), damages are based on individual levels of property flood risk

Vulnerability analysis

A vulnerability analysis for households comprises a method indicating the likely impact of floods of different severities on the households affected. Users are recommended to consider the variables used in the calculation of the FHRC Social Flood Vulnerability Index (SFVI). In addition, users are recommended to assess the following:

- The number of residents in the flood prone area (disaggregated by flood frequency if possible)
- The approximate proportions of households in each social class (from Small Area Census data)
- The proportion of residences which are bungalows, basement flats or ground floor flats (often occupied by the elderly and infirm)
- Predicted flood depths (depths of over 0.6m can be life threatening)
- Flood warning lead times
- Other flood characteristics including the location of residences close to defences which may be over-topped or breached

In undertaking a vulnerability analysis, it is sensible to concentrate on estimating the number of households who will suffer the most severe conditions and who are the most vulnerable. The variables in the SFVI, as well as those above, offer this potential.



Full feasibility project appraisals

In full scale appraisals, it is appropriate to differentiate houses in the benefit area by their type, age and the social class of the occupants (Table 4.3). This means that the most detailed direct damage data provided on the MC CD can be used. In order to reflect socio-economic equity considerations this data should, where it is deemed to be 'necessary' and 'practical' (HM Treasury, 2003), be subjected to a distributional impact analysis. Data required for this analysis includes flood history, depth and duration, small area census data and general information on householders' views on the risk they face.

Detailed standard residential depth/damage data

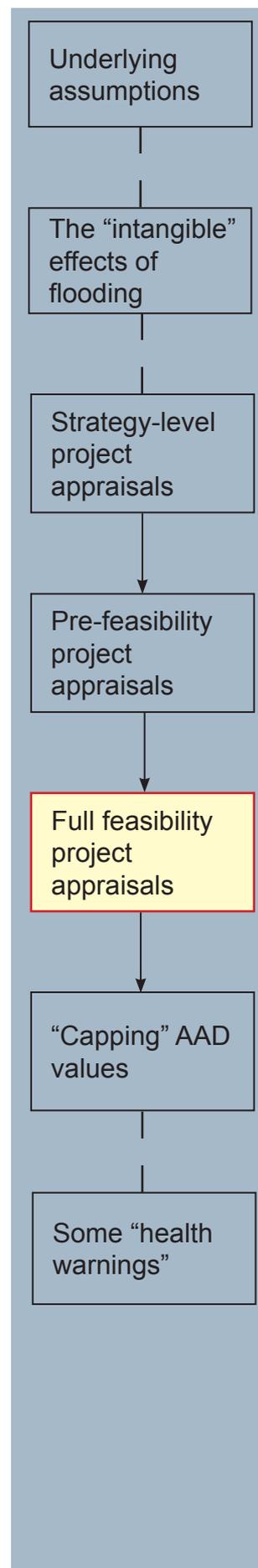
To make full use of the detailed standard residential depth/damage data sets on the MC CD, the social class of the occupants of the houses in the benefit area should be established. Because the social class variable derived from census data relates to the census output area (OA) as a whole, and not to the individual dwelling's occupants, the social class of individual occupants is calculated on the basis of averages. For example, if 60 per cent of the dwellings in the OA fall into the C2 category and 40 per cent fall into the DE category, the depth/damage data should be weighted accordingly.

Distributional impact analysis

The Treasury Green Book (HM Treasury, 2003) recommends that, where it is 'necessary' or 'practical', potential benefits should account for distributional impacts to incorporate social equity considerations into flood and coastal defence appraisals. Determining if it is 'necessary' or 'practical' then depends on a number of circumstances, including:

- The likely robustness of any calculation of distributional impacts. Whether a community at flood risk can be identified with reliable data and categorised according to their prosperity or social class;
- The type of project being assessed. Whether the assessment will contribute to an appraisal that demonstrates equity and fairness to people;
- The scale of the impact associated with a particular project or proposal. Whether the time and effort in undertaking the assessment is proportional to the scale of the overall appraisal, either at a strategic or feasibility level.

If a distributional analysis is not required, the standard depth/damage curves for the property type and age should be used, without accounting for social class (on the MC CD). If a distributional analysis is required, total weighted factors should be applied by social class group (Table 4.6). However, the total



weighted factors for C1 and C2 will generally have a negligible effect. Therefore, use of total weighted factors is only recommended where AB or DE social class groups are predominant. Total weighted factors may then be applied to adjust the standard depth/damage data to obtain potential damages avoided taking account of distributional impacts.

Total Weighted Factors by Social Class			
AB	C1	C2	DE
0.74	1.12	1.22	1.64

A number of points are important in this government guidance:

- Both weighted and non-weighted results should be presented.
- Where property 'write offs' are considered, average values should be based on average 'no risk' values of properties of similar type and region.
- At present, the use of Distributional Impacts should be considered separately from the Priority Scoring System.
- In areas with a high proportion of rented accommodation the social class of the owner of the property should be taken into account for building damages and that of the occupier applied to content damages.

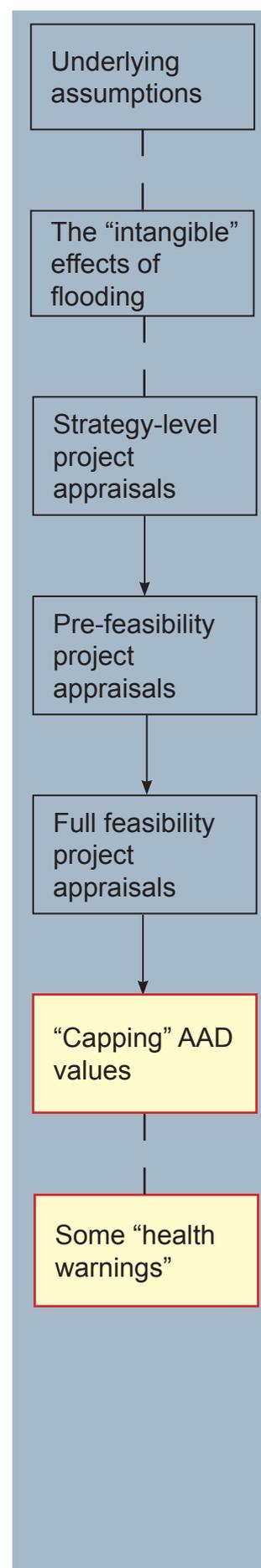
“Capping” AAD values

The capital sum worth investing to reduce the risk of flooding to any residential property should be “capped” at its market value. This is ideally done for all levels of project appraisal but certainly at the most detailed level.

The benefit calculation results should therefore be scanned for such cases, and their values reduced accordingly. The market values used should be averages for each property type for the region involved, obtainable from the Land Registry (www.landreg.gov.uk).

Some “health warnings”

- Damage estimates: Professional opinion varies on the precise effect of flood water on inventory items. Susceptibility must be continually up-dated as more information becomes available
- Inventory and building fabric data: Standard check-lists have been devised which are not exhaustive
- Average Remaining Values are not empirically assessed. Items are generally assumed to be approximately half way



through their lives which may distort the potential damage estimates in some newly established households

- Applying nationally based data to small areas locally may lead to errors
- The figures given on the MC CD do not include damage from saltwater. Where saltwater damage is expected, flood damage repair costs to building fabric are estimated to increase by 10% .

Remaining Issues

- ◆ Flood damage to mobile homes and caravans is not included here (but is covered in the MCM).
- ◆ Flood damage to historic properties (e.g. listed buildings) is not covered here and damage values there may be much higher than in other properties, and renovation work and costs will be affected by constraints imposed by Listed Building Consent considerations, etc.

5 Flood damage to non-residential properties

Flood damage to non-residential properties can be a significant factor when considering major expenditure on engineering works. This chapter contains methods and data for assessing direct flood loss potential for non-residential properties (NRPs) and guidance on indirect losses. The data results from new research on damage to properties in this sector. Depth/damage data is therefore now available for about 90% of all the country's land use represented within the key MCM sub-categories. The data has been broken down by the five components of damage: building structure and fabric, services, fixtures and fittings, moveable equipment, and stock/raw materials. Information on susceptibility to damage is also included (see MC CD).

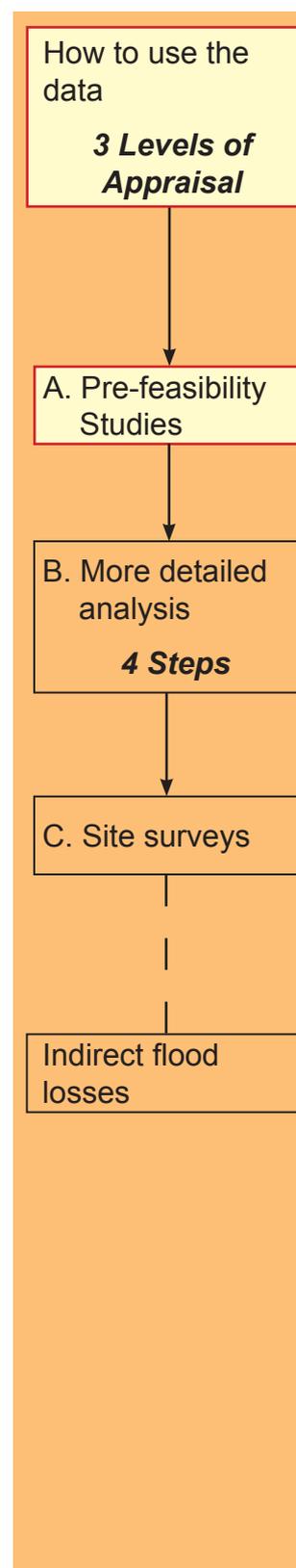
How to use the data

When carrying out a flood damage assessment, a decision needs to be taken on which level of data is necessary. Guidelines are given here for three types of study: pre-feasibility; project appraisal and strategy reports; and individual property site surveys. The potential damage data needs to be related to flood probability to calculate annual average damages and hence benefits (see Chapter 3).

A. Pre-feasibility Studies

Data requirements for NRPs with this method are as follows:

1. The number of properties in each of the four NRP 'Bulk classes':
 - Retail
 - Warehouse
 - Office
 - Factory
 - And, if applicable, Non-Bulk (i.e. all other NRPs not in the four classes above).
2. All depth/damage data for NRPs is per m², therefore the area of the ground floor space is required. This is easily obtained from ODPM's "Commercial and Industrial Floor Space and Rateable Value Statistics, 2004" by Bulk Class for the local authority in which the benefit area falls – www.odpm.gov.uk.
3. The current standard of flood protection provided for the benefit area.



4. The weighted annual average damages (WAAD) are then taken from **Table 5.1** for each Bulk Class and multiplied by the appropriate ground floor area. The weighting refers to the damage associated with each flood return period weighted by statistical distribution of flood depths within properties for those return periods.

Table 5.1 Weighted annual average damage by standard of protection (MCM Table 5.11)

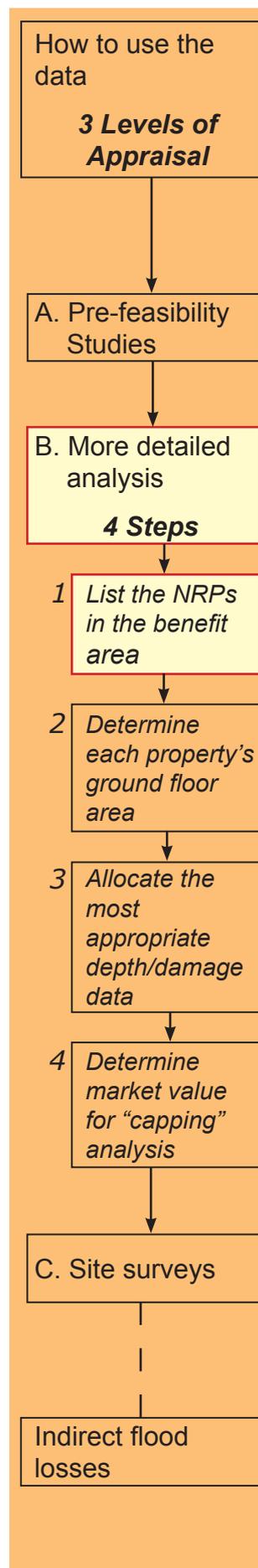
Standard of Protection (years)	Factory Bulk Class (£/m2)	Retail Bulk Class (£/m2)	Warehouse Bulk Class (£/m2)	Office/other Bulk Class (£/m2)
None	38.41	60.80	42.95	48.33
2	33.87	54.11	38.39	43.00
3	29.32	47.43	33.83	37.67
4	23.26	38.51	27.74	30.66
5	20.23	34.05	24.70	27.00
6	18.41	30.87	22.43	24.47
7	16.59	27.70	20.16	21.94
8	14.78	24.52	17.88	19.41
9	12.96	21.35	15.61	16.88
10	11.14	18.17	13.34	14.35
15	9.30	15.07	11.10	11.89
20	7.47	11.97	8.86	9.43
25	5.63	8.87	6.62	6.97
30	5.02	7.90	5.90	6.20
35	4.40	6.92	5.17	5.43
40	3.79	5.95	4.45	4.67
45	3.17	4.97	3.72	3.90
50	2.56	4.00	3.00	3.13
55	2.37	3.70	2.78	2.90
60	2.18	3.40	2.55	2.66
65	1.98	3.10	2.33	2.43
70	1.79	2.80	2.10	2.19
75	1.60	2.50	1.88	1.96
80	1.41	2.20	1.65	1.72
85	1.22	1.90	1.43	1.49
90	1.02	1.60	1.20	1.25
95	0.83	1.30	0.97	1.02
100	0.64	1.00	0.75	0.78
200	0.32	0.50	0.38	0.39

B. More detailed analysis
(e.g. project appraisal, strategy reports)

Note that a Data Quality Score (DQS) 1-4 must be allocated for floor area, the depth/damage data assigned, the land use of each NRP, as well as for the property threshold; see Chapter 3 for explanation.

Step 1: List the NRPs in the benefit area

- Determine the number and type of NRPs in the benefit area



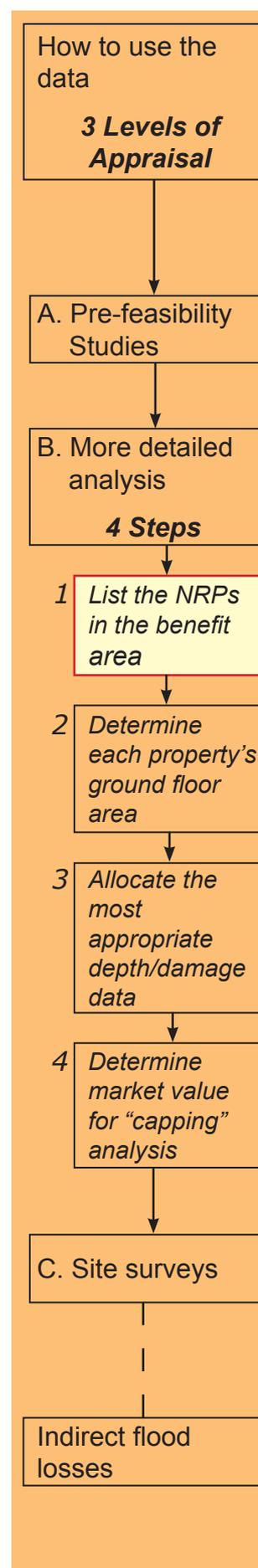
either from secondary source datasets such as the National Property Dataset (NPD), or from a field survey.

- If secondary source data sets are used then field checks are necessary to authenticate data quality.
- Allocate each NRP an MCM code from Table 5.2 (if the NPD is used this forms part of the dataset). If there is no equivalent MCM code in Table see NPD report or Appendix 5.5 to allocate MCM codes to the appropriate Bulk Class.
- Allocate the Data Quality Score 1-4.

Table 5.2 Mean floor area (m²) by sub-category of Non Residential Property for which the MC CD has flood damage data - September 2004 (MCM Table 5.12)

Bulk Class	Focus Code	MCM Code	Description	Mean (m ²)
Retail	CG3	223	Car showroom	1256
	CL1	234	Wine bar	177
	CL2	234	Club (social)	501
	CR	235	Restaurant	193
	CR1	236	Café	96
	CR2	236	Food Court	240
	CS	211	Shop	145
	CS1	320	Bank	297
	CS10	232	Betting shop	88
	CS2	231	Hairdressing salon	54
	CS3	216	Kiosk	16
	CS4	233	Laundrette	76
	CS5	237	Post Office	146
	CS6	215	Showroom	456
	CS7	213	Hypermarket	9948
	CS8	213	Superstore	5260
	CS9	214	Retail warehouse	1860
	Warehouse	LT1	524	Amusement arcade
CG4		430	Road haulage	2369
CW		410	Warehouse	1222
CW1		420	Storage land	1628
CW2		410	Storage depot	1319
Office	CW3	410	Store	170
	CO	310	Office	293
	ML	310	Office (Local Government)	1348
	MP	651	Police station	854
	CO1	311	Hi tech (computer centre)	3500
	MH	620	Surgery	151
	MH1	620	Health centre	368
Factory	CG1	221	Vehicle repair	301
	CG2	221	Garage	268
	IF	820	Factory	2867
	IF1	820	Mill	5973
	IF2	820	Works	4732
	IF3	810	Workshop	312
	IF4	310	Business unit	111
	MS1	650	Fire station	330
	MS2	650	Ambulance station	405

Source: Valuation Office Agency, from amalgamation of ODPM Bulk Class statistics



Step 2: Determine each property's ground floor area (the building only, not carparks, etc)

Depth/damage data for NRPs is produced per square metre of floor area. Therefore, determine ground floor area using one of the following sources of varying data quality. Selection will depend on available budget and timescale.

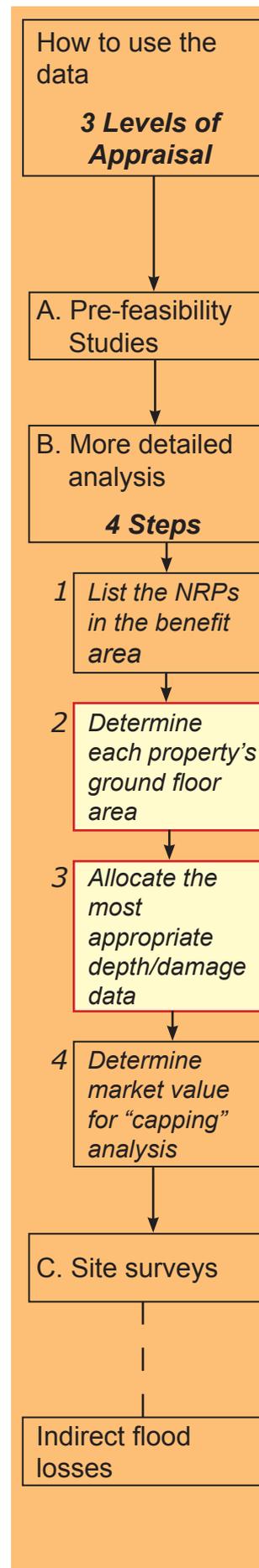
- Determine areas by field measurement (DQS 1)
- Use GIS tools to measure the areas from OS 'Mastermap' or equivalent (DQS 1).
- Use www.royalmail.com to determine property postcode, then use www.voa.gov.uk to determine the 2005 valuation which also gives the total ground floor area of each property (DQS 1).
- Derive the area from statistics within the ODPM's "Commercial and Industrial Floor Space and Rateable Value Statistics, 2004", available by Bulk Class for each local authority (DQS 3) or from Table 5.3 (DQS 4). See Appendix 5.5 on the CD to allocate MCM codes to the appropriate Bulk Class.
- Allocate for each property its MCM code from Table 5.2 (DQS 3). See MCM Appendix 5.5 to allocate MCM codes to the appropriate Bulk Class.

Table 5.3 Mean floor area for Bulk Classes (ODPM, 2004) (MCM Table 5.13)

Bulk Class	Mean floor area (m ²)
Retail	198
Warehouse	755
Office	307
Factory	865
All bulk	442

Step 3: Allocate the most appropriate depth/damage data

- Appendix 5.5 on the MC CD gives the preferred depth/damage data for each NRP MCM code.
- Allocate the appropriate Data Quality Score.
- After 'filtering' to rank each property in the benefit area by the present value of damages (see Chapter 3), if any single property constitutes 10% or more of the total for an assessment, then the depth/damage data should be reviewed with the DQS improved for all four DQS based criteria.
- If after the filtering process an NRP still retains 10% of the assessment benefits then a site survey should be undertaken to confirm potential damages (see below).
- Multiply the depth/damage data values for each property by the floor area from Step 2.



Step 4: Determine market value for ‘capping’ analysis (see Chapter 3)

As government guidance requires the expected value of damage not to exceed the property’s market value, rateable value will need to be determined from one of three sources, with varying data quality. Selection, as for Step 2, will depend on budget and timescale.

- Use www.royalmail.com to determine property post code, then use www.voa.gov.uk to determine 2005 valuation which gives the rateable valuation for the property concerned (DQS 1). Knowing the Bulk Class yield will allow conversion to a suitable market value (see the EA’s National Property Dataset Manual).
- Attached as a field-based ‘valuation’ for each record in NPD (DQS 2).
- Derived from statistics within the ODPM’s “Commercial and Industrial Floor Space and Rateable Value Statistics, 2004” available for each local authority. See Appendix 5.5 to allocate MCM codes to appropriate Bulk Class (DQS 3).

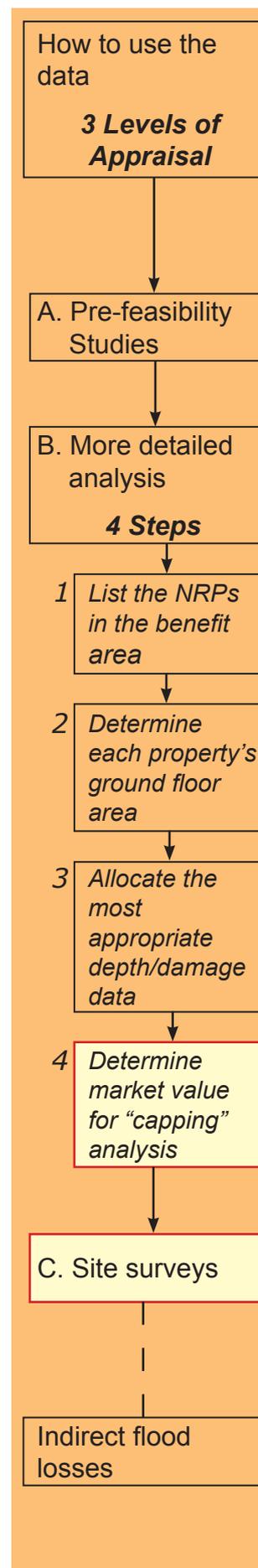
C. Site surveys

The variety of NRPs is considerable, and average/standard depth/damage data given here may not be appropriate, in which case a site survey of the property is probably needed. But these are time-consuming, and site surveys should usually be reserved for large properties with high flood frequencies. For a site survey, the following is a guide as to whom to approach within the organisation concerned to help complete the questionnaire, which is available on the MC CD as Appendix 5.6:

- Small firms – the owner
- Medium firms – plant/company manager
- Large complex firms – risk manager, managing or financial director, accountant, insurance claims officer, estates, facilities or property manager.

A simplified approach will focus on the following questions (all excluding VAT):

1. What is the cost of re-build (the building structure and fabric). Note that this is for the unit not the total footprint.
2. What is the value of services installed?
3. What is the value of moveable equipment?
4. What is the value of fixtures and fittings?
5. What is the value of stock, raw materials and work in progress?
6. Are losses to overseas competitors likely to be significant (see below)? If so, what are they likely to be?



Realistic rounded estimates of damage and loss potential are required (e.g. to the nearest £1,000 for smaller firms, or the nearest £10,000 for larger organisations, where indicative values of moveable equipment and stock etc. can run into £millions).

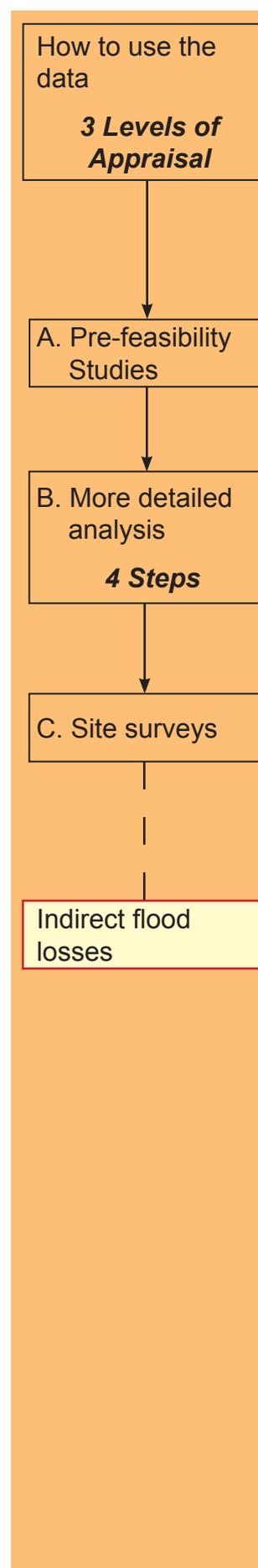
The values for each component are converted to values per square metre of the building(s) in question and entered into the appropriate worksheet, for example, 211 High Street Shop.xls, on the MC CD for the MCM code of the property in question. The susceptibility to damage for each component is assumed unchanged from the previous research and new depth/damage data is automatically generated based on the revised component values derived from the site survey. In short, the valuation of component damages is revised with respect to the specific property and applied to existing susceptibility curves.

Indirect flood losses

Obtaining accurate data on indirect losses is problematic (see MCM, Chapter 5). Where these losses are relevant, they are often difficult to estimate. Issues of confidentiality and security are also of concern to businesses, which may refuse to release any economic or financial data.

As a result of these factors, calculating indirect damage is not recommended in this Handbook for non-residential properties unless a property is likely to contribute significantly to the overall present value of damages (PVd), e.g. over 10%.

These indirect losses are only likely to be significant if production within factories is highly specialised and not transferable within the UK, if other consumers of the finished product in the UK must seek alternatives overseas, or if overseas consumers must seek alternatives away from the UK. See Site Survey questionnaire on the MC CD (Appendix 5.6).



Remaining issues

Certain 'health warnings' remain, for example:

- ◆ The relatively small database (in relation to that for residential property) on which the depth/damage curves are based needs to be extended in the future, and examples are needed for certain sub-categories where data is not yet available.
- ◆ If there are serious doubts about the appropriateness of the available standard depth/damage data then a site survey is required.
- ◆ Data is available on longer duration and coastal flooding, and on the reduction in losses following receipt of a flood warning, including that statistically inferred from the mean values of all these datasets, but this data and should be used with caution (see MCM, Chapter 5).
- ◆ Depreciated values (ARVs) on fixtures and fittings and moveable equipment have not been empirically assessed, but assume that all these items are on average half way through their life span.
- ◆ No consideration is given here or in the MCM to intangible flood losses associated with NRPs.
- ◆ There may be instances (for example multi-storey offices) where there is no direct damage but some indirect losses (see MCM, Chapter 5)
- ◆ Very little MCM data is available on many categories of public buildings (e.g. schools; prisons) but these rarely feature as very significant in project appraisals. Where this might be the case, a site survey would be necessary.

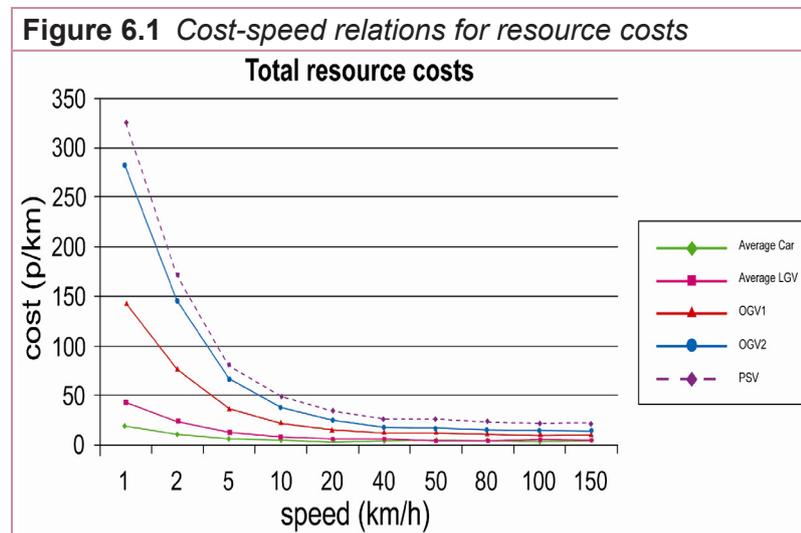
6 Other flood losses: road disruption and emergency costs¹

This chapter presents information on indirect flood losses caused as a consequence of floods disrupting communications and imposing extra costs on those managing the flood incident and in the recovery phases. It is always necessary to ensure that these losses represent economic losses to the nation as a whole, rather than financial losses to the organisations and authorities involved.

6.1 Road traffic disruption

The benefits of flood alleviation include reducing the disruption of road traffic that occurs when roads are inundated. The losses from disruption are the additional costs to each vehicle using the road network incurred by taking longer and/or travelling further to make the desired journey. Those additional costs are:

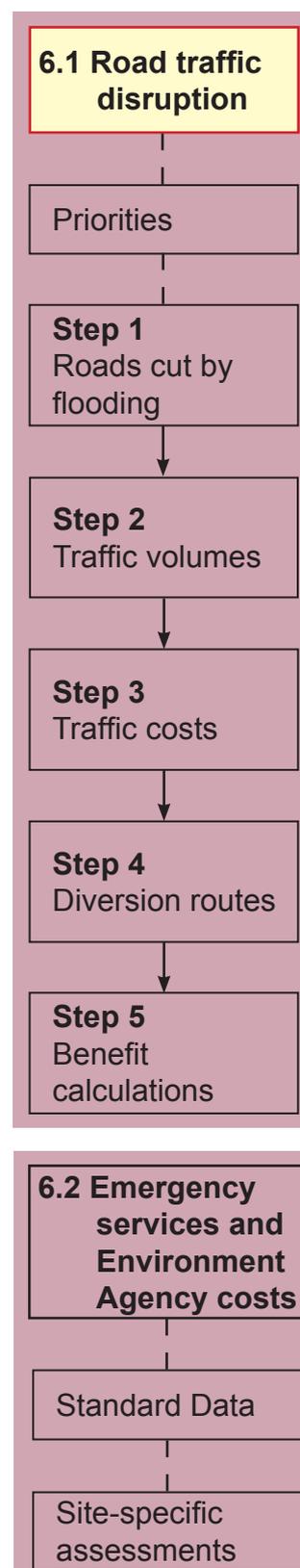
- The additional time costs
- The additional resource costs: these resources are a function of the vehicle's speed (Figure 6.1).



Thus, the additional costs incurred in a flood are given by:

$$\text{Number of vehicles delayed} * \text{additional cost per vehicle} * \text{number of hours that the flood disruption lasts} \quad \text{Equation 6.1}$$

¹ The parallel chapter in the MCM deals also with Railways and Utilities, but these are not significant enough in most benefit assessments for inclusion here.



In this equation it is the total number of vehicles that take longer to make journeys that is important – including the traffic already on those roads on to which traffic is diverted to avoid the flooded roads. Excluded from the equation are those vehicles that are travelling to or from an address that is itself flooded. Relevant data sources are given in Table 6.1.

Data	Source
Traffic flows	Highway Authority
Traffic mix	Highway Authority
Resource costs and values of time	HEN (Department of Transport)
Road levels	GPS based drive through survey
Flood durations	Hydraulic model or flood history

Priorities

When considering the traffic disruption caused by flooding, the first question is whether it is worth calculating these benefits at all. The above Equation 6.1 should be used to derive an initial ‘ball-park’ estimate of the likely benefits of alleviating traffic disruption (see Example).

Example:

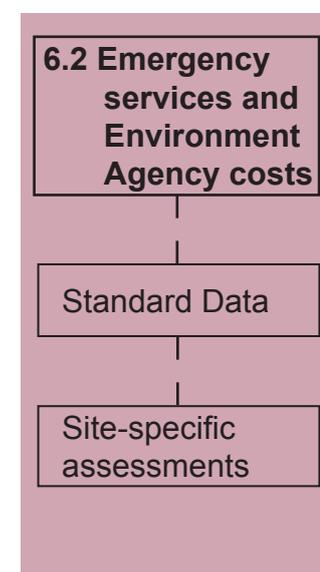
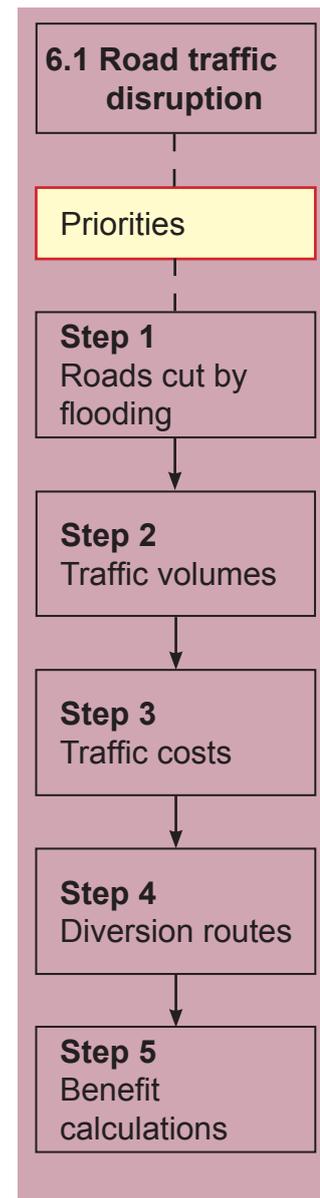
Suppose 15,000 vehicles travel through the local network each hour and they will have to travel an average 2 kilometres further with flood disruption but their average speed (40 kph) remains the same.

The cost of that flood event will be $(15,000 * £0.29 * 2)$ per hour whilst the flood lasts (the £0.29 is from Table 6.3). If the flood lasts six hours, the costs of traffic disruption would amount to £52,200. In this instance, the figure is small – losses to property could be expected generally to far outweigh this value – and this category of benefit is probably not worth pursuing further.

The three contexts when the calculation of traffic disruption costs is most likely to be justified are:

1. When the annual probability of the flood event that causes traffic disruption is greater than 20 per cent;
2. When a significant part of the local network is affected;
3. When the duration of the flooding is several days or even weeks.

In each case, the basic methodology to be adopted is the same but the first two contexts each present special problems (and for these see Chapter 6 in the full MCM).



Step 1: Roads cut by flooding

Determine which roads will be cut by floods of different annual probabilities, and the durations of closure in each case. As an approximation, a road should be assumed to be closed when the crown of the road is covered by water.

Step 2: Traffic volumes

Estimate the volume of traffic using each road in the local network (e.g. including those roads on to which traffic is likely to be diverted in a flood).

If an origin-destination traffic matrix is available for the area, then the flows on the different roads can be calculated using the standard transport models such as DRACULA (Liu *et al.*, 1995). If such a matrix is not available, but only data on the traffic flows on each link, then the flows on the roads at each junction have to be used to estimate the turning movements at each junction – in effect, to derive an origin-destination matrix knowing only the flows along individual roads.

Step 3: Traffic costs

Calculate the costs to traffic of using the local network under normal conditions (related to its speed). For speed/flow relations the data in Table 6.2 can be used but with caution (see full MCM). Above the limiting capacity flow (QM), the following equation is used as an approximation:

$$\text{Speed} = \text{VM} / (1 + (\text{VM} / (8 \cdot \text{DIS})) * ((\text{F} / \text{QM}) - 1))$$

Equation 6.2

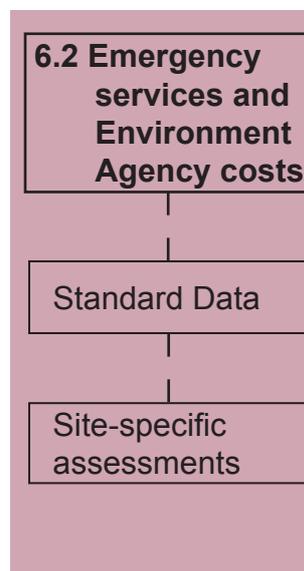
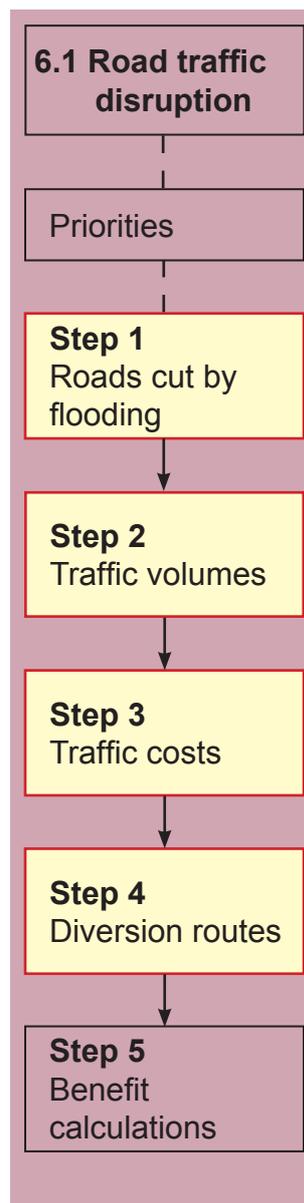
Where:

- DIS is the length of the road between junctions;
- F is the traffic volume in passenger car unit (pcu) equivalents. The number of car equivalents for LGVs, PGVs and PSVs are 1, 2 and 3 respectively; and
- VM and QM are as in Table 6.2.

Total costs of travel as a function of speed are then given in Table 6.3.

Step 4: Diversion routes

For each flood event analysed, determine the routes that diverted traffic will take. Calculate the costs to traffic of using the network under these flood conditions (again, related to its speed and distance travelled). Allow for the speed reduction on



this diversion route of all traffic as a result of that diversion.

Step 5: Benefit calculations

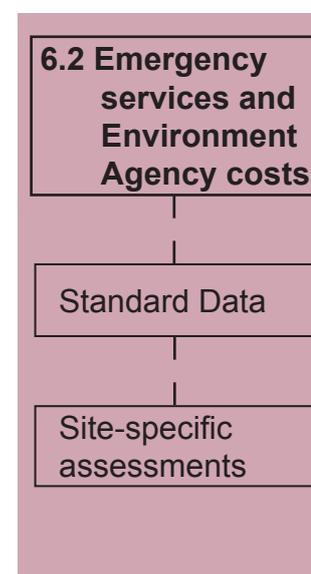
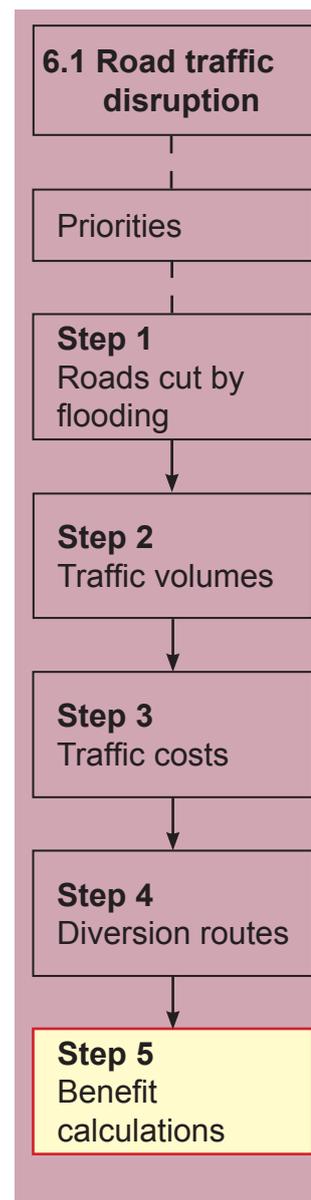
The benefits of flood alleviation for each flood event are the results of Step 4 less the results from Step 3.

Table 6.2 Speed/flow relations (MCM Table 6.6)

Road type	Free flow speed (kph)	Free flow limit (pcu/h/ lane)	Limiting capacity (pcu/h/ lane)	Speed at limiting capacity (kph)
	VC	QC	QM	VM
	Free flow speed	Speed falls linearly over this range		
Rural motorway	90	1800	2600	76
Rural dual carriageway	79	1600	2400	70
Rural all purpose road	70	400	1800	57
Rural all purpose road – poorly aligned	50		600	50
Urban motorway	80	1700	1400	66
Urban dual carriageway				
With limited access and 80 kph limit	65	1400	220	56
65 kph speed limit	50	600	1100	30
Urban single carriageway road				
Outer area	45	500	1000	25
Intermediate area	35	350	600	25
Central business area	25	250	500	15
Suburban – major radial or outer ring roads				
No major intersections	Speed limit		2000	47
< 1 major intersection per km			1700	27
1-2 major intersection per km			1200	20

Table 6.3 Total costs of travel as a function of speed (pence) (MCM Table 6.5)

	Speed (km/hr)									
	1	2	5	10	20	40	50	80	100	150
Car Average p/km	1010	506	205	104	54	29	24	16	14	11
LGV Average p/km	966	486	197	101	53	29	24	17	14	12
OGV1 p/km	937	474	195	103	56	33	28	21	19	16
OGV2 p/km	1086	549	226	119	65	38	32	25	21	19
PSV p/km	7046	3533	1426	723	371	196	161	107	90	68



6.2 Emergency services and Environment Agency costs

The benefits of flood alleviation include the reduction in the costs incurred by a number of organisations in tackling flooding and in the recovery process.

Standard data

The approach adopted has been derived from research taking the total emergency costs incurred by local authorities, the severe weather payments such as to Highway Authorities, and the Environment Agency's emergency costs, and allowing only those costs appropriate to project appraisals (i.e. deducting for betterment).

Expressing this amount as a percentage of the total economic property losses in autumn 2000 gave a percentage of 10.7%. This, therefore, represents a multiplier on top of property damages that accounts adequately and appropriately for emergency costs.

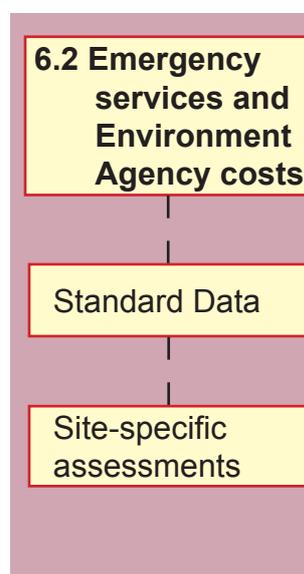
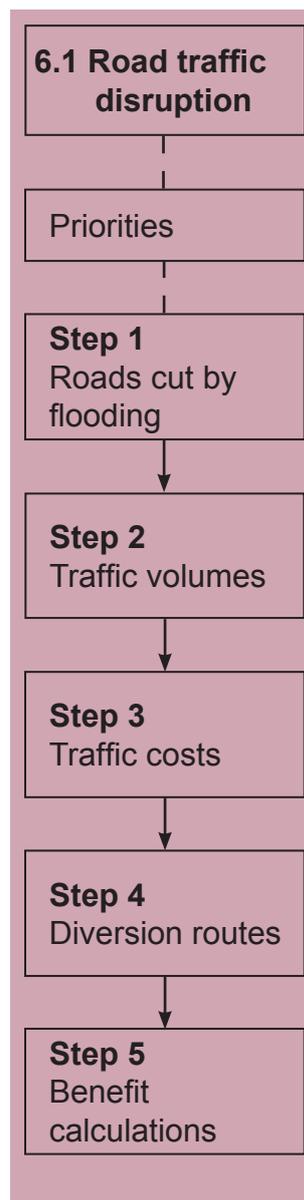
The total property damage calculated in project appraisals of flood alleviation schemes should therefore be multiplied by 1.107 to allow for the emergency costs that can be justified as real economic costs, not counted elsewhere in the benefit assessments. This figure should be applied for floods of all annual probabilities and for all scales of flood alleviation scheme, in the absence of better information.

Site-specific assessments

There will be circumstances in project appraisals where the use of the standard data as given above is not appropriate, or not considered accurate enough for project appraisal purposes.

In this case, it will be necessary to collect data from the authorities relevant to the area in question. This is not easy, particularly in the absence of a recent flood, and care needs to be taken to ensure that fixed and marginal costs are separated, in order to identify just the latter for counting within project appraisals.

Notwithstanding the above comments, a standard checklist is provided on the MC CD (Appendix 6.2) as a guide to obtaining this data.



Remaining Issues

- ◆ In terms of priority within project appraisals, we would emphasise the importance of properly and fully assessing estimated road traffic disruption costs when high volume road networks are affected by flooding at low return period events (i.e. with an annual probability of greater than 5%).
- ◆ We would also give some priority to situations where emergency services costs might be higher than average situations because research has shown these to be more significant than was hitherto appreciated.
- ◆ Rail disruption. As noted at the beginning of this chapter, rail traffic disruption by floods is rare. Severe weather can lead to disruption (e.g. embankment collapse) but this is not necessarily alleviated with flood risk management measures. It is likely that the only cases where the analysis of rail traffic disruption benefits is justified are where mainline links are threatened by floods or coastal erosion, or where rail disruption leads to long diversions.
- ◆ Utilities. Generally, utility installations such as water and sewage treatment works are robust and not damaged by floods. Gas mains are pressurised, limiting damage. Electrical and telecoms switching infrastructure is damage-prone, and significant installations would warrant investigation, as would the disruption of major power cable installations (see MCM Chapter 6).

7 Coastal erosion: potential losses and benefits

This chapter gives the procedures and techniques for assessing the potential benefits of investment in coastal erosion risk management. These benefits principally arise from delaying the processes of erosion, and thereby delaying the loss of land and property for the duration of the life of the proposed protection works.

Key points to understand are:

- Erosion is effectively permanent and irreversible.
- This means that future uses of that land or property are lost.
- Decisions about investment versus no investment must start from a realistic evaluation of the “do nothing” option.

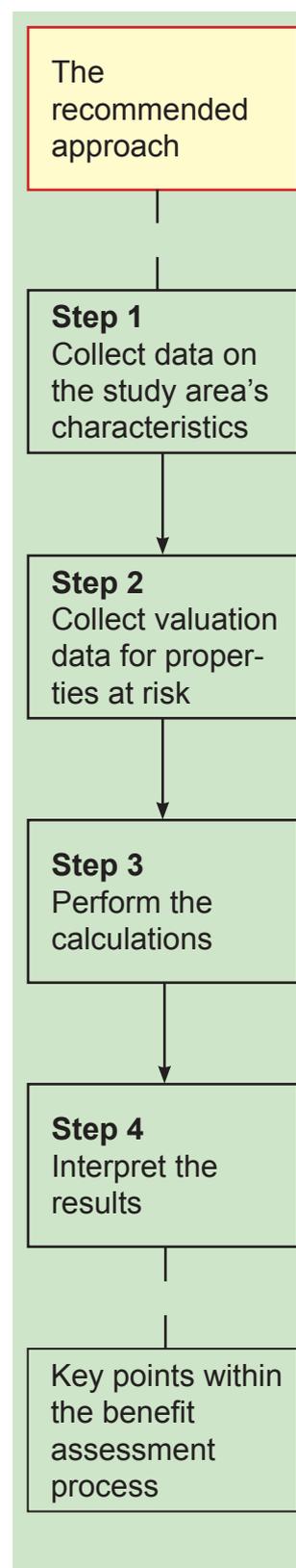
Coast protection works, which are designed to arrest this process of erosion, normally have a finite life.

- Hence the benefit from a particular coast protection project should be seen as a temporary - but usually lengthy - extension to the useful life of the land and property protected.
- The most reasonable assumption thereafter is that the original long term erosion rates as before will start again.
- Coast protection projects are compared with a ‘do nothing’ option. This ‘do-nothing’ option may involve ‘walk-away’ and hence the prospect of substantial erosion of coastal property (see Defra guidance on ‘do nothing’).

The recommended approach

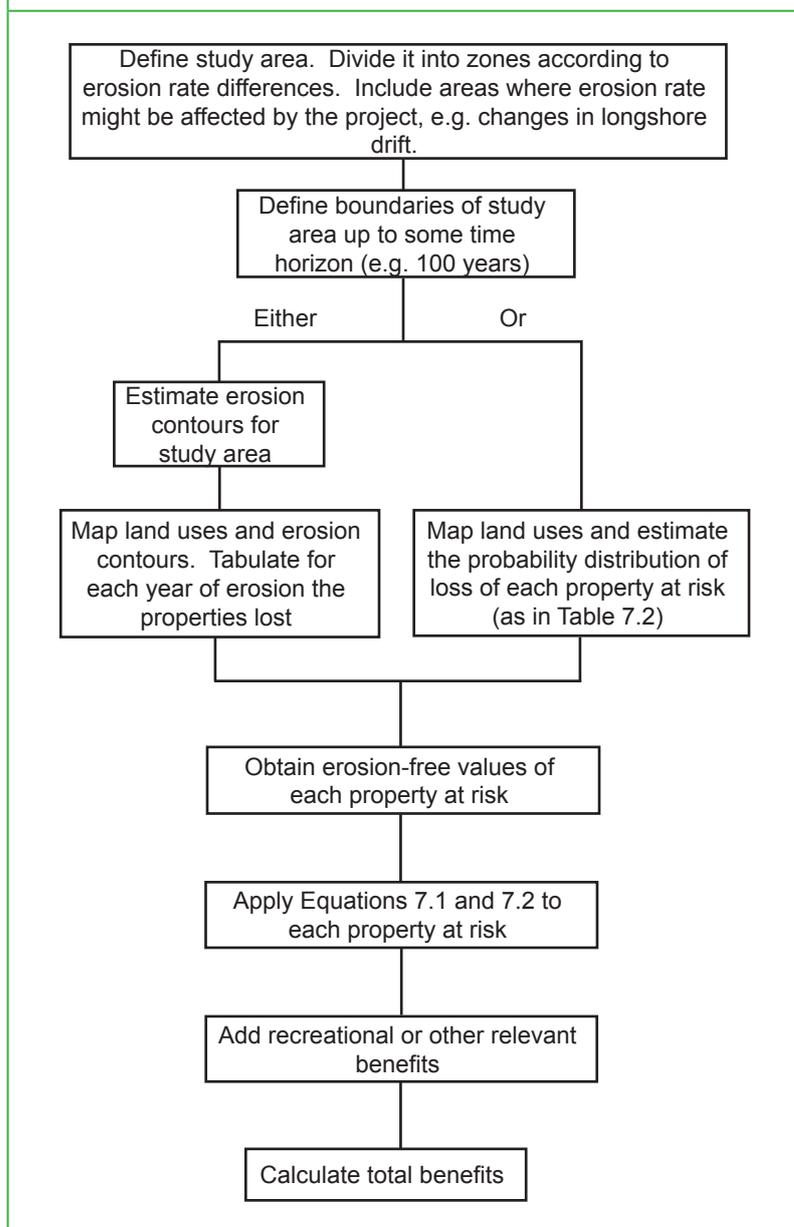
The recommended approach for assessing the benefits of coast protection is summarised in Figure 7.1. The key points about this approach are as follows:

1. Estimates are needed of **erosion rates** and cliff top edges projected for 50 or even 100 years into the future. Alternatively a **probabilistic** approach to erosion can be taken, resulting in a range of probabilities that a particular parcel of land or property will be eroded and therefore lose its use value.
2. A procedure is provided for **evaluating the losses** due to erosion, or the **extension** to the expected life and use of the property and land due to a delay in the erosion process resulting from investment in coast protection. Techniques are provided for finding the appropriate **values for properties** (residential and NRPs) whose market prices are likely



to be affected by perceived erosion risk.

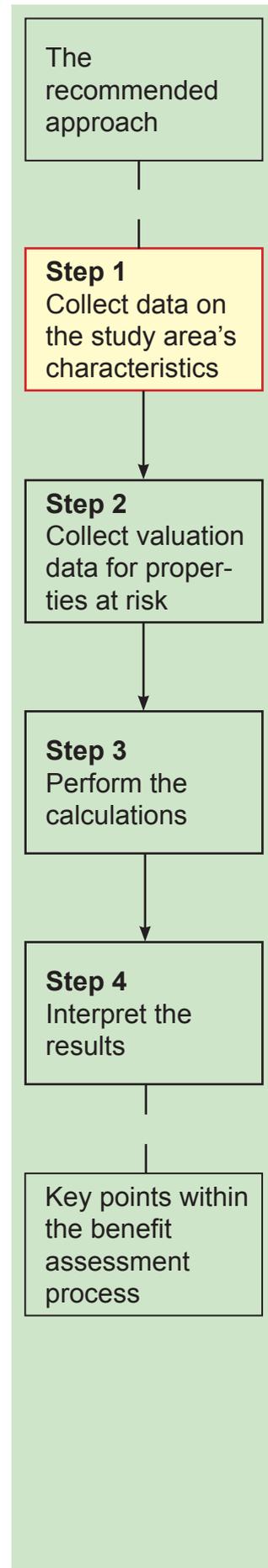
Figure 7.1 Flow chart of assessment process



Step 1: Collect data on the study area's characteristics

Erosion rates and erosion 'contours'

- Produce a set of predicted erosion 'contours' for the coastline in question, initially using, say, 5-year intervals, for at least the projected life of the proposed coastal protection works. Use smaller time intervals if erosion rates are particularly rapid.
- These erosion predictions will not be certain, and will need to be based on averages of the likely effects of storms



of different magnitudes, and sensitivity analysis used to gauge the significance for benefit totals of the assumptions made.

- For properties at risk from erosion there will be some minimum acceptable safety margin between the cliff top edge and the building: this is the point of erosion where the use of the property is assumed to be lost. Defra recommends a 2-year margin.

Calculating benefits by assessing the probabilities of erosion

Since erosion is often episodic, with sudden losses of land and slides of cliffs, the use of erosion lines can be misleading whereby it is assumed that erosion will reach a certain point inland in a given year. Therefore, the use of a probabilistic approach should be considered, depending on the distribution of probabilities of cliff falls and hence losses over time.

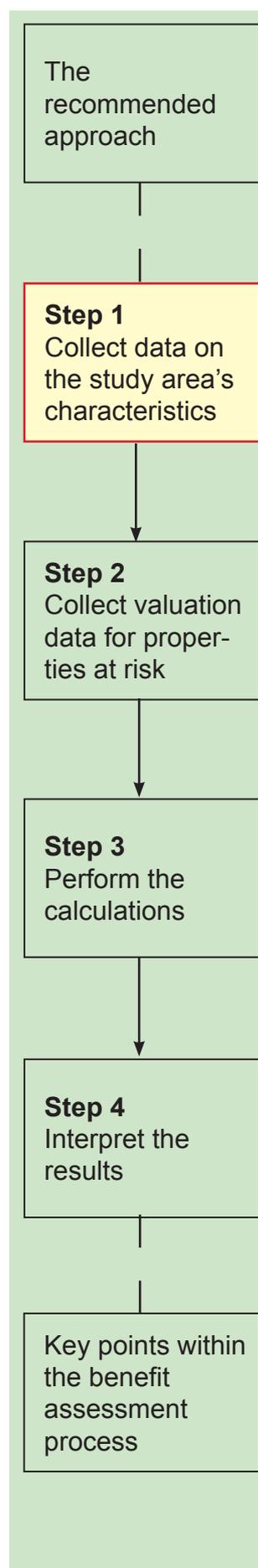
Table 7.1 gives some data for a hypothetical project and Table 7.2 gives a best estimate of the probability that house “A” will be lost in any given year where the same probability function also applies to all the other properties. If it is assumed that the scheme has an engineering life of 20 years at which point it fails, then the present value of erosion benefits is £215,758.

Property	Value (£)	Mean year lost
House A	80,000	4
House B	60,000	7
3 mobile homes	3,000	10
Public house	240,000	13
House C	120,000	16
House D	90,000	17

Year	0	1	2	3	4	5	6
Probability	0.05	0.10	0.15	0.20	0.35	0.10	0.05

If, instead, we assume that each property is lost in the year at which the probability of loss is the maximum (i.e. year 4 for house “A”), then the present value of erosion benefits is £205,000. So, in this case the probabilistic approach makes very little difference. However, where the distribution of probabilities (as in Table 7.2) is very asymmetric there can be much larger differences in calculated benefits.

Spreadsheet fcdpag31.xls in FCDPAG3 uses the probabilistic approach (see Defra Flood Management website). If the probability of loss for a given property is set to 1.00 in a given year then the method can be used deterministically.



Step 2: Collect valuation data for properties at risk

The idea of benefit as a delayed loss

The benefit of coast protection works is an extension to the life of, or the delay in the loss of, erosion-prone property and land for a period of time equal to the life of the protection works (scheme life). This assumes that erosion after the end of the project's life would proceed at the same rate as it would have done without the project.

Thus a property that is predicted to be lost by erosion in 20 years' time without protection would, with effective coast protection works having a life of 50 years, be expected then to be lost in 70 years' time. Thus the benefits of coast protection are critically affected by the timing of the extension of the life of the property.

The procedure for valuing property life extension

The procedure recommended here for valuing erosion-prone properties, involves the following stages:

- Determine the erosion-free market value of similar properties in the local area; market-based property prices;
- Use the Equation 7.1 [see **Step 3**] to determine the present value of the use of that property up until the time when it is lost through erosion at current erosion rates;
- Use the Equation 7.2 [see **Step 3**] to determine the present value of the use of the property with the extended life provided by the coast protection scheme (i.e. the life as above plus the anticipated lifetime of the scheme).

Erosion-free property prices

The property and land prices required are market freehold values, not adjusted for erosion risk. Tables 7.3 and 7.4 provide data sets for values of the main types of dwelling found in this country. These values can be used in the equations below, but greater reliability may be achieved by obtaining values locally for the specific types of property to be affected by the project. Values used for residential property should reflect its location type – such as being near the sea – but it should be safe (i.e. based on properties which do not have an erosion risk).

Defra provides guidance on distributional impacts in their July 2004 PAG3 supplement.

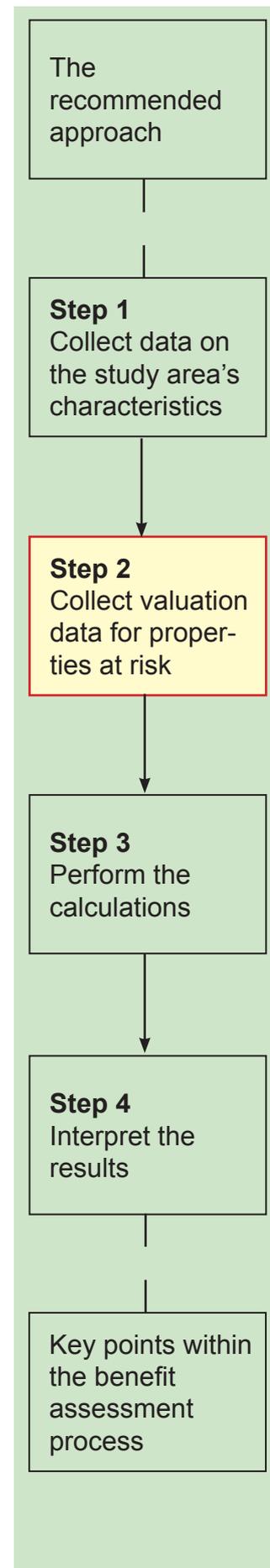


Table 7.3 Residential property prices by region.

N.B.: This data set and that in Table 7.4 is given as an EXAMPLE only. Appraisals must use up-to-date data from the sources given in the Notes below.

	Housing land price (£/ha) Jan 2005 For bulk land (greater than 2 ha) (1)	Average new dwelling price (£) 2005 1st quarter (2)	Average (all) dwelling price (£) 2005 1st quarter
North East	2,210,000	162,766	131,979
North West	2,520,000	195,979	146,895
Yorkshire and The Humber	2,320,000	172,536	142,516
East Midlands	2,010,000	195,250	162,258
West Midlands	2,120,000	192,071	164,602
East	3,425,000	240,786	208,824
London	*6,895,000	307,253	273,402
South East	2,960,000	279,641	240,066
South West	2,200,000	225,990	209,076
Wales	2,180,000	189,030	146,333
England	not available	225,320	198,752
Scotland	1,680,000	169,857	124,494
Northern Ireland	1,675,000	141,380	122,655

*average of Inner London (£7,800,000/ha) and Outer London (£5,990,000/ha)

Notes:

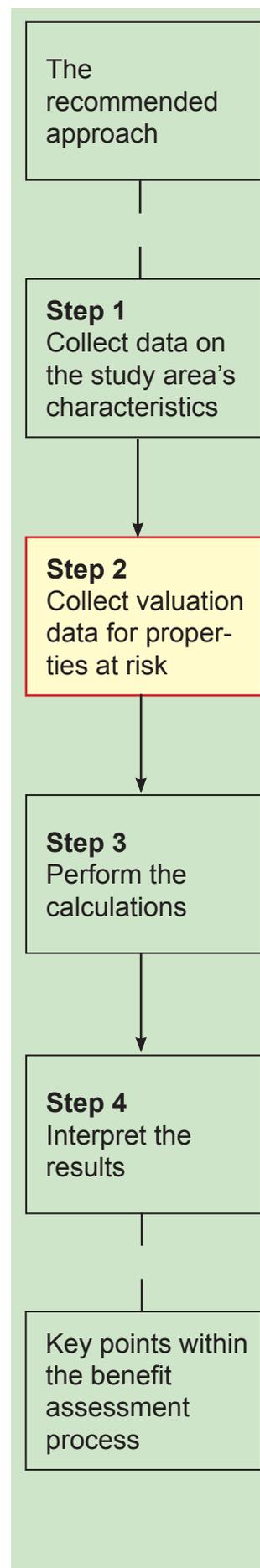
(1) VOA publications, Property Market Report, January 2005: www.voa.gov.uk/publications/property_market_report/pmr-jan-2005/residential.htm

(2) ODPM publication: Table 504 Housing market: simple average house prices www.odpm.gov.uk/stellent/groups/odpm_housing/documents/page/odpm_house_604091.xls

Table 7.4 UK residential property prices by dwelling type

N.B.: See Table 7.3 for the need for up-to-date data.

Dwelling type	Price (£) in 2005, 1st quarter (1)	% of average for all dwellings
Bungalow	193,006	102%
Detached	287,110	151%
Semi-detached	170,947	90%
Terraced	145,854	77%
Flat or Maisonette	153,143	81%
All dwellings	190,012	100%



Note:

(1) ODPM Survey of Mortgage Lenders www.odpm.gov.uk/stellent/groups/odpm_housing/documents/page/odpm_house_029003.xls

Locally appropriate property prices can be obtained through:

- The Coast Protection Authority's own valuation department, if it has one;
- Local estate agents: use typical or average values for the type of property which ignore the risk of the properties being lost through erosion without a coast protection scheme also and ignore factors such as a sea view.

Step 3: Perform the calculations

The two formulae identified in Step 2 are as follows:

$$PV \text{ (without scheme)} = MV (1 - 1 / (1 + r)^p) \quad \text{Equation 7.1}$$

and

$$PV \text{ (with scheme)} = MV * (1 - 1 / (1 + r)^{p+s}) \quad \text{Equation 7.2}$$

Where:

PV = present value

$$PV \text{ asset value} = MV * (1 - [1 / (1 + r)^{\text{year of loss}}]),$$

where r = discount rate

$$PV \text{ asset loss} = MV - PV \text{ asset value} =$$

$$MV * [1 / (1 + r)^{\text{year of loss}}]$$

p = expected life of property with no coast protection project

s = expected life of the coast protection project

This amounts to:

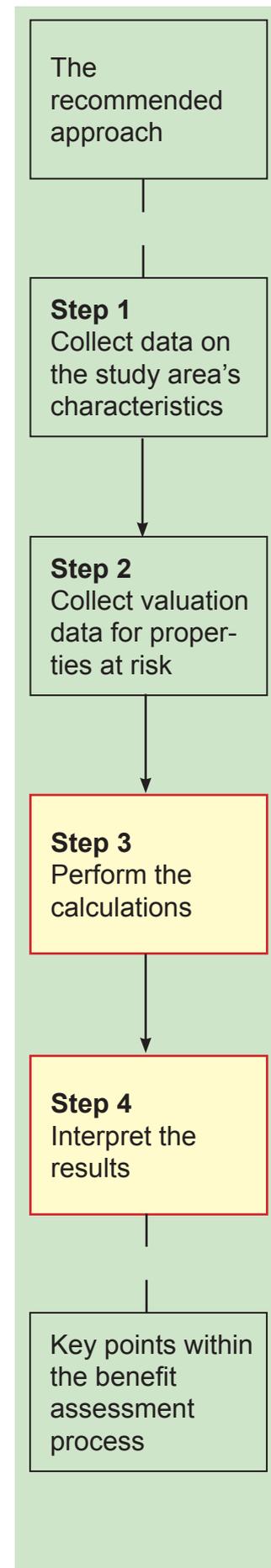
PV benefit = PV asset value (with scheme) – PV asset value (without scheme) or

PV benefit = PV asset losses (without scheme) – PV asset losses (with scheme)

Both calculations of PV benefit produce the same answer.

Step 4: Interpret the results

The benefit of carrying out the scheme is the difference between the two values of present value which represent the gain from 's' years of equivalent annual benefit ('s' being the scheme's effective life).



The procedure, very simply, involves the calculation of the discounted value of the property loss with coast protection less the discounted value of the same property loss without any proposed protection works.

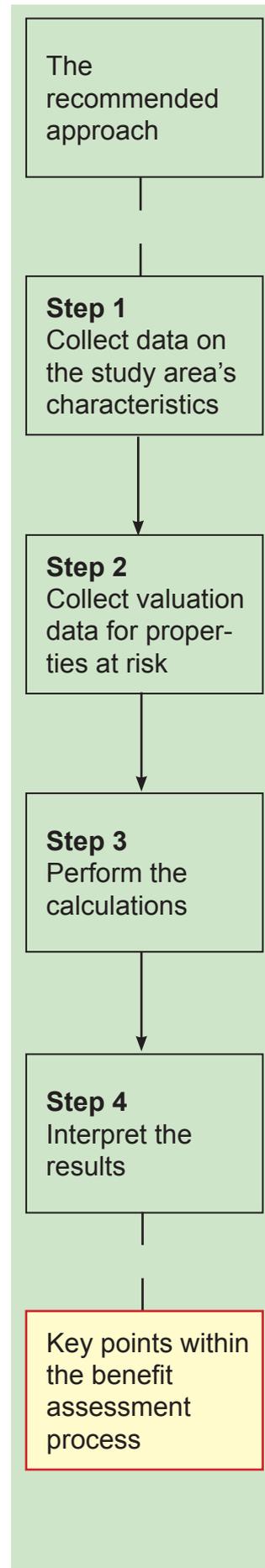
The greater the life of the scheme the larger the benefit, but not proportionately, because losses further into the future are discounted more heavily than those incurred in the medium or short term.

The benefits calculated as above need to be compared with the costs of the scheme, both capital and maintenance. Costs in the future need to be discounted to present values.

- A ratio of benefits:costs greater than 1.0 indicates that the scheme is economically worthwhile.
- Delay in scheme implementation will increase the benefits:costs ratio, as property gets nearer to the cliff edge.

Key points within the benefit assessment process

- Realistic erosion rates and probabilities are the key to accurate benefit estimation.
- Assessment of the effective life of any scheme is important to determine, with as much accuracy as possible, as this determines the delay of erosion and 'drives' the benefit calculations.
- The recreation benefits of coast protection are often very large and can be a key reason for scheme implementation. They can be costly to assess (with site surveys), so caution is necessary here.
- All appraisals should be based on the existing properties at risk. No allowance should be made for new developments or possible regeneration of sea frontages.



Remaining Issues

1. House price trends not covered here

Coast protection works are generally appraised for a long expected project life of perhaps 50 or even 100 years. Whilst general inflation over this time is ignored in benefit-cost analysis, potential changes in relative real prices are relevant (HM Treasury, 1991).

However, no conclusive reason and no reliable method for making future predictions of long term house price trends has been found. The standard approach of assuming constant relative prices is therefore recommended, for benefits and costs.

2. Other matters not covered here

The following are not covered here but are tackled in the full MCM:

- ◆ Infrastructure loss (promenades and associated structures).
- ◆ Infrastructure loss integral to properties at risk from erosion (gas; water; electricity; etc).
- ◆ Infrastructure lost that is serving areas not at risk from erosion at the same time (gas; water; electricity; etc).
- ◆ Valuing non built-up land: agricultural land and other open space.

Some common misconceptions

- ◆ Property and land must be protected at all cost.
- ◆ Decisions in the future about coast protection should reinforce planning decisions made in the past.
- ◆ A valuable promenade is a benefit if it is to be protected (even if it is falling down).
- ◆ There is no merit in delay.
- ◆ The sea will not win in the end.

Key lessons from experience

- ◆ Flooding and erosion are often inextricably interlinked; probabilities can become very complex to calculate.
- ◆ Market prices of houses situated on the tops of cliffs do not accurately reflect their risk of falling into the sea.
- ◆ Many people claim that the loss of a view from a property, if that property is lost due to erosion, is important. But the loss of one person's view is another person's gain: the view itself is not lost (so there is no economic loss)!
- ◆ The environmental benefits of coast protection are mixed: some assets gain (e.g. eroding cliffs revealing important geological sites); others involve losses (e.g. the loss of habitats for birds).
- ◆ Delay is a real option that should be seriously considered.

8 Recreational gains and losses

This chapter outlines the procedures and techniques for assessing the potential recreation and amenity benefits of - or losses from - coastal erosion or fluvial flood risk management. The term 'recreation benefits' covers benefits arising from the enjoyment of landscape, wildlife and natural amenities as well as from the enjoyment of recreational activities.

Estimating recreation benefits

Recreation benefits are calculated by multiplying the £ value of a visit for recreational use (often a small number) derived using the Contingent Valuation (CV) method by the number of visits or beneficiaries (often a large number). Hence the crucial stage in estimating recreational benefits is usually the estimation of the number of visits or beneficiaries.

The CV method (see Chapter 2 herein) is essentially a questionnaire survey method in which respondents are asked directly in carefully designed survey questions to say what value they place on, or how much they would be willing to pay (WTP) for, a change in the availability of a resource such as beach or riverside recreation.

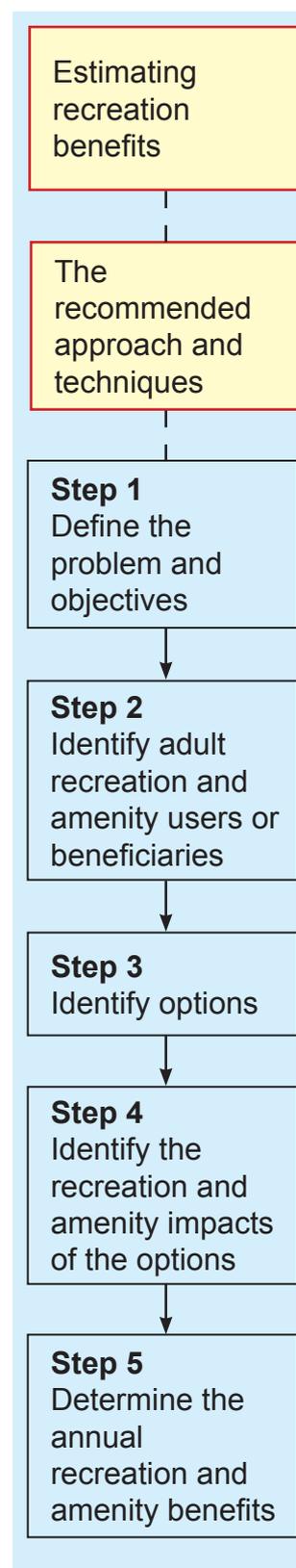
We have developed and tested a particular variant of the CV method, the value of enjoyment per adult visit (VOE) method. In this approach, respondents are asked to say what value they put on their enjoyment of a day's visit under varying options in £ and pence.

In the WTP approach, respondents are asked how much they would be willing to pay in entrance fees or in rates and taxes for a change such as a coastal protection scheme. The advantages and disadvantages of the two approaches have been debated but in this Handbook and the associated MCM the VOE approach remains the recommended method and the basis for the standard data presented here.

The recommended approach and techniques

A two-stage framework for recreation benefit assessment is recommended. This involves:

- **A pre-feasibility study stage** for initial examination of projects and for strategy studies. This will normally rely upon secondary source data and desktop methods. Table



8.1 presents a range of methods for estimating visit numbers. It is acceptable here to use standard values or data from existing CV studies and visit data. Data that can be used on visit numbers are presented in Table 8.2. Table 8.3 gives data on losses and gains with various options at coastal sites, and for rivers in Table 8.4. Using secondary source data on values and visit numbers is, however, a very approximate approach.

- **The feasibility study stage** involving detailed site-specific information and data collection methods: site-specific counts of visit/visitor or resident numbers and a site-specific CV survey to provide site-specific estimates of the value of recreation with the different scheme options. These surveys and count procedures are expensive and time-consuming activities to mount and manage.

In making the key decision as to whether or not to proceed to a feasibility study, it is recommended that a form of sensitivity analysis is undertaken using combinations of the highest and lowest appropriate estimates of visit numbers and £ value per visit (based on data in Tables 8.2-8.4) to obtain four annual recreation benefit assessments.

Then, the difference the four estimates make to the overall benefit:cost ratio for the scheme can be considered, to aid a decision as to whether it would be worth refining visit number estimates or valuations through site-specific data collection.

At both pre-feasibility and feasibility study stages it will be necessary to go through the same steps (see below) but at different levels of detail.

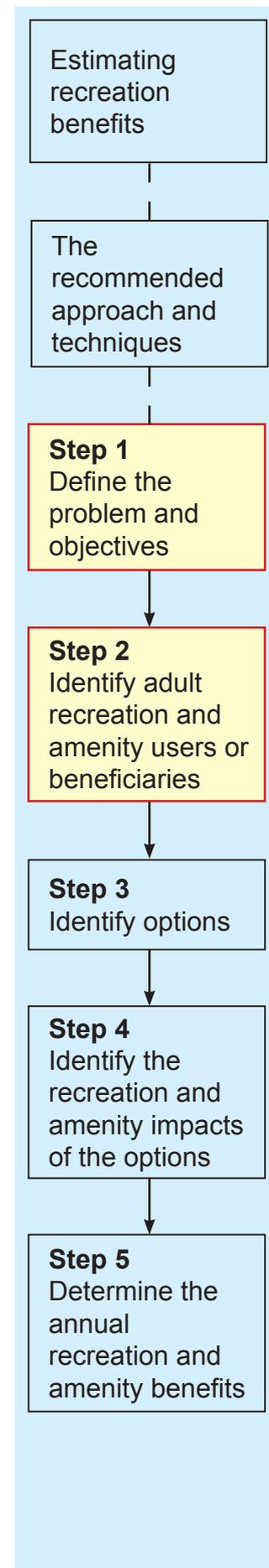
Step 1: Define the problem and objectives

This is the definition of the nature and rate of coastal erosion or degradation or of coastal or fluvial flooding, and with it the geographical area affected: its length and breadth and its characteristics and the type of changes to the physical characteristics that are likely to take place in the future with the 'do nothing' situation.

Problems such as coastal erosion may be site-specific or may affect a more extensive area. Similarly the problems affecting a river may be present in much of the catchment or may be site-specific. It is essential in this way to consider problems and the options for dealing with them in their wider context.

Step 2: Identify adult recreation and amenity users or beneficiaries

Find out whether there is current or potential for recreational use



of the site and identify the range of recreational activities that are, or could be, undertaken there. Although children may be important users of the coasts and riversides, the benefit assessment methods apply to adult users or beneficiaries only.

Visitors can also be classified according to their origins:

- **Local visitors.** Those living within a three-mile radius of a site.
- **Day visitors.** Anyone starting and finishing their trip from their permanent home.
- **Staying visitors.** Anyone staying away from home for one or more nights.

Recreation benefit assessments can be refined by obtaining and using separate visit number and £ value per visit estimates for these different categories of user presented in the MC CD Appendix 8.1 and 8.2.

A crucial issue in both pre-feasibility and feasibility studies is to establish the level of use of the site in terms of the number of visits it receives or the number of those who benefit from recreation at the site. It is recommended that two or more of the methods presented in Table 8.1 should be used and that indirect methods (items 4-8) should only be used in pre-feasibility stages.

Step 3: Identify options

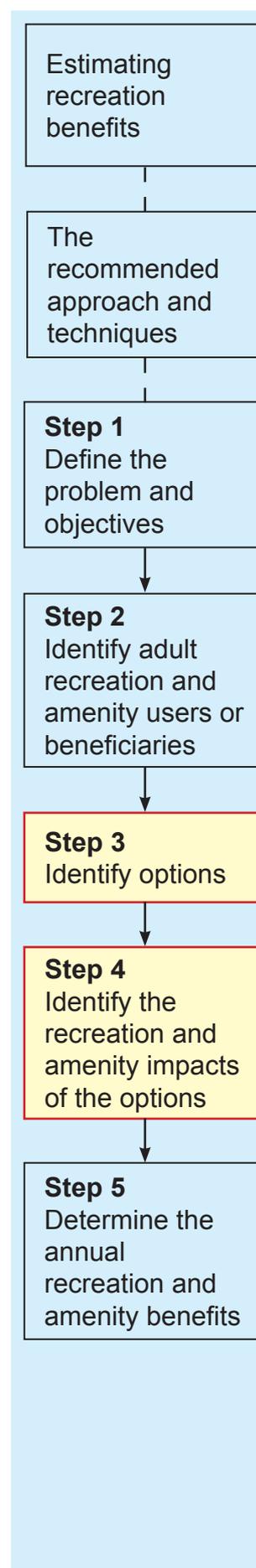
Identify the options for dealing with the problem and their likely impacts on the physical characteristics of the site as well as the 'Do nothing' option. Thus recreation benefits may have the following two components:

1. The prevention of further deterioration - **losses** with the 'Do nothing' option.
2. A reinstatement 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 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.

Step 4: Identify the recreation and amenity impacts of the options

Identify the impacts on recreation and amenity of the changes to the physical environment resulting from the 'Do nothing' and the 'Do something' options.

This process will benefit from the participation of the recreational



stakeholders, particularly at the pre-feasibility stage. They may have particular insights into how changes will impact on their recreational enjoyment.

Step 5: Determining the annual recreation and amenity benefits

Annual recreation benefits. Step 5 involves first deriving estimates of the annual recreation benefits arising from the options and comparing the benefits for the options.

There are two components that have to be estimated:

1. The value that individual adult users or beneficiaries place on the changes that would occur with the options in place. These values will be derived from an application of the CV method using either the VOE per visit or the WTP approach.
2. The annual number of adult visits to the site (for the VOE approach) or beneficiaries who have an interest in the site (for the WTP approach).

The annual recreation benefits can then be determined as:

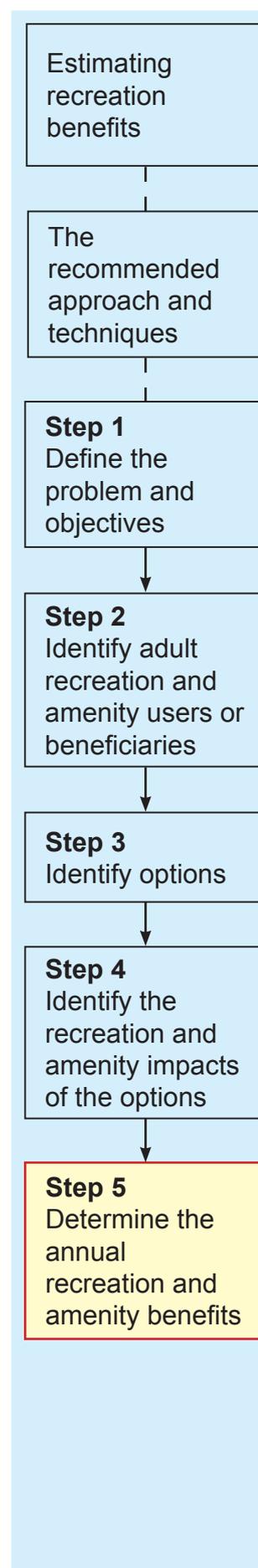
Annual benefits = £ value of the options (VOE gains and/or losses) or (WTP valuations) * the number of visits per annum (VOE) or number of beneficiaries/visitors (WTP).

Equation 8.1

Where the options involve both VOE losses and gains, the annual benefits should be calculated separately for the losses and the gains because these may need to be treated differently for discounting (see Total recreation benefits below).

National economic benefits and substitute sites. If changes to a particular coastal or river site simply transfer recreation from one site to another without any overall gains or losses in the value of recreational enjoyment, once travel costs have been taken into account, then no national gain or loss will be involved. The availability of substitute sites must therefore be considered when recreation benefits are being assessed.

Total recreation benefits. The total recreation benefits of a scheme are estimated by discounting the annual benefits over the life of the project using the recommended 'Green Book' discount rates. A different approach and separate calculations are required where there are annual benefits from both VOE losses and gains with the options since gains become available on scheme completion whereas losses are likely to be incurred only after some years of site deterioration.



Losses under the 'Do nothing' option: VOE approach¹

The following two equations should be used for estimating possible losses (or gains) under the 'Do nothing' option: some respondents may enjoy the site under the 'Do nothing' option more than the current site and therefore might gain.

Benefit for those who continue to visit:

$$L_1 = E_0 - E^1 \quad \text{Equation 8.2}$$

Benefit for those who would visit an alternative site under the 'Do nothing' option:

$$L_2 = (E_0 - E_a) + (C_a - C_0) \quad \text{Equation 8.3}$$

Where:

- L is the benefit per person (in cases 1 and 2)
- E₀ is the value of enjoyment of today's visit/ a visit in current conditions
- E¹ is the value of a visit under the 'Do nothing' option
- E_a is the value of a visit at the alternative site under the 'Do nothing' option
- C₀ is the cost incurred visiting the present site
- C_a is the cost incurred in visiting the alternative site under the 'Do nothing' option. The difference between C₀ and C_a is derived from a question in the questionnaire.

Gains under the 'Do something' option formulae: VOE approach¹

Two similar equations should be used for estimating possible gains (or losses) under the 'Do something' options: some respondents may enjoy the site less than the current site under the 'Do something' option, for example where there is a radical change in the appearance or recreational facilities with the option. Also they might wish to visit elsewhere instead.

Benefit for those who continue to visit:

$$G_1 = E_x^n - E_0 \quad \text{Equation 8.4}$$

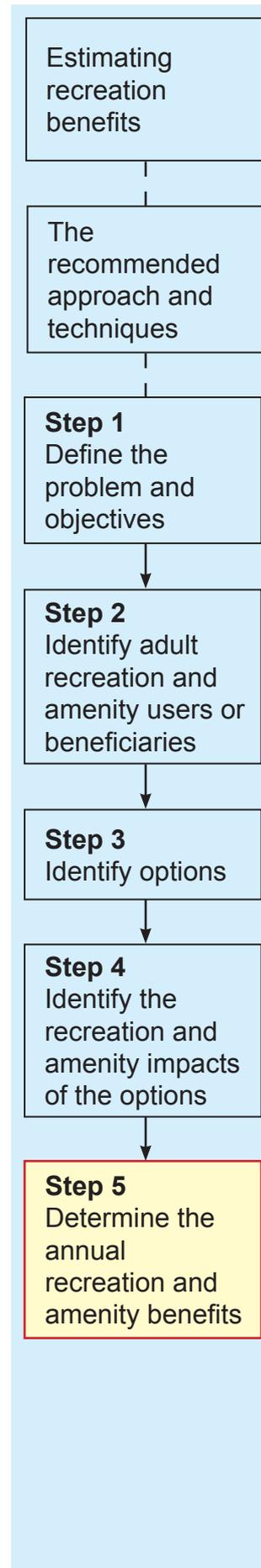
Benefit - for those who would visit an alternative site under the 'Do something' option ⁿ:

$$G_2 = (E_0 - E_a^n) + (C_a^n - C_0) \quad \text{Equation 8.5}$$

Where:

- G is the benefit per person (in cases 1 and 2)
- E₀ is the value of enjoyment of today's visit/ a visit in current conditions
- E_{xⁿ} is the value of a visit under the 'Do something' option n
- E_{aⁿ} is the value of a visit at the alternative site visited under the 'Do something' option n
- C₀ is the cost incurred visiting the current site
- C_{aⁿ} is the cost incurred in visiting the alternative site under the 'Do something' option n. The difference between C₀ and C_a is given by a question in the questionnaire.

¹ These equations are explained more fully in the MCM, where they have the same reference numbers.



Using these equations, the losses and gains should be calculated for each person in the survey and then the mean value should be calculated.

Source/method	Comments
1. Long period counts using people counters	Infra-red or other counters installed over a period (at least March to September). Counters are manually calibrated to relate passages to adult visits. Mainly applied in feasibility studies: in conjunction with a CV survey.
2. Short period annual counts/surveys	Manual counts/surveys over a period of days normally including the August Bank holiday. At pre-feasibility stage, this method might be combined with site visits, and at feasibility stage with the CV survey.
3. CV survey data	CV survey data on the frequency of visiting by local residents in conjunction with census data on the number of adult residents and staying visitors (in conjunction with managers' estimates of occupancy rates) can be used to generate visit number estimates. However, the tendency of survey respondents to overstate their visiting frequency has to be noted.
4. Old survey/count data for the project	Planning, tourism or recreation departments of local authorities or local colleges or schools may have undertaken surveys or counts at the project site in the past, which can be updated to indicate current levels of use.
5. Inferred estimate	The number of visits to a coastal or river site is inferred from counts of visits to a related site nearby such as: Car and coach parks multiplied by the average adult car or coach occupancy rate: funfair, cafe, visitor centre, historic site or museum. This requires estimating the proportion of all visitors to the project site who also use the counted site and vice versa. At feasibility level, this can be done in conjunction with the CV survey.
6. Visitor equations	A number of equations have been developed which predict distance-frequency functions so that from census data on the population in different zones a prediction can be made as to the number of visitors generated by the site.
7. Estimates from an informed person or source	Written, telephone or personal contacts with: Car park attendants, park rangers/wardens, visitor centre staff, staff at associated visitor attractions, local authority tourism, sport and recreation or planning staff, regional or local offices of organisations such as the English Tourist Board, National Trust or English Heritage and their Welsh equivalents, the Environment Agency's recreation and fisheries staff, managers of visitor facilities or tourism business organisations; both commercial and club managers of specialist facilities (e.g. sailing, boating/sailboarding, fishing, birdwatching) and specialist organisations at national, regional and local level for information on the availability of alternative sites e.g. for caravans or sailing.
8. Average number of visits to equivalent sites	This benefit transfer approach is only suitable for pre-feasibility and strategic studies. The number of adult visits to the project site is estimated as being of the same order as the number of visits made to an equivalent site. However, there are few sites for which good data are available and little research to enable reliable identification of an equivalent site.

Table 8.2 Examples of visit numbers used for benefit assessment purposes (see also the MCM for further examples)

Site		Annual visit numbers	
Name	Characteristics	High estimate	Low estimate
Undeveloped coastal sites			
Hengist-bury Head, Christchurch, Dorset	Natural headland, a SSSI, with nature, geology and archaeology sites	609,000	584,000
Hurst Spit, Hampshire	Undeveloped shingle spit with heritage site, Hurst Castle	107,000	88,000
Developed coastal sites			
St Mildred's Bay, Westgate, Kent	Small resort with promenade and sandy beach	212,000	-
Cliftonville, near Margate Kent	Small resort with clifftops and a mainly sandy beach	146,000	136,000
Corton, near Lowestoft, Suffolk	Small village resort with cliffs and partly sandy beach	97,000	75,000
River sites			
Local park	Park drawing visitors from 800m radius with no special attractions	30,000	60,000
'Honey pot' site, country park	Site drawing visitors from a 3 km radius	60,000	250,000

Table 8.3 £ gains and losses per adult visit with coastal protection scheme options at coastal sites (MCM Table 8.7)

		£ per adult visit updated to 2004	
		Mean gain with options	Mean loss with 'Do nothing'
Beach and promenade erosion			
'Yellow Manual' standard data:4 sites	Nourished beach and promenade	2.39	5.75
Lee-on-Solent	(a) Shingle beach renourishment	1.36	2.95
	(b) Rock groynes with shingle beach renourishment	1.34	
Herne Bay visitors survey	(a) Reef or jetty with no boat facilities	4.01	5.51
	(b) Reef or jetty with boat facilities	2.08	
	(c) Higher seawall, and promenade, rock groynes	-2.58	

Cliftonville	(a) Concrete lower promenade	3.58	6.35
	(b) Rock lower promenade	2.11	
Corton	(a) Hold the line for a limited period. Short term protection to cliff, limited access to beach and along seawall	2.06	2.07
	(b) Hold the line for a longer period >50 years. Full access along renewed seawall and on to all the beach from village	9.20	
	(c) Managed retreat. Sea defences and seawall removed to leave a 'natural' seafront', direct access from village to beach	1.42	
St Mildred's Bay	Improved beach and promenade	2.24	8.26
Hastings	Beach improvement	NA	5.86
Breach Scenarios			
Hengistbury Head	(a) 5 rock groynes; full cliff protection	0.04	3.45
	(b) 3 rock groynes; partial protection	-1.92	
	(c) Beach nourishment; Annual disruption	-2.90	
Hurst Spit	Slightly enlarged shingle spit	0.55	5.20

Site	£ mean value of loss: updated to 2004	£ mean value of gain: updated to 2004
River Misbourne: Low flows		
Visitors	3.67	2.15
Residents	3.70	1.83
River Wey: Low flows		
Residents	1.53	2.10
River Ravensbourne: Full river restoration		
Visitors and residents	-	1.92
River Skerne: River restoration		
Residents	-	2.43

Remaining Issues

- ◆ Estimating the visit numbers or the number of beneficiaries deserves to be given as much attention as estimating the valuations. Shoreline Management Plans (SMPs) should be investigated for this data, and Catchment Flood Management Plans (CFMPs) may be sources for fluvial cases.
- ◆ Coastal studies indicate that the public are often reluctant to see natural processes take their course at the coast and want the coast to continue to be maintained and defended as it had been in the past.
- ◆ Visitors who visit 'natural' undeveloped coasts are different in some respects from those who go to developed sites.
- ◆ Public responses to, and thus valuations of, options and structures at the coast such as rock groynes, vary from site to site in ways that are difficult to predict. Therefore there is still a need for most schemes for site-specific CV surveys at feasibility stage for both coastal and riverine sites.
- ◆ The few river restoration studies, in contrast, show that residents are supportive of, and attach value to, works to restore rivers to a more natural condition where the level of flood risk is not increased.
- ◆ The recommended methodology does not take into account new visits (as opposed to transferred visits) that may be generated among local residents or more widely. Nor is additional visiting by current users easily allowed for (again not transferred visits). Both are impossible to gauge without substantial databases or surveys. There may, therefore, be significant underestimating of the benefits of schemes which offer substantial improvements or attractive new facilities.

9

Appraisal of flood risk management for agriculture

Flood risk management for farmland is an important element of support to the agricultural sector in Britain but there is now limited economic justification for public funding of agricultural enhancement schemes.

Flood risk management (FRM) for agricultural land should facilitate agricultural production where otherwise it would be impeded – for the whole or for part of the year - by either saturated soils or surface inundation (Table 2.1). Also, agricultural land may be lower than high tide or fluvial flood levels, and FRM for agriculture protects these areas from regular flooding. Erosion management at the coast may prevent agricultural land from being lost to the sea.

The current role of appraisal is mainly to determine whether it is worthwhile to continue to provide flood defence for agriculture (Figure 9.1). This may involve comparing some existing standard with the 'do nothing' option (Table 9.1).

Alternatively some intermediate option - neither the current situation nor 'do nothing' - may offer better value. The appraisal will then require some comparison of the financial and economic performance of agricultural land use under different flood risk management regimes, and how these compare with the costs of delivering those options.

Where farming is impossible in the absence of flood defence, the advice is to estimate economic loss (and therefore the benefits of flood defence) in terms of the likely reduction in the value of the agricultural land.

The approaches needed for appraisal are:

- At a broad catchment scale, appraisals will at least require information on categories of land use, and the extent to which these might be affected by a change in flood risk.
- At a detailed scheme appraisal level, however, there is likely to be a need to collect primary data and undertake detailed farm-by-farm analysis, in proportion to the significance of agriculture within the scheme as a whole.

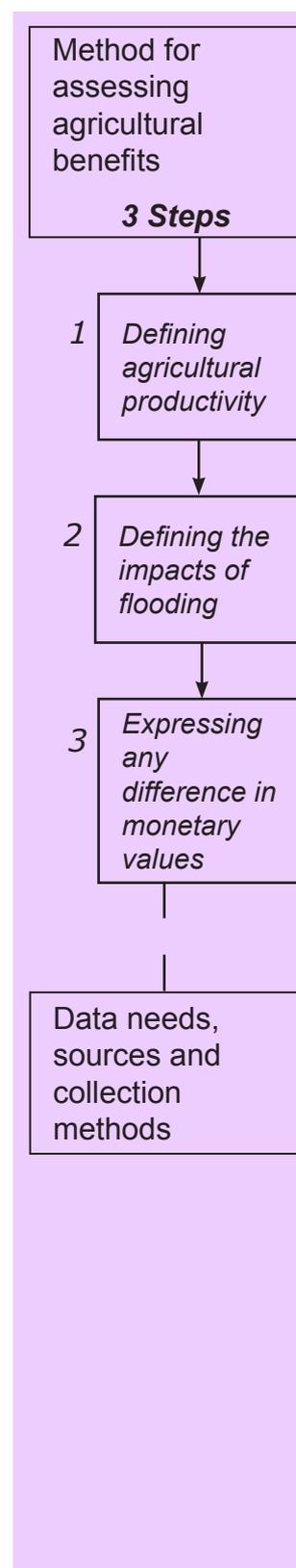


Figure 9.1 Causes of flooding and poor drainage conditions on farmland

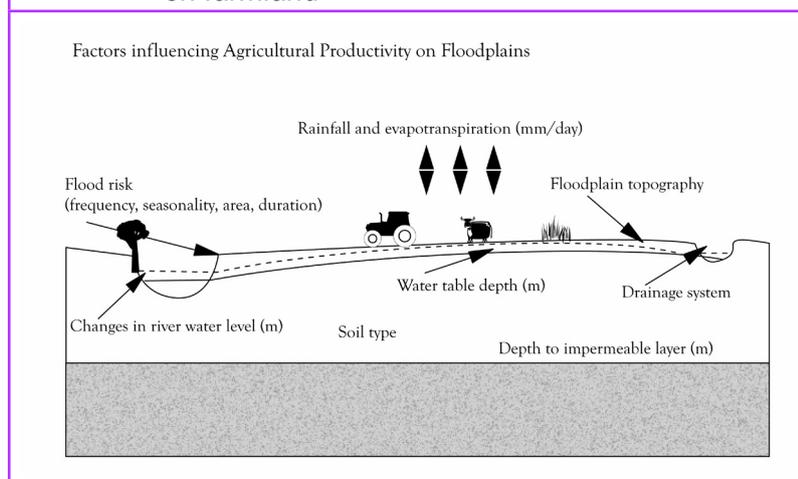


Table 9.1 Maximum flood probability tolerated by different agricultural land uses and crops

Land use type	Whole Year	Summer April-October
	Annual probability	
Horticulture	5%	1%
Intensive arable including sugar beet and potatoes	10%	4%
Extensive arable: cereals, beans, oil seeds	20%	10%
Intensive, improved grass, typically dairy cows	50%	20%
Extensive grass: usually cattle and sheep	≥100%	33%

Method for assessing agricultural benefits

The principle behind this method is to establish the impact of flooding regimes on agriculture, and then to quantify those impacts as rigorously as possible. Three main steps are required to derive a monetary value of agricultural benefits under different flood risk management conditions:

- Step 1: Defining agricultural productivity
- Step 2: Defining the impact of flooding on agricultural productivity
- Step 3: Expressing any difference in agricultural productivity with different flood risks in monetary values

The greatest detail will be required to assess reductions in flood defence or flood risk management standards for specific schemes on relatively intensively cropped land, including intensive grassland. Less detail is justified for broad scale or reconnaissance level assessment at the catchment scale.

Method for assessing agricultural benefits

3 Steps

1 Defining agricultural productivity

2 Defining the impacts of flooding

3 Expressing any difference in monetary values

Data needs, sources and collection methods

Step 1: Defining agricultural productivity

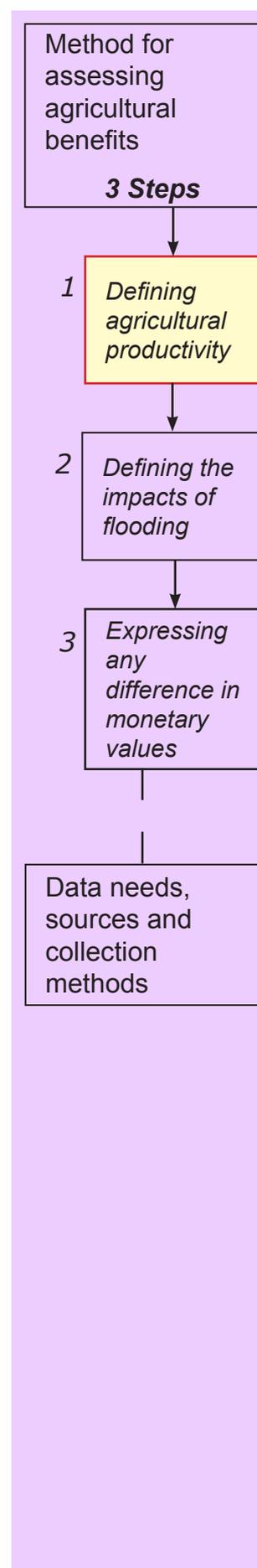
For the area in question we need, first, to estimate the level of the water table during the critical periods of the farming calendar, as this parameter is critical to soil drainage and therefore to agricultural production. This level can be expressed as a drainage 'condition' and an agricultural productivity class (Table 9.2).

Information on land use, classified into major crop and grassland types (Table 9.1), is then used to determine the likely consequences for the physical and financial performance of arable crops and grassland under different levels of flood risk.

- For **arable land**, estimates of crop yields can be obtained from farm surveys or from data on regional yields adjusted for local drainage conditions (Table 9.3). Farmers are usually able to report the degree to which yields on poorly drained parts of their farm are lower than elsewhere.
- Assessing **grassland** productivity is more complicated, requiring information on type and age or weight of grazing livestock; livestock feeding regime; length of grazing season; liveweight gain or milk yield; and type and tonnage of conserved grass.
- Using data from secondary sources and from farm surveys in the study area, it is possible to estimate the productivity of grassland according to the type and number of livestock that can be carried per ha under different drainage conditions (see MCM Chapter 9).

Agricultural drainage condition	Agricultural productivity class	Depth to water table from surface	Spring time freeboards in water-courses (natural drainage)	Spring time freeboards in water course (field drains)
Good: 'rarely wet'	Normal, no impediment imposed by drainage	0.5m or more	1m (sands), 1.3m (peats) 2.1m (clays)	1.2m (clays) to 1.6m sands (0.2m below pipe outfall)
Bad: 'occasionally wet'	Low, reduced yields, reduced field access and grazing season	0.3m to 0.49m	0.7m (sands) 1m (peats) 1.9m (clays)	Temporarily submerged pipe outfalls
Very Bad: 'commonly or permanently wet'	Very low, severe constraints on land use, much reduced yields, reduced field access and grazing season: mainly wet grassland	Less than 0.3m	0.4m (sands) 0.6m (peats) 1m (clays)	Permanently submerged pipe outfalls

*Freeboard here is the height difference between water in the ditch and adjacent field surface level.



Step 2: Defining the impacts of flooding

These can be distinguished in terms of:

- Frequency of occurrence (including the chance of multiple floods per year)
- Seasonality (especially the distinction between winter and summer floods)
- Duration (from one or two days in some cases, to two or three months in washland areas)
- Depth (as this affects damage to crops and livestock)
- Soil compaction; erosion risk; chance of crop recovery.

Flood damage costs include:

1. The loss of output due to inundation, plus
2. The cost of remedial work, such as re-sowing crops.

A similar approach is adopted for grassland. The impact of a flood occurring in a given month is assessed in terms of the animal food lost. This is measured as the energy lost from grass (effectively the food's calorific value) valued at substitute feed prices, less any savings in hay/silage making costs if relevant, plus stock relocation and clean-up costs.

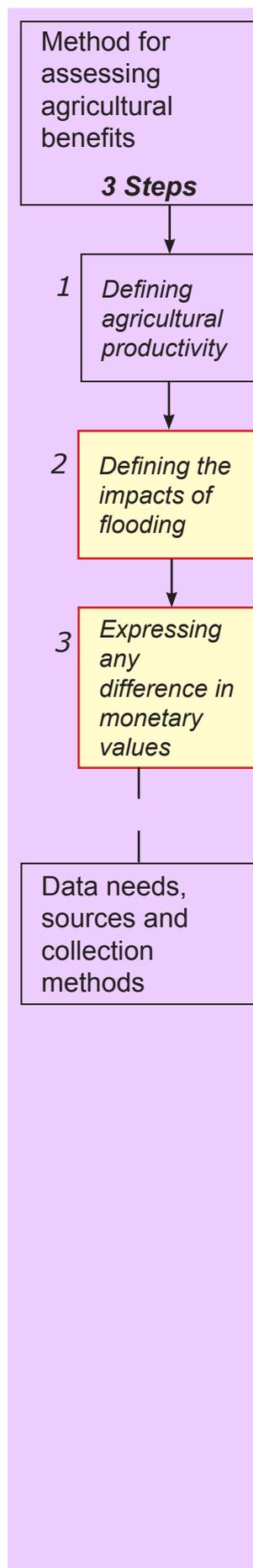
Step 3: Expressing any difference in monetary values

1. Gross and net margins

The financial impacts of changes in flood risk management standards can be determined using the accounting conventions of gross margins, fixed costs and net margins, expressed either per hectare (ha) or for a farm as a whole.

The level of detail required depends on the purpose and context of the appraisal. Where the 'do-nothing' option involves write-off of agricultural assets, the appraisal can use the estimated reduction in land values (suitably adjusted: see Table 9.6) as a basis for assessment. In many other cases, however, it will be necessary to estimate the financial and economic performance of agriculture under different flood management options.

For this, for arable crops (Table 9.4), gross margins per hectare measure the value of output, including any remaining direct subsidies, less variable costs such as seeds and fertiliser. Variable costs are directly related to each unit of activity, and can be avoided if that activity is not pursued (see MCM, Chapter 9). Gross margins show the monetary gain (or loss) associated with one more (or one less) unit of an activity, assuming other so-called 'fixed' resources available to the business, such as



regular labour, machinery, buildings and land (and their associated costs) remain unchanged.

There is currently (2005) considerable uncertainty in the UK farming sector as farmers adjust to new policy and market conditions. For this reason, estimates of measures of financial performance (gross and net margins) should be kept under review during a scheme's development.

3. Scenarios and their treatment

In 2005 a major change affected the way farmers in England and Wales receive government financial support. Instead of payments per ha (typically about £250/ha) for crops such as cereals, proteins and oilseeds and payments per head of beef or sheep animal, farmers now receive a Single Payment per year which is not related to output.

Previous Defra guidance (e.g. MAFF, 1999) required removal of direct subsidies from crop and livestock gross margins. This no longer applies because, with a number of small exceptions, these direct subsidies no longer exist. Thus the economic analysis is more straightforward than before. Defra issued revised guidance in winter 2005/2006 to accommodate these important changes.

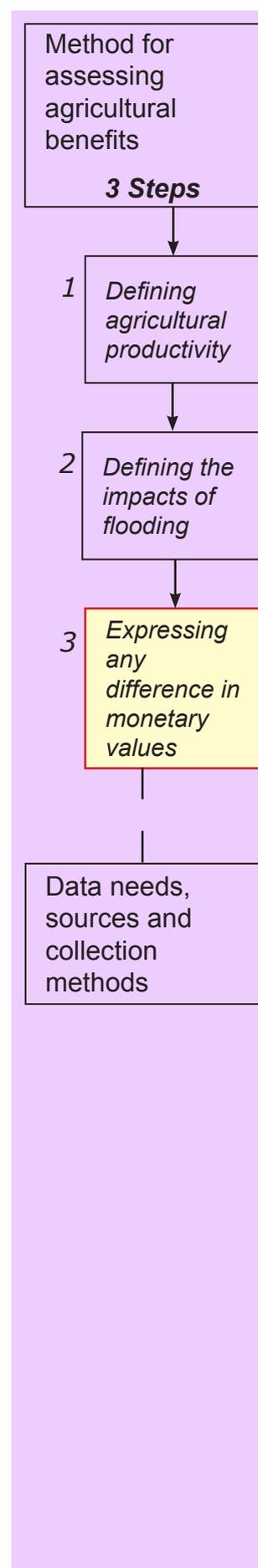
Tables 9.4 and 9.5 contain examples of financial (to farmers) and economic (to the national economy) returns for selected crop and livestock enterprises. High value horticultural crops, field vegetables and potatoes, and commodities whose production is limited by quota such as milk and sugar beet, should be treated as though they are a wheat crop. Persistent losses through flooding of these high value or quota commodities would result in the relocation of their production, displacing wheat as the most common arable crop.

Consistent with the view that agricultural enhancement through flood defence investment is no longer a prime policy objective, Defra guidance (MAFF, 1999: FCDPAG3) identifies three scenarios which reflect the nature of flood risk change, namely:

- Scenario I: Permanent loss of agricultural land;
- Scenario II: One-off damages arising from infrequent flood events;
- Scenario III: A permanent deterioration in flood risk management standards.

These scenarios justify different approaches and methods for the assessment of flood risk management benefits (Table 9.6). Specific guidance should, however, be sought from Defra for:

- High level strategic assessments;



- Large scale schemes of more than 10,000ha; and,
- Agriculturally less-favoured areas where there could be significant impacts on vulnerable farming communities and local economies.

Data needs, sources and collection methods

It is advisable to start with an exploratory survey of the study area to define the geographical boundary of influence, that is the benefit area, and to determine current flood risk management standards and issues arising.

The exploratory survey will also identify broad categories of land use, dominant farm types and systems, possible flood risk management options, the likely impact of these and the likely attitudes of key stakeholders, especially farmers.

Key informants will include:

- Staff with flood risk management interests in regional offices of the Environment Agency, and Defra;
- Local Internal Drainage Boards if relevant;
- Representatives of farmer organisations (such as the National Farmers' Union),
- Local advisors and land agents;
- Environmental groups such as the local wildlife trusts and Farming and Wildlife Advisory Groups (FWAGs).
- University Agricultural Economics and Agriculture Departments.

In most cases some form of farm survey will also be needed, usually involving a quota of representative farmers that covers the major variations in farm circumstance (e.g. size, tenure, land type, flood risk), farm practices (e.g. enterprise mix, drainage improvements), and farmer characteristics (e.g. age; family circumstances and motivation).

For agricultural enhancement schemes, the extent to which flooding and drainage currently constrain farming will be a focus of enquiry, together with the factors that are likely to encourage farmer take-up of potential benefits. Conversely, the scope for, and attitudes towards, reconciling flood storage, wildlife and farming interests will be a focus for wetland and washland development schemes.

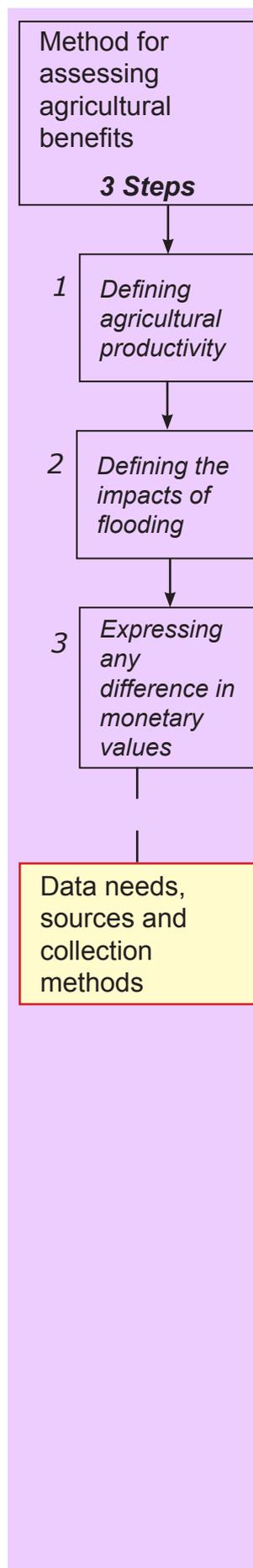


Table 9.3 Common farming performance by field drainage conditions (England and Wales)			
Land Use	Field Drainage Conditions		
	Good	Bad	Very Bad
Arable			
Yield as % of 'good' category			
Winter wheat and barley	100	80	50
Spring wheat and barley	100	90	80
Oil seed rape	100	90	80
Potatoes, peas, sugar beet	100	60	40*
Typical wheat financial gross margin £/ha	£300-£350	£200-£250	£25-£75
Grassland			
Typical nitrogen use on grass kgN/ha	150 - 200	50 – 75	0 - 25
Grass conservation	2 cut silage	1 cut silage or graze	1 cut hay or graze
Typical stocking rates: Livestock units/ha	1.7 – 2.0	1.2 - 1.4	0.7 - 1.0
Typical livestock type	Dairy, intensive beef and sheep	Beef cows, 24 month beef, sheep	Fattening of 'store' cattle, and sheep
Typical financial gross margins £/ha (after forage costs)	£1,200-1,400 (dairy) £400-£500 (intensive beef/sheep)	£150-£250	£100-£150
Days reduction in grazing season compared to 'good' category	none	Spring: 14 to 21 Autumn: 14 to 21	Spring: 28 to 42 Autumn: 28, no stock out in winter

Livestock units: dairy cow, 1 Lu; beef cow, 0.8 Lu; 24 month beef, 0.7 Lu; sheep plus lamb, 0.14 Lu.

A grazing day is worth about £1.12/lu in spring, £0.8/lu in autumn, and £0.38/lu in winter in terms of savings in housing costs and feed conservation costs.

*not grown if persistently 'very bad'.

Table 9.4 Financial and economic gross margins, fixed costs and net margins for selected crops								
			Winter wheat	Oil seed rape	Peas	Beans	Sugar Beet*	Pota-toes*
a	Gross Output	£/ha	595	392	374	374	1760	4050
b	Variable Cost	£/ha	250	225	185	130	650	1800
c	Gross Margin (a-b)	£/ha	345	167	189	244	1110	2250
Fixed Costs								
d	Semi Fixed	£/ha	135	120	116	99	216	652
e	Full Fixed Costs*	£/ha	313	318	274	240	434	1506
Financial Returns								
Net Margin/Crop								
f	after Semi Fixed Costs (c-d)	£/ha	210	47	73	145	894	1598
g	after Full Fixed Costs (c-e)	£/ha	32	-151	-85	4	676	744
Economic Returns (Defra PAG3, Scenario II: one-off loss)								
	Economic adjustment	%	none	none	remove area payment		treat as wheat	
h	Reduction in Gross Output	£/ha	0	0	34	34	0	0
i	Adjusted Gross Output (a-h)*	£/ha	595	392	340	340	595*	595*
j	Adjusted Gross Margin (c-h)*	£/ha	345	167	155	210	345*	345*
Economic Returns (Defra PAG3, Scenario III: permanent loss)								
	Economic adjustment	%	none	none	remove area payment		treat as wheat	
	Adjusted Gross Margin (j)	£/ha	345	167	155	210	345	345
Adjusted Net Margin								
k	after Semi Fixed Costs (j-d)*	£/ha	210	47	39	111	210*	210*
l	after Full Fixed Costs (j-e)*	£/ha	32	-151	-119	-30	32*	32*

Notes: * treated as a wheat crop for economic analysis

Arable farmers receive about £250/ha subsidies in 2005 for eligible land, that was previously in receipt of area payments.

Excluding land rent and land purchase costs, which are omitted from economic analysis

Wheat yields are average for first and subsequent crops in rotation first wheats: barley GMs about 75% of wheat GM

Source: Farm Business Survey and Defra sources, Regional and local estimates may vary

Table 9.5 Financial and economic gross margins, fixed costs and net margins for selected livestock enterprises						
			Dairy Cows	Beef Cows	Beef Cattle	Sheep
a	Gross Output	£/head	1150	250	180	48
b	Variable Costs	£/head	460	150	95	27
c	Gross Margin (a-b)	£/head	690	100	85	21
Fixed Costs						
d	Semi Fixed	£/head	241	93	55	20
e	Full Fixed Costs*	£/head	531	256	144	54
Financial Net Margin per head						
f	After Semi Fixed Costs (c-d)	£/head	449	7	30	1
g	After Full Fixed Costs (c-e)	£/head	159	-156	-59	-33
h	Typical Stocking rates: Head per ha		2	1.7	4	11
Financial Returns (excluding single farm payments)						
Returns per hectare						
i	Gross Output (a*h)	£/ha	2300	425	720	528
j	Gross Margin (c*h)	£/ha	1380	170	340	231
Net Margin						
k	After Semi Fixed Costs (f*h)	£/ha	898	12	120	11
l	After Full Fixed Costs (g*h)	£/ha	318	-265	-236	-363
Economic Returns (Defra PAG3, Scenario II: one-off loss)						
	Economic adjustment		wheat*	none	none	none
m	Adjusted Gross Margin		345	170	340	231
Economic Returns (Defra PAG3, Scenario III: permanent loss)						
	Economic adjustment		wheat*	none	none	none
	Adjusted Gross Margin (m)	£/ha	345	170	340	231
Adjusted Net Margin						
n	After Semi Fixed Costs (k or wht)	£/ha	210*	12	120	11
o	After Full Fixed Costs (l or wht)	£/ha	32*	-265	-236	-363

Notes: Some rounding errors.

*dairy area treated as a wheat crop for economic analysis.

As from 2005, milk, and beef and sheep headage subsidies are discontinued, eligible farmers receive payments of £100-£350/ha depending on intensity of land use

Estimates exclude land rent and/or land purchase costs, which are omitted from economic analysis

Variable costs include average forage costs such as fertilisers on grass.

Beef cows: single sucklers, mix of autumn and spring born calves
 Beef cattle: finishing mix of suckled calves on grass (summer) and silage (winter)
 Source: Farm Business Survey and Defra sources, Regional and local estimates may vary

Table 9.6 Different assumptions for alternative agricultural flood risk management scenarios (Defra advice)

	Scenario I	Scenario II	Scenario III
	Land lost to agriculture	Temporary, one-off loss of agricultural output	Permanent reduction in the value of agricultural output
All agricultural land use	Loss assumed equivalent to 65% of prevailing land values		
Crops: Cereals; oilseeds; beans/ peas. Grassland: Beef and sheep		Loss of Gross Margins per ha (adjusted for possible savings in costs), plus clean-up costs	Reductions in Net Margins associated with change in flood and land drainage conditions*
Other: Dairy; sugar beet, potatoes; high value fruit/ vegetables		As above, treated as though the area is occupied by wheat	As above, treated as though the area is occupied by wheat

(See also Tables 9.4 and 9.5)

* Calculate net margins (gross margins minus fixed costs)

Remaining issues

- ◆ The agricultural support regime introduced in 2005 represents a major change from the pre-existing regime. This means that the gross margins tabulated here may change as the cropping and land use patterns become fully adjusted.
- ◆ Farm surveys should be carried out by competent and experienced interviewers with knowledge of farm management systems
- ◆ Flooding from estuarine and coastal sources may result in greater impact and higher losses than are given here, and the land is likely to take longer for full production to be restored.

10 Assessing environmental benefits and costs

This chapter discusses how to take account, in the appraisal of FCERM schemes, of their impact on the environment (both positive/benefits or negative/costs). This is an essential component of project appraisal (HM Treasury, 2003).

This appraisal should be:

- Approached positively to explore the case for flood and coastal erosion risk management schemes contributing to environmental improvement.
- Part of mainstream appraisal, both from the outset and throughout.

An appraisal should aim to assess all the costs and benefits, including those environmental costs and benefits which are not straightforward to value in monetary terms. The costs and benefits of goods and services that are not traded in markets must not be ignored just because they are more difficult to assess (e.g. nutrient capture or a breeding site for birds).

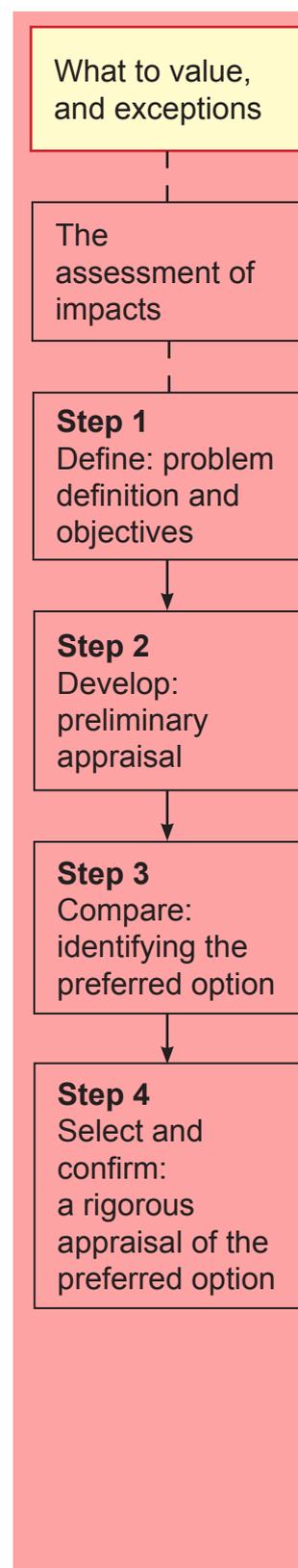
What to value, and exceptions

In principle, all environmental costs and benefits that can be valued in monetary terms should be included in the benefit-cost analysis. The only exceptions are:

1. When environmental valuation is likely to be very difficult (or disproportionately expensive), and when a sensitivity test has clearly shown that it would make no difference to the decision about what scheme/option to develop;
2. Where no meaningful monetary valuation is possible. In this case the environmental costs and benefits should still be fully described and taken account of outside the benefit-cost analysis, so as still to have a bearing on the overall appraisal. Multi-Criteria Analysis (MCA) provides a framework for this.

Even if it is not feasible or practical to value all costs and benefits of a proposal, it is important to consider:

- How the scheme options differ in environmental terms; and
- How only these differences might be best described and possibly valued in money terms.



The assessment of impacts

Proper assessment of environmental impacts depends on a structured and rigorous approach to appraisal, which should include the steps described in Defra's project appraisal guidance: define; develop; compare; select and confirm. These are discussed below. For assessment at strategy, pre-feasibility, and feasibility study levels, see "Remaining Issues", 6.

Step 1: Define: problem definition and objectives

This stage should define the full range of FCERM options.

In all cases, the environmental consequences and objectives should be brought into the appraisal at the start. The most important aspect at this stage is an acknowledgement that avoiding environmental damage and achieving environmental gains are material considerations for scheme definition and objectives. They are just like any other category of benefit which may justify a flood or coastal erosion risk management scheme. In all cases, the relevant stakeholders (e.g. Natural England and English Heritage, or their equivalents for Wales) should be contacted for their advice at this stage.

When considering environmental objectives, appraisers should identify:

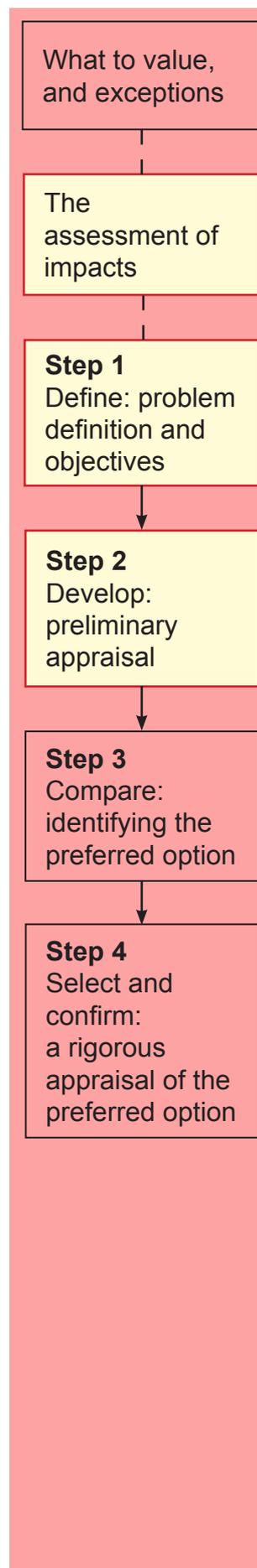
- Any *critical environmental criteria*, such as meeting legal requirements;
- Any *highly desirable objectives*, such as meeting high level targets (e.g. the PSA target for SSSIs); and
- Any *more general* environmental outcomes that may be desired.

Step 2: Develop: preliminary appraisal

Having defined the FCERM options, a preliminary assessment should *describe* all the costs and benefits, including the positive and negative environmental impacts of all the alternatives.

When considering strategies and high level plans, a scheme's Strategic Environmental Assessment should help this task. The purpose here is not to attempt a monetary valuation or consider the balance of the costs and benefits (that comes later). But it is important here that descriptions of the effects are as *clear* and *quantified* as practicable.

What needs describing (and later valued) is the change (positive or negative) brought about by the options being consid-



ered, not an overall valuation of all aspects of the environment. Both the costs (damages) and the benefits of the “Do nothing” option should always be fully appraised. One approach here is to use Total Economic Valuation (Turner *et al.*, 2005) (see “Remaining Issues”, 1). This comprises both ‘use’ and ‘non-use’ values (e.g. carbon sequestration (a use value) and knowing that a wetland will be available for future generations (a non-use value)). See also Table 10.1 for costs of environmental enhancement and mitigation.

The next task is a preliminary appraisal and eliminating those options that are definitely not feasible, while ensuring that options with environmental benefits are not ruled out. Only options clearly not meeting the *critical criteria* such as complying with legal requirements should be eliminated here. For example, a scheme having an adverse impact on a site designated under European Directives might be ruled out if there were an alternative solution not adversely affecting the site (see “Remaining Issues”, 2).

Care should be taken not to let appraisers’ views or prejudices eliminate options that further analysis might justify. For example, until a realistic assessment is made of total benefits it might not be possible to say that the costs of a scheme with substantial environmental benefits, such as habitat creation, are disproportionate. Any grounds for ruling out options should be clearly reported. Appraisal Summary Tables may help structure this initial assessment to ensure that all environmental effects are captured.

Step 3: Compare: identifying the preferred option

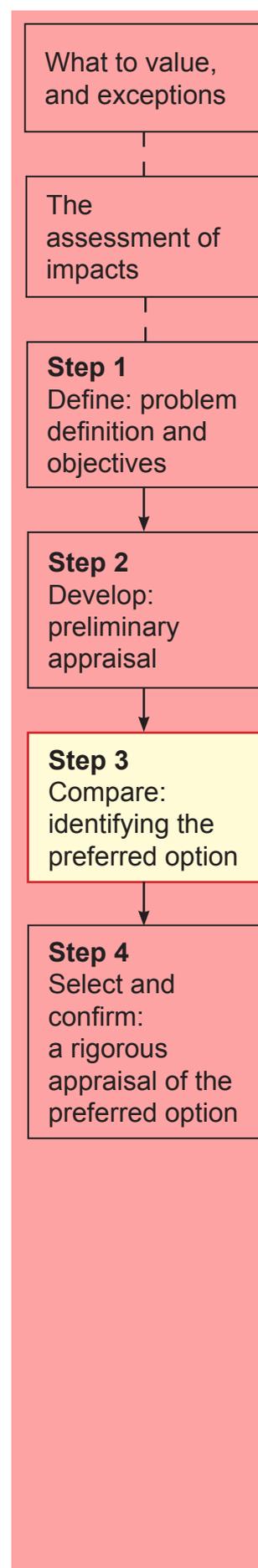
A more detailed appraisal should be made of the options that have not been eliminated in Step 2.

This should include the statement describing the environmental costs and benefits of options together with a monetary valuation of those impacts where possible, subject to the principles described above. Care and rigour in the appraisal process will be needed to ensure that all relevant effects are captured and double counting is avoided (see “Remaining Issues”, 3).

A sequential approach should be used to decide on the method for:

- Calculating a monetary value for an environmental cost or benefit, and
- Ensuring that any impacts which cannot be included in the benefit-cost analysis are taken into account.

Following the principles outlined above, impacts on the envi-



Environment should be valued in the following way:

1 Market Prices

Market prices, where available, should be used to establish a value for environmental benefits/costs. Establishing monetary valuations should be relatively straightforward where there is a market price. For example, if a managed re-alignment increases fish stocks this will have benefits to the local fishery, which can be valued.

However, many environmental goods and services do not have readily available market prices. In which case, alternative means of establishing values will need to be considered (see below).

2 Benefit Transfers

In some cases, values from previous studies may be transferable. Care must be taken to allow for the fact that in differing circumstances values may vary, which may limit the validity of this approach. Where available, benefits functions should be used rather than unit benefits, as benefits functions can take into account important variables, which may differ from site to site (Brouwer *et al.*, 1999).

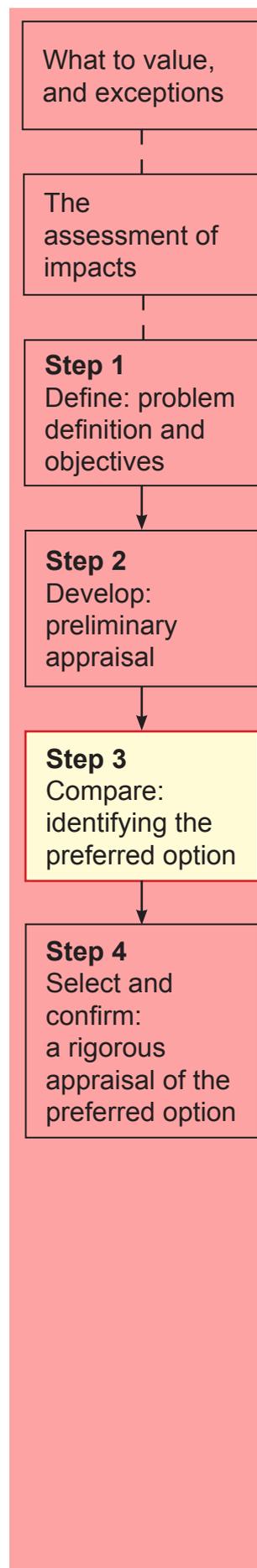
As the number of valuation studies increases, the opportunity for drawing on their results should expand. If credible applicable values from previous studies are not available, plausible upper and lower bounds on values may be possible, helping to consider whether it is worth commissioning further work to establish more robust values.

Where there is no market price, or acceptable proxy or robust transfer value available, a scheme-specific study to establish values should be considered. Before undertaking this, an assessment should be made:

- To clarify whether the results are likely to affect the preferred option;
- To clarify whether a meaningful monetary valuation is likely from that study.

3 Replacement costs

This method is only to be used where a prior decision has been made to maintain or replace a feature, for either policy reasons, or to meet a statutory requirement. Then the cost of maintaining it *in situ*, relocating it or recreating it, whichever is the lower, can be used as a minimum value for the appraisal. However, this technique has limited applicability (see “Remaining Issues”, 4).



4 Willingness to Pay

Where none of the above methods is applicable, a new study should be considered to establish values by calculating people's willingness to pay for the proposed environmental enhancement.

At this stage, appraisers with experience and competence in environmental valuation need to:

- Make a realistic assessment of the feasibility of such studies;
- Ensure that the values derived are credible.

The preferred method is to calculate the relevant population's willingness to pay as inferred by observing consumer behaviour (i.e. revealed preference using hedonic pricing). Where this is not feasible the alternatives are to ask people what they would be willing to pay for a particular benefit (stated preference) or identifying the compensation that they would require in order to accept a cost (willingness to accept). See MCM Ch. 10.

5 *Taking account of environmental costs and benefits that have not been valued in money terms*

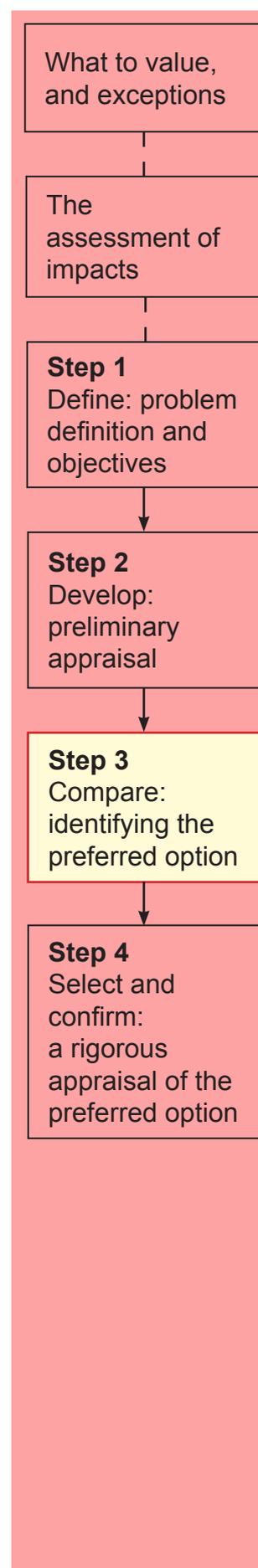
At this stage of appraisal all the environmental costs and benefits of all the options should be described and those that can be valued should have been valued.

If all the effects were included (through monetary valuation) the preferred option should be revealed by the scheme meeting Defra guidance on decision rules (PAG3): see Chapter 3. Any environmental costs and benefits that it has not been feasible to include will need to be clearly identified, because they may still influence the decision about which option to choose. Again, Appraisal Summary Tables can help here.

Where there are significant non-monetised costs and benefits, judgement will be needed as to whether they are sufficient to influence the preferred option. The most common framework for comparing unvalued costs and benefits is weighting and scoring (such as Multi-Criteria Analysis). This technique can help rank options taking account of both monetised and non-monetised costs and benefits¹.

Even if all the costs and benefits of an option cannot be valued, it is important to consider how the options differ and whether the difference can be valued. Switching analysis is one way of valuing the difference between options (see "Remaining Issues",

¹ Guidance is available from: www.odpm.gov.uk/stellent/groups/odpm_about/documents/pdf/odpm_about_pdf_608524.pdf and www.defra.gov.uk/research/project_data/More.asp?I=FD2013&M=KWS&V=2013&SCOPE=0



5).

Step 4: Select and confirm: a rigorous appraisal of the preferred option

The final Step is a rigorous appraisal to determine whether the preferred option is justified in terms of the funding criteria. Much of the work for this should already have been done in Steps 2 and 3.

However, if a scheme has been chosen on the basis of benefits that have not been valued in money terms, extra consideration may need to be given to ensure that the non-monetised benefits justify the expenditure.

Table 10.1 The costs of environmental enhancement and mitigation

In the case of the protection of environmental assets, costs include:

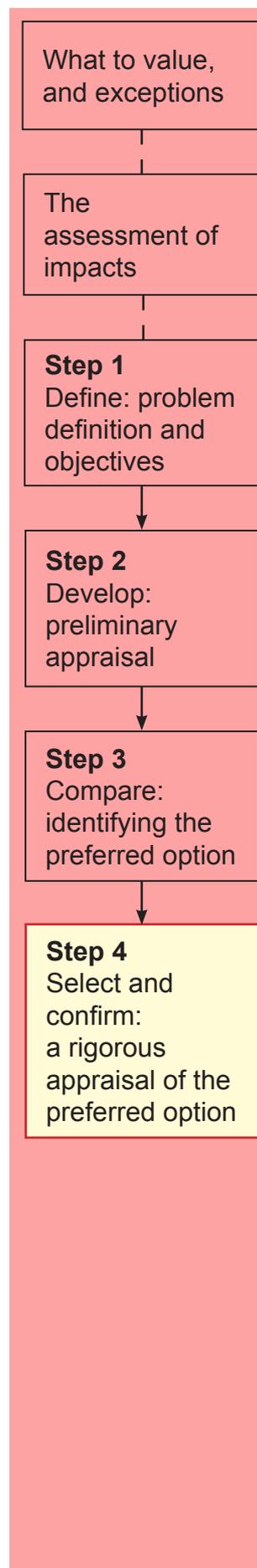
- Increased time for negotiation in the planning and design stages
- Increased land-take for the project
- Increased construction costs due to on-site mitigation measures during the operational stage
- Management after construction
- Monitoring and management adjustments

In the case of the replacement of environmental assets, costs should cover:

- Land acquisition
- Initial site survey/feasibility study
- Background research including species and population studies
- Removal and maintenance of plant species (ex-site conservation)
- Seed bank creation from sources at site to be lost or damaged
- Reintroduction
- Habitat creation including physical factors (e.g. hydrological and sediment regimes)
- Habitat management/site wardening
- Control of competitors
- Monitoring: short, medium and long-term
- Site safeguards
- On-going advice to land managers
- Publicity and public relations.

With the creation of substitute sites as a replacement for what is being lost, the main costs should cover:

- Land acquisition
- Set-up costs
- On-going management during the establishment stage
- On-going monitoring
- Subsequent adjustment of management regimes over several years, depending on habitat type



Remaining issues

- ◆ **1: Total economic value.** The most comprehensive method of assessing the value of environmental impacts is to take a functional systems approach to establishing a total economic value for the effect that each option will have on the environment. In theory this should capture most (but not all) values and avoid double counting. However, there are a number of practical difficulties and some of these - but by no means all - are rooted in quantifying environmental risks and uncertainties.
- ◆ **2: Legal requirements.** Schemes that are necessary to meet legal requirements may be assessed using cost-effectiveness analysis. The benefits of meeting the legal requirements are assumed to outweigh the costs and hence the focus can be shifted to achieving these objectives at least cost. However, often other types of benefits will differ between options which aim to meet the objective, in which case it may still be necessary to identify, describe, quantify and monetise the benefits, to the extent that they materially affect the choice.
- ◆ **3: Avoiding double counting.** Double counting is best avoided by recognising the impact pathway, the final impact on human welfare and the means of measuring this impact. For example, an environmental improvement that benefits anglers by improving fish nursery conditions and increasing fish stocks leading to higher catch rates should be evaluated via the change in the anglers' willingness to pay for these improvements. Other impacts such as increased fish size, increased bait sales, consequential tourism impacts etc. should already be reflected in this value, and separate estimations would lead to double counting.
- ◆ **4: Replacement cost and its limitations.** The replacement cost method as an appraisal valuation technique is contingent on there being a prior decision to maintain, replace or relocate the feature being valued. What is then being assessed is the cost of complying with a policy/requirement and not the value of the feature (so these values cannot be used in benefit transfers). This is therefore not an acceptable measure of value where one is considering the merits of going beyond compliance with policy / statute or assessing the acceptability of an option that would lead to the loss of a feature, whether or not it is protected by statute (see Defra Project Appraisal Guidance (PAG5)). Where the preferred option is to relocate or replace a feature, this method of valuation may not capture some potentially significant costs (disbenefits), such as loss of local amenity or historical significance: these effects will need to be considered separately.

◆ **5: Switching analysis.** Consider two alternative schemes A and B. The whole-life cost of A is £10m compared to £8m for B, but A has significant additional environmental benefits. These environmental benefits would need to be at least £2m for B to be preferable to A. Some 5,000 people live in the affected area, who might benefit from these environmental improvements. Each beneficiary would need to be willing to pay £400 for these benefits to be sufficient to alter the choice based on the whole life costs.

◆ **6: Levels of assessment: Strategy, pre-feasibility, and feasibility.** To avoid disproportionate time and resources being spent on environmental benefit assessments, such as inappropriate use of willingness-to-pay surveys, questions need to be asked at strategy and pre-feasibility stages:

- Is there an environmental concern significant enough to warrant such time and resources in assessment?
and
- Is option choice likely to hinge on the environment issues to be tackled?

If appraisers have evidence that impacts are significant, then more consideration of them should take place at the pre-feasibility and feasibility stages, exploring any concerns confirmed at strategy stages. There will normally be a pressing need for assessment at pre-feasibility stages, although at feasibility levels the need may vary on a case by case basis, depending again on the size of environmental impacts identified within the relevant area.

References

Please note that for this Handbook the number of references to additional documents has been restricted to the absolute minimum. However, appraisers should always, in cases of doubt, seek guidance (starting with the Multi-Coloured Manual (MCM), referenced below), or refer to the over-riding policy framework in the Treasury 'Green Book' (below) and the associated Defra guidance (e.g. MAFF (1999), below).

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