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

The 'Sugden' Approach - Testing a Disaggregated Approach to Appraisal

R&D Technical Report FD2018/TR1

Environment Agency

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R&D Technical Report FD2018/TR1

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Statement of use: This report expands on Prof. Robert Sugden's disaggregated approach to cost benefit analysis in improve transparency in economic appraisal (See TR3 and TR4). It tests the approach on four case studies and highlights lessons learned, gaps and further research.

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Executive summary

In this report we have tested and developed the approach recommended by Professor Sugden and we endorse the principle of making clear the various sources of funds and the distribution of benefits. We have developed an appropriate table of monetised costs and benefits and a consistent Appraisal Summary Table that would bring together the material for a final multi-criteria analysis. We have developed and tested templates for their use in appraisal. We find the approach has the following advantages:

- The method provides greater transparency and more information to aid decision making.
- The approach supports both improved quality assurance of appraisals, and optimisation of option design
- It makes it clearer what has been monetised and included in the appraisal and what has not.
- It allows the benefit of schemes to individual businesses or groups of businesses to be identified and therefore may assist in negotiation of contributions from third parties.

Data is generally available to support the application of the approach and practitioners confirm that the process is unlikely to involve significantly more work. We have, however, identified a number of areas where further research, or policy input, is required. These include:

- Data issues – The recommendation to use the numeraire of market prices has implications for the FHRC MCM datasets and capping of damages.
- Methodological issues – We have made recommendations regarding the treatment of tourism, disruption to trade/services and agricultural losses. Further work is also needed to understand how easily the MDSF model - which we understand is used reasonably widely for strategy level assessments - can be adapted.

A number of issues were identified whose resolution was outside the scope of this project, we have made recommendations for carrying these forward. They concern:

- Identification of property ownership – this is required to support proper application of social equity weighting factors and allocation of impacts to the appropriate economic interest group
- Treatment of social equity – we have recommended that the income distribution of household beneficiaries of flood protection might be handled in a fair and simple way by valuing flood damage to all domestic properties equally in the CBA
- Development of the appraisal process - to optimise the quality assurance of appraisals, allow the additional information provided by the disaggregated approach to be accounted for in the decision making process, and reduce the cost of the appraisal process

- The interface of the cost benefit analysis (CBA) with the multi criteria analysis (MCA) framework suggested as a way of accounting for non-monetised benefits within the appraisal process and currently being piloted by the EA
- The consistency with which the appraisal approach is currently applied and implications for resource allocation across schemes
- The choice of metric and treatment of contributions

Ultimately the choice of metric is a matter for policy as it reflects the objectives of the risk management programme. Our clear recommendation is that the appropriate benefit:cost metric to use is NPV/ Cg (present value of net benefit/ cost to exchequer), to allow most benefit from the use of public money to be achieved, including the benefit of private contributions.

We recommend that a single expert source within government/Defra is considered to oversee appraisal development, supporting FCERM in this regard, in consultation as occasionally appropriate with Treasury.

Our detailed recommendations are presented in Section 7 of the main technical report. They are arranged in three categories:

- Adoption of the disaggregated approach
- Methodology development
- Review of processes

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1. Introduction

1.1 Background

Cost-benefit analysis is a key technique recommended in HM Treasury's Green Book, and is an important part of project appraisal for flood and coastal erosion risk management strategies and schemes. For a number of reasons, including ease of assessment, the current appraisal framework uses an aggregated approach to calculating costs and benefits – the social costs and benefits (SCB) approach. The SCB approach seeks to measure costs incurred and benefits created by a project in national economic terms.

The aim of this project is to investigate the feasibility of, and where appropriate develop proposals for, the improved appraisal framework proposed by Professor Sugden, Professor of Economics at the University of East Anglia, in his reports to Defra on "Developing a cost-benefit framework" for flood risk management and "Integrating cost-benefit analysis and multi-criteria analysis".

The approach, sometimes referred to as the 'Sugden-WTP' approach, differs from the SCB approach, in that it seeks to measure the net welfare change (or net benefit) caused by the project for individual economic interest groups. This is a disaggregated approach to presenting costs and benefits, but summing the individual net benefits leads to the same value for net social benefits as the SCB approach. This disaggregation is the key feature of the approach, rather than the WTP (willingness to pay) element; for this reason we refer to this potential new approach as the disaggregated approach

The main advantage of the disaggregated approach is that it presents the results in a format that shows more clearly how different economic interest groups (e.g. in a flood risk management context house owners, farmers, taxpayers) benefit (or not) from a project. It also shows how it affects different financial budgets (e.g. the budgets of different public bodies, and those of other project partners).

1.2 Overview

The project reported here included consideration of some specific technical issues related to the work carried out and matters raised by Professor Sugden's work, in addition to testing the approach using case studies based on projects for which appraisal has been completed using existing guidance, preparation of an outline methodology and completion of a gap analysis. The first task, consideration of specific technical issues, is reported separately in an accompanying technical report (Jones-Lee and Spackman 2006).

Section 2 describes the methods applied to conduct the research.

Section 3 summarises the expert review of issues raised by Professor Sugden.

Section 4 describes the outputs and findings of a series of case studies undertaken to explore various aspects of the application of the new approach.

Section 5 presents a discussion of the findings.

Sections 6 and 7 present our conclusions and recommendations.

2. Methods

2.1 Overall approach

The work has involved:

1. A detailed review of the current and proposed disaggregated approach including:
   - Initial information gathering and a stakeholder workshop to gather views and discuss priorities for the first stage of the work
   - An expert review of Sugden's proposals.
   - Development of initial proposals for a preferred methodology and Appraisal Summary Table

2. Development and testing, via case studies, of the preferred methodology for the appraisal of FCERM projects using the disaggregated approach.

3. A gap analysis to establish any gaps or wider implications relating to the use of the disaggregated approach for FCERM projects, and

4. Production of a report and supporting documentation providing an explanation of the process and any necessary calculation tables.

2.2 Methods used

We used a number of sources of information and methods of research to achieve the objectives of the project. While essentially desk-based research, we used a variety of tools, techniques and methods including:

- Telephone and face-to-face interviews and meetings
- Review of relevant literature and existing guidance materials
- Stakeholder workshop
- Case studies

These are outlined in the following sections.

2.2.1 Desk-based reviews

In addition to the detailed expert review of Professor Sugden's proposals reported in Section 4, we undertook desk-based reviews of existing guidance materials including FHRC's MCM (Penning-Rowsell *et al*. 2005) and existing PAG guidance, to ensure that we had a good understanding of the existing appraisal system. Other literature and materials were reviewed as required.

2.2.2 Interviews

Interviews were used to explore the following issues:

- perceptions of the strengths and weaknesses of the existing appraisal system from the perspective of:
    - project officers from Defra and EA
    - other individuals involved in flood and coastal erosion risk management appraisals and assessments

- detailed technical and economic issues including:
    - insurance issues,
    - the approach to Multi-Criteria Analysis developed and tested for use in FRM project appraisal and decision-making
    - the assumptions underlying the data presented in the 'Multi-Coloured Manual' (MCM) (Penning-Rowsell *et al*. 2005) was provided by the flood hazard research centre (FHRC) at Middlesex University, and discussed in a liaison meeting at FHRC which allowed queries to be resolved.
    - practical issues of implementation including likely additional costs was provided by an EA contractor.

A list of interviewees is provided in Annex A.

2.2.3 Stakeholder workshop

Early in the project we held an engagement workshop for a range of stakeholders. This was intended to raise awareness of the project, and to gather the opinions of the wide range of participants. The workshop included presentations and discussions involving the whole group. At the end of the workshop we sought suggestions for projects that might make useful case studies. In addition, facilitated breakout sessions were held, designed to elicit views from participants in two areas. Firstly, we sought views on what works well in the current appraisal system and what areas might be helped by a disaggregated approach. Secondly, as the expert review phase of the project included consideration of a number of issues that were desirable but not essential, we asked participants to rank both 'essential' and 'desirable' issues to inform the balance of effort to be allocated to those issues during the expert review . The workshop report is provided as Appendix A.

2.2.4 Case studies

We used case studies as the main vehicle for testing the disaggregated approach to project appraisal. This required selection of suitable case studies in conjunction with Defra and EA, liaison with EA personnel with responsibility for the selected cases and with the contractors who had undertaken the appraisals on behalf of EA. In one case, liaison was with local authority personnel responsible for the appraisal. Four case studies were undertaken, two schemes and two strategies, including one coastal erosion case study.

The case studies were undertaken using data from appraisals that had been completed, (or were nearing completion). While all contacts were very helpful, providing background data and additional breakdowns where they were available, it must be noted that available data were limited to those required for the current appraisal system, so that in some cases data were not available at the level of disaggregation that we might have preferred. In some instances, assumptions were made so that the method could be tested and demonstrated more fully. These are noted for individual case studies.

Case studies were undertaken one at a time, so that lessons learned and issues arising – such as categories of economic interest groups required - could be considered and addressed before moving to the next case study.

The findings of the case studies were presented to a group including Defra and EA officials and FRM appraisal practitioners and are given in Section 4.

3. Expert review

3.1 Background

The first area of work undertaken was to examine and comment on the reports to Defra by Professor Sugden on “Developing a cost-benefit framework” for flood risk management (Sugden 2005) and “Integrating cost-benefit analysis and multi-criteria analysis” (Sugden 2005). These two reports make many recommendations for introducing into flood risk management (FRM) a disaggregated accounting approach to CBA, which would set out clearly how the costs and benefits of a proposed scheme would be distributed. The reports also made a number of other proposals about general methodology, relating to, for example, the numeraire, the benefit/cost ratio and MCA.

This detailed review of the reports is provided in a separate, companion report (Jones-Lee, Spackman 2006), but a summary of the conclusions and recommendations is included here, together with additional consideration of insurance issues. As noted earlier (Section 2) the balance of effort allocated to each of the issues considered was informed by the output of the engagement workshop held early in the project. The output from the workshop is included at Appendix A.

3.2 Conclusions and recommendations

3.2.1 The disaggregated approach

In our review we endorse the disaggregated accounting proposals. We make a specific proposal for the inclusion of private contributions in the CBA benefit/cost ratio. More radically we suggest that the income distribution of household beneficiaries of flood protection might be handled in a fair and simple way by valuing flood damage to all domestic properties equally in the CBA. We endorse the principle of making clear the various sources of funds and the distribution of benefits, and propose an appropriate table of monetised costs and benefits and a consistent Appraisal Summary Table that would bring together the material for a final multi-criteria analysis.

Since the data needed for the disaggregated accounting recommended by Sugden are already available, and the other changes proposed are essentially presentational we conclude that it is unlikely that the ongoing costs of adopting the principles advocated by Sugden would be significant; this conclusion was tested further through the case studies (see Section 4). Discussions with practitioners suggest that modifying existing damage calculation spreadsheets to support a disaggregated presentation would not be an onerous task. For example, in a list of properties, each property might be ‘tagged’ as pertaining to

a particular economic interest group (data sorting should allow this to be done in blocks, rather property by property), with Excel functions such as SUMIF used to aggregate monetised impacts by economic interest group. Costs would be incurred in rolling out a new approach, for example, in preparing guidance materials, ensuring that practitioners understood the requirements of the new approach, and – if a decision was taken to move to market price as the numeraire – in producing datasets in market prices. issues of property ownership, stakeholder communication and inclusion of broader contributions and benefits (e.g. regeneration) could add complexity. Practitioners would incur 'one-off' costs in reviewing the requirements and amending in house calculational tools. However, our view is that ongoing costs would not be materially higher.

3.2.2 General methodology

We also broadly endorse the recommendations in the main Sugden report on general methodology, with regard to the benefit/cost ratio, where we suggest the denominator should be total net exchequer cost, and with regard to the numeraire, which, with Sugden, we suggest should be expenditure at market prices. We also suggest some further standardisation of terminology, such as the use, following Treasury convention, of appraisal to describe ex ante analysis and evaluation to describe ex post analysis, and a clear understanding of what by convention is included and not included in a "cost benefit analysis".

We are impressed by the professionalism of the current MCA project management, which embraces a strong understanding of MCA. We are also impressed by the quality of the economic advice available in Defra and the EA. We found that in contrast to practice in Transport appraisal, that there is no single expert authority within government controlling FRM appraisal development, in consultation as occasionally appropriate with the Treasury, in the sense that control is exercised over the development of WebTAG.[1]

A review of the kind launched with Sugden papers inevitably opens up other areas of potential refinement. Examples in this case include the review of the handling and valuation of agricultural and non-agricultural land use impacts, and of impacts on employment. There may also be scope for further work developing from this project in helping to facilitate the coordination of methodological development and of technical expertise.

We also note comments made to us that the appraisal process under the current FRM regime appears to be relatively costly as a percentage of the total programme cost.

As noted above, the priorities for the review reported in the companion report to this report (Jones-Lee and Spackman, 2006) were informed by the views of participants at the workshop described in Appendix A. This included some work

[1] This professional role in controlling the development of CBA and NATA in Transport is led by senior management , with substantial professional interest and input at Grade 3 level, and very strong inputs at Grade 5 level, from more than one division.

on the implications of insurance for the application of the "Sugden", or disaggregated, approach to cost-benefit analysis in flood and coastal defence. However, as work continued on the project, it was decided that some additional work was required in this area. We reviewed literature (in particular Huber 2004 and Crichton 2005) and discussed the issues with a number of experts[2]. Appendix B summarises these discussions.

It appears that there is now little cross-subsidy between premiums for dwellings at risk from flooding and those not at risk. We conclude that as the market is moving increasingly towards risk-based premiums there is no need for any line in the Appraisal Summary Table for the disaggregated approach to show cross-subsidisation by households not at flood risk of those that are flooded.

3.2.3 Preferred methodology

Our recommendations for a preferred methodology are based on the findings of the review. The detailed suggestions on presentation and handling (see Appendix C, which reproduces Appendix A of Jones-Lee and Spackman 2006) are used as the basis for the calculation and summary tables. In addition, the methodology was informed by work carried out by FHRC setting out the assumptions underlying the data in their multi-coloured manual (see Appendix D). The methodology was tested and developed through a series of case studies presented in the following sections. The methodology thus developed is described in Section 4.7.

[2] Defra and EA economists, and particularly Matt Crossman, Policy Adviser, Natural Perils, ABI (on secondment from Defra) and Federico di Pace, Economist, ABI

4. Case studies

4.1 Case study selection

We worked with Defra and EA, informed by interviews with practitioners and the output from the engagement workshop, to identify aspects of projects that it would be useful to include in case studies. These were:

- Borderline / marginal scheme – to test/ see whether the detail of the potential new method might make a scheme more or less marginal
- Contributions – to test whether the handling of contributions within a potential new approach would alter the outcome of the appraisal materially
- Deteriorating defence – as the economics of such schemes may be quite different from others
- Large Beneficiaries (i.e. industrial sites)
- Small Beneficiaries (i.e. households)
- Environmental issues
- Other intangibles (e.g. social, recreation, leisure benefits)
- Multifunctional / multi-departmental schemes
- Political pressure – particularly in the context of local stakeholder groups
- Regeneration/ development benefits
- PFI Aspects – although it was recognised that a suitable project might be difficult to find
- Readily available information – ideally project appraisal should be complete (or nearing completion), but have been completed in the recent past, so that information would be readily available.
- Scheme or strategy – it would be desirable to test the method at both strategy and scheme level
- Coastal erosion – it would be desirable to test the method on a coastal erosion project

We selected a range of potential case studies and identified, with assistance from EA and contractors involved in the projects, which of the aspects above were a feature of those schemes. We selected four case studies that appeared to offer a good mix of these aspects:

- Stallingborough
- Old Goole
- Boston
- Lyme Regis

The initial assessment of the aspects these projects offered for testing the method is summarised in Table 1, below.

Table 1: Initial case study selection assessment

Scheme Aspects	Stallingboro'	Old Goole	Boston	Lyme Regis
Borderline / marginal scheme				
Contributions	✓			
Deteriorating Defence	✓			✓
Large Beneficiaries	✓	✓	✓	✓
Small Beneficiaries	✓	✓	✓	✓
Environmental	✓	✓	✓	✓
Other intangibles		✓	✓	✓
Multifunctional / multi-departmental schemes			✓	✓
Political pressure			✓	
Regeneration/ development			✓	
PFI Aspects			?	
Readily available information	✓	✓	✓	✓
Strategy			✓	✓
Scheme	✓	✓		
Coastal erosion				✓

As the table above shows these schemes address all of the required aspects with the exception of PFI involvements and that none of the schemes is marginal.

4.2 Case studies

The initial draft worksheets were developed in Excel based on the proposals in the companion technical report to this (Jones-Lee and Spackman, 2006), and reproduced in Appendix C. These initial worksheets were used in case study A, after which the worksheets were reviewed and amended reflecting lessons learned during the first case study (see Section 4.3.5). This iterative approach was followed for all four case studies so that each case study workbook was built upon lessons learned previously (as described for each individual case study in the following sections). The general approach to each case study was to:

- Discuss the case study with the identified contact:
  For each case study we had an initial discussion with the identified contact to discuss at data requirements for the case studies. During each case study we held further discussions as required to clarify issues such as data availability, relevant economic interest groups, potential additional sources of funding for schemes
- Review data:
  In some instances, particularly for the scheme level appraisals the data provided was very detailed. We spent some time making sure that we understood the links between the workbooks in sufficient detail to be able to use the data sensibly.

- Identify the relevant economic interest groups:
  Relevant economic interest groups were identified using the project appraisal report supplied by the contact and through discussions. In some instances we selected a single commercial property as representing an economic interest group simply to demonstrate the method, categorising it as an 'Example Business'. In a live test, an example business would be chosen that might be expected to benefit to a significant degree from the scheme. As our 'Example Businesses' were chosen without this knowledge, while they allowed us to demonstrate the method, they would not have the same characteristics in terms of benefits as businesses that might be selected as economic interest groups in a live context.
- Data preparation:
  This involved copying the workbooks provided, and disaggregating some of the calculated damages. For example, for a detailed scheme appraisal, commercial and residential properties are typically identified separately but damages are aggregated at an early stage as there is no need to keep them separate for the current appraisal methodology. Data preparation in such cases therefore required some additional calculations to be undertaken to maintain the separation between residential and commercial damages (and so benefits). As the expert review recommended the use of market prices rather than factor costs we also adjusted some data by adding VAT. From discussions with FHRC, it is apparent that while the damage values in the multi-coloured manual (MCM) (Penning-Rowsell *et al* 2005) are generally presented in the numeraire of factor costs, data from WTP valuations are in market prices. Thus, such data were not adjusted, as noted in the descriptions of individual case studies.
- Populate workbook:
  The economic interest groups identified are entered into a 'lists' section of the workbook (see Table 2, below). This was then used to generate an appropriate data entry sheet into which the processed data were entered. The process of generating the data entry areas was increasingly automated and improved as the case studies progressed.
- Review lessons learned:
  Review the case study identifying any useful modifications to the workbook and methodology together with any wider implications.

It is important to note that we designed each case study to test the overall approach and specific aspects of relevance to that case study. Where not all the data required to perform the calculations were readily available it was necessary to make some assumptions, outlined in the notes for each individual case study. In addition, in all cases, except for case study B, appraisal was nearing completion but not finalised, and so we worked with draft workbooks and not final values. Therefore, the results of the case studies should be considered illustrative of the method, and not representative of the actual values of costs or benefits for the specific cases considered.

4.3 Case study A – Stallingborough

This is a scheme appraisal and part of the Humber strategy. Toe protection works are needed to prevent undermining of the defences protecting Stallingborough (which is just south of Immingham) due to falling foreshore levels. In addition to carrying out the toe protection works some local crest raising may be undertaken subject to the results of a detailed review of joint water level and wave height predictions.

The area includes major port facilities, power stations, oil refineries and chemical plants. There are also a number of residential properties in the flood cell. There are a total of 11,479 properties at risk with an indicative range of 100 to 300 years and a preferred standard of 200 years.

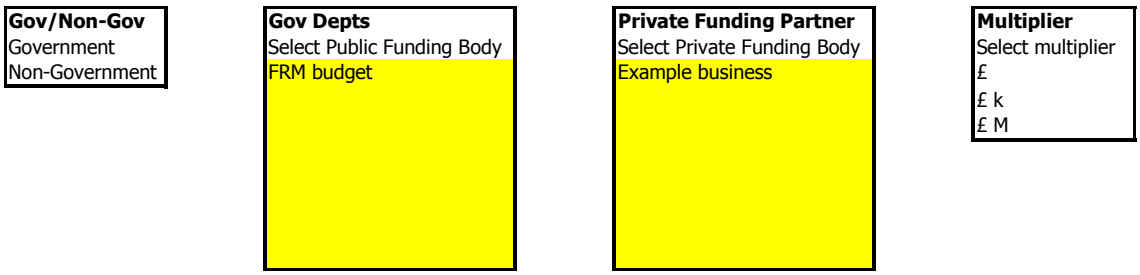
4.3.1 Economic interest groups

The project appraisal report (PAR) does not indicate any possibility of contributions from any businesses. To illustrate the method an example commercial property was selected from the list of properties giving the following interest groups for this case study:

- Residential
- Example business
- Non funding businesses
- FRM budget
- Emergency services (allowance for costs to emergency services added as percentage of flood damages)

No other economic interest groups were identified from discussions with the project contact or the PAR. Table 2 below shows the first draft of the lists area of the workbook, completed for the first case study. Note that emergency services and residential do not need to be entered as they are always included. The categories shown were based on the initial methodology described in Appendix A, while the economic interest groups selected are based on discussions with the project contact and information in the PAR. Data are entered only in the yellow area of the workbook

Table 2: First draft of lists area of workbook



4.3.2 Data processing

As data processing for each option required considerable work, not all options have been included in the disaggregated presentation of the economic appraisal for this scheme. Six options have been included, and these are considered sufficient to demonstrate the method. These are:

- Option 1 Do nothing
- Option 2 Do minimum
- Option 3 1 in 20 SOS
- Option 4 1 in 50 SOS
- Option 5 1 in 100 SOS
- Option 6 1 in 200 SOS

For this case study, no major costs or benefits had been derived using WTP methodologies, and so it was considered appropriate to increase most costs and benefits by 17.5 per cent to convert to market prices. The exception to this is that the monetised values ascribed to household stress were not adjusted, as we believe these to be presented in market prices.

4.3.3 Social equity weighting

The economic appraisal of this scheme did not use any social equity weighting. Instead, in the table of key impacts included in the project appraisal report, the deprivation indices for the three wards in the area are stated (3,188, 2,332, and 549), and the effect of each index on priority scoring is considered. Use of the most deprived ward changes the priority score by one.

The source data from which flood damages (and therefore scheme benefits) are estimated are at the individual household level. In theory, it would have been possible to group the properties by ward to present benefits by economic interest group. However, this would have required significant additional work and so was not undertaken. This does not mean that separating out the data in this way would always be onerous; our view is that planning to aggregate costs in this way prior to appraisal would result in little additional effort being required.

4.3.4 Disaggregated presentation

Table 3, below, shows cost, damage and benefits data are entered. Note that some of the unused lines in the table have been deleted to aid inspection. Again, data are entered in the yellow cells; blue cells contain calculated fields. Where cells have no values entered, for example environmental damage, this is because these items were not monetised in the economic appraisal data provided; either because they were not relevant or were not required under the existing appraisal methodology.

Table 3: Case study A – costs and benefits calculation

	Option 1 - Do Nothing	Option 2 - Do Min	Option 3 - 1 in 20 SOS	Option 4 - 1 in 50 SOS	Option 5 - 1 in 100 SOS	Option 6 - 1 in 200 SOS
Monetised Costs	£ k	£ k	£ k	£ k	£ k	£ k
Total monetised cost	**-**	**24,051**	**27,283**	**27,308**	**29,830**	**30,022**
Funded from:						
Public Agencies	**-**	**24,051**	**27,283**	**27,308**	**29,830**	**30,022**
FRM budget	**-**	**24,051**	**27,283**	**27,308**	**29,830**	**30,022**
Example business						
Businesses	-	**-**	**-**	**-**	**-**	**-**
Example business	**-**					
Increase in agricultural subsidies						
Monetised Benefits						
Total monetised damage	559,503	279,196	171,492	59,859	12,874	6,068
Total monetised FRM benefits	-	284,569	401,274	522,602	571,610	578,951
Total monetised benefits	**-**	**284,569**	**401,274**	**522,602**	**571,610**	**578,951**
of which:						
Reduced flood damage to/ abandonment of buildings ie damage avoided	**-**	**279,966**	**386,476**	**490,470**	**521,289**	**526,325**
of which:						
Residential damage avoided	-	35,544	124,389	137,757	141,673	142,067
Residential damage	142,347	106,803	17,957	4,590	674	279
Public Agencies damage avoided	-	-	-	-	-	-
FRM budget		-	-	-	-	-
Example business		-	-	-	-	-
Public Agencies damage	-	-	-	-	-	-
FRM budget						
Public funding partner 1						
Businesses - damage avoided	-	244,422	262,087	352,714	379,615	384,258
Example business	-	9,671	9,940	10,341	10,341	10,342
Non funding businesses	-	234,751	252,147	342,373	369,274	373,916
Businesses - damage	388,636	144,214	126,550	35,923	9,021	4,379
Example business	10,342	671	402	1	1	1
Non funding businesses	378,294	143,543	126,147	35,921	9,020	4,378
Reduced flood damage to/ abandonment of agricultural land (damage avoided)	-	-	-	-	-	-
Damage to agricultural land						
Reduced disruption to trade (damage avoided)	-	-	-	-	-	-
Example business	-	-	-	-	-	-
Non funding businesses		-	-	-	-	-
Disruption to trade (damage)	-	-	-	-	-	-
Example business						
Non funding businesses						
Net impact on transport, utilities, emergency services (damage avoided)	**-**	**4,261**	**13,262**	**22,958**	**24,980**	**25,515**
of which:						
emergency services damage avoided	**-**	**4,261**	**13,262**	**22,958**	**24,980**	**25,515**
emergency services damage/ cost	26,008	21,747	12,746	3,050	1,028	493
transport users damage avoided	-	-	-	-	-	-
transport users damage						
Public Agencies (damage avoided)	-	-	-	-	-	-
FRM budget	-	-	-	-	-	-
Public funding partner 1		-	-	-	-	-
Public Agencies (damage)	-	-	-	-	-	-
FRM budget						
Public funding partner 1						
Intangibles (households) - damage avoided	**-**	**342**	**1,536**	**9,174**	**25,341**	**27,110**
Intangibles (households) - damage (stress)	**28,520**	**28,178**	**26,984**	**19,347**	**3,179**	**1,410**
Environmental/heritage value damage avoided	**-**	**-**	**-**	**-**	**-**	**-**
Environmental/heritage value damage						
of which						
historic environment						
landscape and visual amenity						
Impact on recreational value - damage avoided	**-**	**-**	**-**	**-**	**-**	**-**
Recreational value - damage						
Development/ regeneration benefits	**-**	**-**	**-**	**-**	**-**	**-**
Business Funding Partner 1						
Non funding businesses						

Table 4: Case study A: Comparison summary table

Comparison Summary Table						
	Option 1 - Do Nothing	**Option 2 - Do Min**	**Option 3 - 1 in 20 SOS**	**Option 4 - 1 in 50 SOS**	**Option 5 - 1 in 100 SOS**	**Option 6 - 1 in 200 SOS**
Gross benefit = B(total)	-	284,569	401,274	522,602	571,610	578,951
FRM benefits = B(frm)	-	284,569	401,274	522,602	571,610	578,951
Net benefit (net present value, NPV) = B(total) – C(total)	-	260,518	373,991	495,294	541,780	548,929
Net FRM benefit (NPV(frm) = B(frm)-C(frm)	-	260,518	373,991	495,294	541,780	548,929
Total cost (PV, C(total))	-	24,051	27,283	27,308	29,830	30,022
Net exchequer cost = C(g)	-	24,051	27,283	27,308	29,830	30,022
Net cost to FRM budget = C(frm)	-	**24,051**	**27,283**	**27,308**	**29,830**	**30,022**
B/Cg = B(total)/C(g)		12	15	19	19	19
B/Cg incremental		*12*	*36*	*4,793*	*19*	*38*
B(frm)/C(frm) = B(total)/C(frm)		12	15	19	19	19
B(frm)/C(frm) incremental		*12*	*36*	*4,793*	*19*	*38*
NPV/Cg		**11**	**14**	**18**	**18**	**18**
						highest NPV/Cg
NPV/Cg incremental		***11***	***35***	***4,792***	***18***	***37***
NPV(frm)/C(frm)		11	14	18	18	18
NPV(frm)/C(frm) incremental		*11*	*35*	*4,792*	*18*	*37*

Attribution of net benefits						
Households	-	**35,886**	**125,925**	**146,930**	**167,014**	**169,178**
residential damage avoided		35,544	124,389	137,757	141,673	142,067
intangibles eg stress		342	1,536	9,174	25,341	27,110
environmental/ heritage damage avoided		-	-	-	-	-
recreational value		-	-	-	-	-
Public Agencies	-	**- 24,051**	**- 27,283**	**- 27,308**	**- 29,830**	**- 30,022**
FRM budget	-	- 24,051	- 27,283	- 27,308	- 29,830	- 30,022
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Business Funding Partners	-	**9,671**	**9,940**	**10,341**	**10,341**	**10,342**
Example business	-	9,671	9,940	10,341	10,341	10,342
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Business Non-Funding	-	**234,751**	**252,147**	**342,373**	**369,274**	**373,916**
Emergency services		**4,261**	**13,262**	**22,958**	**24,980**	**25,515**
Transport		-	-	-	-	-
Utilities		-	-	-	-	-
Agriculture	-	-	-	-	-	-

Table 4 shows the comparison summary table for case study A; all fields in this worksheet are calculated. Note that Table 4 includes calculation of a number of benefit: cost ratios. Our preferred benefit: cost metric is NPV/C_g; other metrics are included for comparison. The ranking of the options is essentially unchanged when compared with the original project summary sheet. Note that the benefit cost ratio B(total)/Cg is equivalent to the current benefit: cost ratio used – total benefit/ total costs – as Cg and total cost are the same in this example. Options 5 and 6 have essentially the same cost benefit ratio different only in the first decimal place with Option 6 having the highest value.

Figure 1 shows the attribution of net benefits by initial incidence from Table 4 (Option 1, Do nothing, is not shown). The left hand bar chart shows clearly that the percentage of net benefits accruing to households is lower for Option 2 than for the other options, while the right hand bar chart shows that net benefits to both households and businesses increase from Option 2 to Option 6. The right hand chart shows that the example business selected to illustrate the method gains most benefit by moving from Do nothing to Option 2, with all options offering similar benefits to that business..

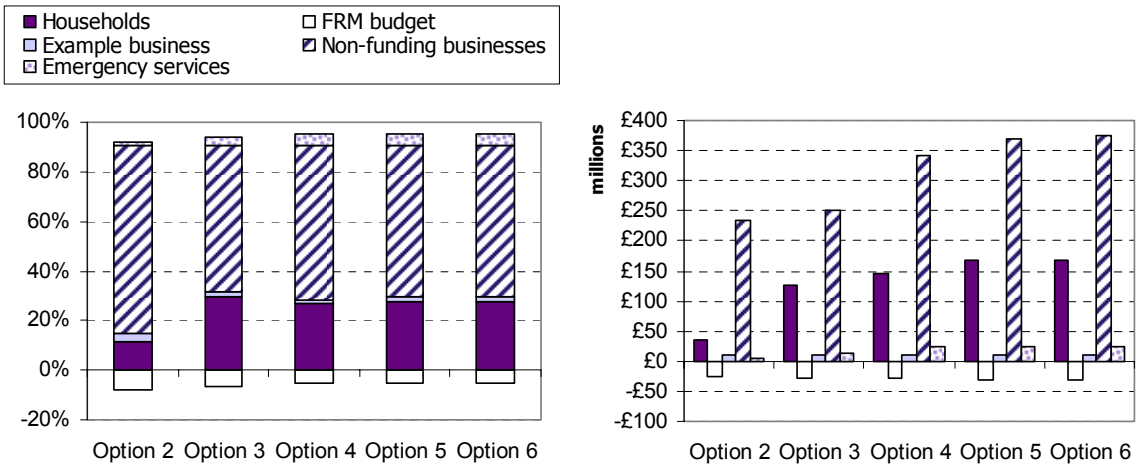


Figure 1: Case study A attribution of net benefits

4.3.5 Learning points

In this appraisal damages are aggregated at an early stage, in line with the requirements of the current appraisal process. However the structure of the workbooks suggests that data could be kept disaggregated for longer without this being an onerous task, and aggregated by economic interest group in line with the methodology proposed here. ,

Adding VAT to give costs and benefits in market prices is not difficult. However, as property values appear to be at market prices, with no further modification this would bring forward the point at which damages are capped.

The disaggregated presentation allows the decision-maker to see the effect of alternative options on the benefits to individual economic interest groups. This may be of particular interest with regard to negotiating contributions. In this case study, the 'example business' benefits from the least expensive of the 'do something' options, but gains little from the other, more expensive options, implying a ceiling on the contribution that might be negotiated.

In addition, the transparency offered by the disaggregated presentation shows clearly that in this case, for all the 'do something' options, the net benefits to businesses are significantly greater than the net benefits to households.

4.4 Case study B – Lyme Regis

This is a coastal erosion strategy level appraisal. The area around Lyme Regis is subject to some severe levels of coastal erosion. The coast is the site of an ancient landslide with unstable surfaces and complex fault lines running under and around Lyme Regis itself. There are also slip faults and surface mudslides. An added complication is caused during flooding events as the slides have been known to damage surface drains resulting in a reduction in safety factors.

There is also an area of beach protected by a seawall. The beach is a zeta beach due to the spiral pattern of the flow. The pattern is not fully developed because of the proximity of the seawall. The beach suffers from erosion at high tide due to the circulation flows that result from the spiral. These flows are also causing undermining of the seawall. The seawall also protects from further land slippage. The area includes a mix of residential and commercial properties - some 450 in total.

The project appraisal includes economic appraisal of two options: 'Do nothing' and 'Do something'. A number of options were addressed all offering similar benefits; all but those appraised were rejected on non-economic grounds. These included do minimum, reacting to failures once they have occurred and early warning systems.

- Do minimum, i.e. ongoing maintenance of structures, 'patch and mend', was considered to be acceptable only in non-urgent cases and in the short term, and considered unsustainable in the long term.
- Reacting to failures once they have occurred was considered to offer the potential for severe damage and disruption, with the cost of subsequent remedial work significantly greater than the cost of works to prevent the damage in the first place.
- Early warning systems would, in theory, give prior warning of landslide events to allow evacuation to ensure public safety. They would not protect assets and so were considered discordant with the guidelines in the Shoreline Management Plan, if used in isolation.

4.4.1 Economic interest groups

The workbook draft used for Case study A included two groups of economic interest groups government departments and funding partners. This study highlighted the importance of property ownership (see section 4.4.5) and the need for a property owners list. Review of the data provided and assistance from the contact for this case study suggested the economic interest groups shown in Table 5. Our contact confirmed that there is no social housing in the area and identified some properties as owned by West Dorset District Council (WDDC) or Lyme Regis Town Council (LRTC). However it was noted that some properties categorised as residential, and in this case study as owner-occupied - are actually holiday lets.

Table 5: Case study B economic interest group lists

Property owners
Select property owner
Households
Private sector landlords

Public Bodies
Select Public Body
FRM budget
LRTC
WDDC
County Council

Businesses
Select Business
Utilities
Other businesses

4.4.2 Data processing

The key cost categories in this case study are:

- Property
- Services and infrastructure
- Amenity
- Construction and other project costs

Property values used in the appraisal are from valuation surveys carried out in 2003, uprated for a year's increase in property prices using the Halifax house price index. Strictly speaking market prices for housing would include stamp duty, and there is an argument for including transaction costs. However, we consider the uncertainties associated with the valuation and the additional effort required to calculate stamp duty for individual properties (particularly given the different bands of stamp duty rates that apply) is unlikely to exceed the benefits thus achieved. We have, therefore, not modified property values.

The value allocated to amenity benefits was derived using a benefits transfer approach based on a survey of the visitor numbers combined with valuations from the multi-coloured manual (MCM) (Penning-Rowsell *et al* 2005) for Herne Bay. From discussions with FHRC we understand that these values are essentially market prices, and so we have not modified them.

Costs in the remaining two categories – services and infrastructure, and construction and other project costs – have been increased by 17.5 per cent to give market prices.

Our contact for this case study provided considerable assistance, reviewing the list of properties and identifying them, where possible, as owner occupied, commercial properties, or private rented sector. However, while our contact was able to confirm that there was no social housing in the area, it should be noted that there is uncertainty relating to private rented sector housing, and, as noted earlier, some properties categorised as owner-occupied are actually holiday lets. Therefore, benefits to owner-occupiers are probably overstated, while those to private sector landlords and businesses are probably understated.

4.4.3 Social equity weighting

No social equity weighting was applied in this case study, and no allowance was made for household stress caused by flooding.

4.4.4 Disaggregated presentation

Table 6, below, shows the costs and benefits calculation sheet for case study B. As for case study A, some unused lines have been deleted to aid inspection.

Table 6: Case study B – costs and benefits calculation

		Do Nothing	Do Something
Monetised Costs		£ k	£ k
Total monetised cost		**-**	**28,017**
Funded from:			
Public Agencies		**-**	**28,017**
FRM budget	*FRM budget*	**-**	**24,609**
Public body 1	*LRTC*		
Public body 2	*WDDC*		**1,058**
Public body 3	*County Council*		**2,350**
Businesses		**-**	**-**
Business or Group 1	*Utilities*	**-**	
Monetised Benefits			
Total monetised damage		105,630	-
Total monetised FRM benefits		-	142,386
Total monetised benefits		**-**	**142,386**
of which:			
Reduced flood damage to/ abandonment of buildings ie damage		**-**	**46,810**
of which:			
Residential damage avoided		-	36,756
Inventory/ damage			-
Property owners 1	*Households*		35,493
Property owners 2	*Private sector landlords*		*1263*
Residential damage			
Inventory/ damage	*Households*	-	-
Property owners 1	*Households*	35,493	-
Property owners 2	*Private sector landlords*		-
Public Agencies damage avoided		-	2,319
FRM budget	*FRM budget*		-
Public body 1	*LRTC*		382
Public body 2	*WDDC*		1,936
Public body 3	*County Council*		-
Public Agencies damage		2,319	-
FRM budget	*FRM budget*		
Public body 1	*LRTC*	**382**	**-**
Public body 2	*WDDC*	**1,936**	**-**
Public body 3	*County Council*		**-**
Businesses - damage avoided		-	7,735
Business or Group 1	*Utilities*	-	-
Other businesses		-	7,735
Businesses – damage		7,735	-
Business or Group 1	*Utilities*		-
Other businesses		7,735	-
Reduced flood damage to/ abandonment of agricultural land (damage		-	-
Damage to agricultural land			
Reduced disruption to trade (damage avoided)		-	-
Net impact on transport, utilities, emergency services (damage avoided)		**-**	**3,396**
of which:			
emergency services damage avoided			**-**
emergency services damage/ cost			
transport users damage avoided			**-**
transport users damage			
Public Agencies (damage avoided)		-	1,698
FRM budget	*FRM budget*	-	-
Public body 1	*LRTC*	-	-
Public body 2	*WDDC*	-	-
Public body 3	*County Council*		1,698
Public Agencies (damage)		1,698	-
FRM budget	*FRM budget*		
Public body 1	*LRTC*		

		Do Nothing	Do Something
Public body 2	*WDDC*		
Public body 3	*County Council*	**1,698**	
Businesses (damage avoided)		-	1,698
Business or Group 1	*Utilities*	**-**	**1,698**
Other businesses		**-**	**-**
Businesses (damage)		**1,698**	**-**
Business or Group 1	*Utilities*	**1,698**	**-**
Non funding businesses			
Intangibles (households) - damage avoided		**-**	**-**
Intangibles (households) – damage		**-**	**-**
Environmental/heritage value damage avoided		**-**	**-**
Impact on recreational/ amenity value - damage avoided		**-**	**92,180**
Recreational/ amenity value – damage		**92,180**	**-**
Development/ regeneration benefits		**-**	**-**

Table 7, below shows the comparison summary table for case study B. All cells in this table are calculated. The value of our preferred benefit: cost ratio metric (NPV/C_g) is 4.8, compared with a benefit/cost ratio of 6.1 for the original appraisal. The difference results from the addition of VAT to project costs, so that they are presented in terms of market prices as the amenity benefits are.

Table 7: Case study B - Comparison summary table

	Do Nothing	Do Something
Gross benefit = B(total)	-	142,386
FRM benefits = B(frm)	-	142,386
Net benefit (NPV) = B(total) – C(total)	-	114,369
Net FRM benefit (NPV(frm) = B(frm)-C(frm)	-	117,777
Total cost (PV, C(total))	-	28,017
Net exchequer cost = C(g)	-	24,000
Net cost to FRM budget = C(frm)	**-**	**24,609**
B/Cg = B(total)/C(g)		6
B/Cg incremental		*6*
B(frm)/C(frm) = B(total)/C(frm)		6
B(frm)/C(frm) incremental		*6*
NPV/Cg		**5**
NPV/Cg incremental		***5***
NPV(frm)/C(frm)		5
NPV(frm)/C(frm) incremental		*5*
Attribution of net benefits		
Residential of which:	**-**	**36,756**
inventory damage avoided		-
intangibles eg stress		-
Property loss – Households	**-**	35,493
Property loss - Private sector landlords	**-**	1,263
Public Agencies	**-**	**24,000**
FRM budget	-	24,609
LRTC	-	382
WDDC	-	879
County Council	-	652
Specified Businesses	**-**	**1,698**
Utilities	-	1,698
Other Businesses	**-**	**7,735**
Environmental/ heritage		**-**
Recreation/ amenity		**92,180**
Emergency Services		**-**
Transport		**-**
Agriculture	**-**	**-**

Figure 2 shows the attribution of positive net benefits graphically. In this case, the disaggregated presentation shows clearly how benefits are dominated by amenity benefits. The next largest beneficiaries are households followed by businesses, with small net benefits to utilities, private sector landlords, and local authorities.

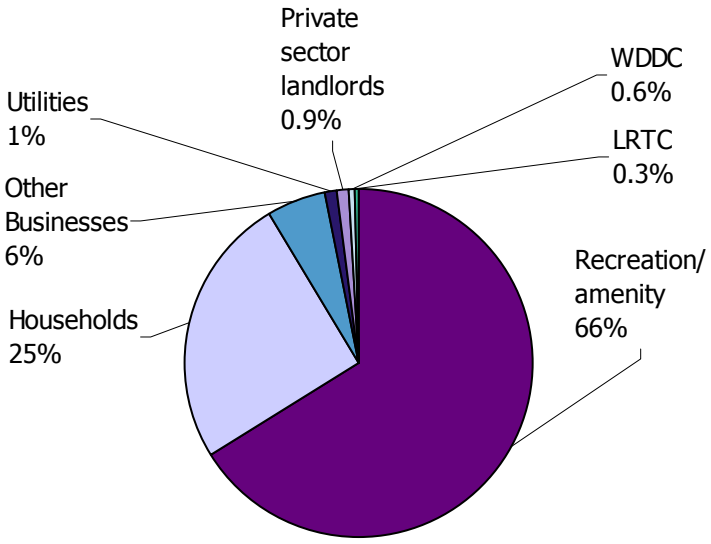


Figure 2: Case study B- attribution of positive net benefits

4.4.5 Learning points

This case study highlighted that identifying the ownership of properties may be important in some case studies. Simply categorising property as residential or commercial may not adequately reflect where the costs and benefits lie. In coastal erosion, damages results from property loss, so ownership is clearly important. However in non-coastal erosion cases damages comprise damage to or loss of household inventory items and damage to building fabric. The former implies losses to households and the latter implies losses to the property owner. It should be noted that FHRC's MCM (Penning-Rowsell *et al*, 2005) also highlights this issue, noting the importance of applying social equity weightings only to inventory damage for rented accommodation. Thus, in the current context, ownership of property should be considered, so that social equity weightings can be applied correctly. Our understanding is that weightings should be applied on the basis of the social group suffering the loss; the weighting appropriate for a household occupying a property may be different to that applicable to the owner of the property.

In addition, for coastal resorts in particular, there is an added issue, in that some properties classified as residential are holiday lets; and should be considered as business properties. There may also be an argument for categorising second homes as a separate economic interest group.

It is not clear whether it would be straightforward to identify property ownership for cases where large numbers of properties are at risk, however, census information may provide the data required. While our experience, based on a limited number of case studies, suggests that property ownership is not generally identified, it should be noted that this is a requirement of the current approach (in respect of social equity) and therefore should not theoretically result in more work. In practice, by highlighting the issue of property ownership, the disaggregated approach may result in more work being required and it is not clear to us that the data are readily available to support this.

A minor issue arising from this case study is the treatment of private members' clubs. These are generally not residential but neither are they always truly commercial. For practical purposes allocation depends on whether treating them separately is material or not.

4.5 Case study C - Boston

The town of Boston in Lincolnshire is situated on low lying land which without defences in place would flood during a normal high tide. The walls forming the existing defences are approximately 2m high in many areas of the town. Boston has many socio-economic issues and many of the local development plans are aimed at improving the quality of life within the town.

A number of schemes are underway to regenerate the riverside and ensure that the heritage and leisure potential of the area can be improved and used by residents and visitors. The council is particularly keen to develop this area to ensure the long-term prosperity of the town is enhanced. The waterways division of the environment agency also has a high level scheme to connect the fenland waterways in a more comprehensive fashion with the aim of increasing the navigation and leisure potential of the river. Schemes have been appraised to achieve this connection in the area of Boston.

While the project appraisal report recognises that the scheme offers potential development and regeneration benefits, these have not been monetised.

In addition to a 'Do nothing' option, the strategy looks at two navigation options and three flood management options, each flood management option being combined with each navigation option to give six options in total (plus ' Do nothing').

The three flood management options are:

1. Maintain existing defences
2. Maintain the current SOP space (1 in 50 years) i.e. improve defences as sea levels rise to maintain the current SOP.
3. Flood barrier - increases SOP to one in 300 years.

The two navigation options are:

1. Western channel

2. Navigation barrage and link.

4.5.1 Economic interest groups

While the port has been identified as a potential contributor, limited consideration has been given to this in the project appraisal report at the current stage, as this is a strategy level appraisal. The current appraisal report identifies limited potential contributions available from Lincolnshire County Council, the East Midlands development agency (EMDA) and the European regional development fund (ERDF). As the options considered include navigation schemes, EA Waterways is also identified as a relevant economic interest group and contributor.

Table 8: Case study B- economic interest groups identified

Residential property owners	**Public Bodies**	**Businesses**
Select property owner	Select Public Body	Select Business
Households	FRM budget	European Reg Dev Fund
	EA Waterways	Other businesses
	Linc CC, EMDA	Utilities

4.5.2 Social equity weighting

The project appraisal report states that there is a predominance of social grade D and E within the central wards of Boston that are subject to flooding and that this can be demonstrated using census data. The appraisers have used this to justify the inclusion of a distributional impact weighting factor to allow for social equity issues, in line with PAG3 supplementary note July, 2004. A factor of 1.64 has been applied to all residential flood damages; the appraisal report demonstrates using sensitivity testing that the inclusion of distributional impact weighting does not affect the choice of preferred option. In the workbook for this case study we have included the distributional impact weighting on a separate line so that its impact can be seen more clearly. As for case study B, no monetary value appears to have been placed on household stress due to flooding.

4.5.3 Data processing

For this appraisal, calculation of damages was carried out using MDSF. Perusing the project appraisal report suggests that this package can output damages at a number of levels of aggregation. For example, for one option damages are shown separately for residential and commercial, but for other options damages are not available separately for residential and commercial in the workbooks provided. To allow completion of the case study, without requiring additional work to be carried out by the appraiser, we have used the same split for all options. Practically, this assumes that the mixture of commercial and residential properties – eg the relative numbers, sizes and

values of properties - is the same across the whole of the area under consideration, which may not be valid.

Use of the MDSF package for this strategy appraisal means that the level of detail provided in the calculational workbooks was limited. As we could not ensure correct application of adding VAT to produce market prices no adjustment for VAT has been made. Project costs are also presented exclusive of VAT. However, navigational benefits have been estimated using a willingness to pay methodology and so are probably expressed in market prices.

4.5.4 Disaggregated presentation

Table 9, below, shows the monetised costs and benefits for all the options considered in this case study. Some unused lines have been omitted to aid inspection. Where yellow cells have no entry this indicates that no value was available from the data provided, or the item value was not calculated, or was included in another category and could not be disaggregated. For example, in this case study, while the PAR indicates that agricultural land will be protected by the options considered, it is not clear whether the benefits were monetised.

As in the original project appraisal it is assumed that EA Waterways funds the cost of the navigation parts of the scheme, and that the total contribution of £8M from Lincolnshire CC, EMDA and ERDF reduces the funding required from EA Waterways.

Table 9: Case study C costs and benefits calculation

		Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Monetised Costs		£ M	£ M	£ M	£ M	£ M	£ M	£ M
Total monetised cost		-	94	96	105	107	122	105
Funded from:								
Public Agencies			90	92	101	103	118	101
FRM budget	*FRM budget*	-	44	44	55	55	73	54
Public body 1	*EA Waterways*		41	43	41	43	41	43
Public body 2	*Linc CC, EMDA*		4	4	4	4	4	4
Businesses and other sources		-	4	4	4	4	4	4
Business or Group 1	*European Reg Dev Fund*	-	4	4	4	4	4	4
Increase in agricultural subsidies								
Monetised Benefits								
Total monetised damage		159	49	49	28	28	9	9
Total monetised FRM benefits		-	849	849	1,015	1,015	1,158	1,158
Total monetised benefits		-	865	915	1,031	1,081	1,174	1,224
of which:								
Reduced flood damage to/ abandonment of buildings ie damage avoided		-	849	849	1,015	1,015	1,158	1,158
of which:								
Residential damage avoided		-	739	739	884	884	1,008	1,008
Inventory/ damage base			451	451	539	539	615	615
social equity adjustment			289	289	345	345	393	393
Property owners 1	*Households*		-	-	-	-	-	-
Residential damage								
Inventory/ damage base	*Households*	652	201	201	113	113	37	37

		Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
social equity adjustment	*Households*	417	129	129	73	73	24	24
Property owners 1	*Households*							
Public Agencies damage avoided		-	-	-	-	-	-	-
FRM budget	*FRM budget*		-	-	-	-	-	-
Public body 1	*EA Waterways*		-	-	-	-	-	-
Public body 2	*Linc CC, EMDA*		-	-	-	-	-	-
Public Agencies damage		-	-	-	-	-	-	-
FRM budget	*FRM budget*							
Public body 1	*EA Waterways*		-					
Public body 2	*Linc CC, EMDA*		-					
Businesses - damage avoided		-	110	**110**	**131**	**131**	**150**	**150**
Business or Group 1	*European Reg Dev Fund*	-	-	-	-	-	-	-
Other businesses		-	110	**110**	**131**	**131**	**150**	**150**
Businesses - damage		159	49	**49**	**28**	**28**	**9**	**9**
Business or Group 1	*European Reg Dev Fund*		-					
Other businesses		159	49	**49**	**28**	**28**	**9**	**9**
Reduced flood damage to/ abandonment of agricultural land (damage avoided)		-	-	-	-	-	-	-
Damage to agricultural land								
Reduced disruption to trade (damage avoided)		-	-	-	-	-	-	-
Business or Group 1	*European Reg Dev Fund*	-	-	-	-	-	-	-
Other businesses		-	-	-	-	-	-	-
Disruption to trade (damage)		-	-	-	-	-	-	-
Business or Group 1	*European Reg Dev Fund*							
Other businesses								
Net impact on transport, utilities, emergency services (damage avoided)		-	-	-	-	-	-	-
of which:								
emergency services damage avoided		-	-	-	-	-	-	-
emergency services damage/ cost								
transport users damage avoided		-	-	-	-	-	-	-
transport users damage								
Public Agencies (damage avoided)		-	-	-	-	-	-	-
FRM budget	-	-	-	-	-	-	-	-
Public body 1	-	-	-	-	-	-	-	-
Public body 2	-	-	-	-	-	-	-	-
Public Agencies (damage)		-	-	-	-	-	-	-
FRM budget	*FRM budget*							
Public body 1	*EA Waterways*							
Public body 2	*Linc CC, EMDA*							
Businesses (damage avoided)		-	-	-	-	-	-	-
Business or Group 1	-	-	-	-	-	-	-	-
Other businesses	-	-	-	-	-	-	-	-
Businesses (damage)	-	-	-	-	-	-	-	-
Business or Group 1	*European Reg Dev Fund*	-	-					
Other businesses								
Intangibles (households) – damage avoided		-	-	-	-	-	-	-
Intangibles (households) – damage								
Environmental/heritage value damage avoided		-	-	-	-	-	-	-
Environmental/heritage value damage		-	-					

		Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
of which								
historic environment								
landscape and visual amenity								
etc [using AST headings, where values are available]								
Impact on recreational value/ tourism – benefits, damage avoided		-	16	66	16	66	16	66
Recreational value – damage			-					
Recreational value/ tourism - benefits			16	66	16	66	16	66
Development/ regeneration benefits		-	-	-	-	-	-	-
Business or Group 1	*European Reg Dev Fund*							
Other businesses								

Table 10: Case study C - Comparison summary table

	Option 2 - Maintenance + channel to west	Option 3 - Maintenance + nav barrage	Option 4 - Sustain SOP + channel to	Option 5 - Sustain SOP + nav barrage	Option 6 - 1 in 300 flood barrier +	Option 7 - 1 in 300 flood barrier +
Gross benefit = B(total)	865	915	1,031	1,081	1,174	1,224
FRM benefits = B(frm)	849	849	1,015	1,015	1,158	1,158
Net benefit (net present value, NPV) = B(total) – C(total)	771	819	926	974	1,052	1,119
Net FRM benefit (NPV(frm) = B(frm)-C(frm)	805	805	960	960	1,085	1,104
Total cost (PV, C(total))	94	96	105	107	122	105
Net exchequer cost = C(g)	90	92	101	103	118	101
Net cost to FRM budget = C(frm)	**44**	**44**	**55**	**55**	**73**	**54**
B/Cg = B(total)/C(g)	10	10	10	11	10	12
B/Cg incremental	*10*	*27*	*13*	*27*	*6*	*- 3*
B(frm)/C(frm)	19	19	18	18	16	21
B(frm)/C(frm) incremental	*19*	*-*	*15*	*-*	*8*	*-*
NPV/Cg	**8.6**	**8.9**	**9.2**	**9.5**	**8.9**	**11.1**
						highest NPV/Cg
NPV/Cg incremental	***9***	***26***	***12***	***26***	***5***	***(4)***
NPV(frm)/C(frm) ([B(frm)-C(frm)]/C(frm))	18	18	17	17	15	20
NPV(frm)/C(frm) incremental	*18*	*0*	*14*	*0*	*7*	*(1)*
Attribution of *net* benefits	771	819	926	974	1,052	1,119
Residential of which:	**739**	**739**	**884**	**884**	**1,008**	**1,008**
inventory damage avoided and property loss base	451	451	539	539	615	615
social equity weighting adjustment	**289**	**289**	**345**	**345**	**393**	**393**
intangibles eg stress	0	0	0	0	0	0
Property loss – Households	0	0	0	0	0	0
Public Agencies	**(90)**	**(92)**	**(101)**	**(103)**	**(118)**	**(101)**
FRM budget	(44)	(44)	(55)	(55)	(73)	(54)
EA Waterways	(41)	(43)	(41)	(43)	(41)	(43)

Linc CC, EMDA	(4)	(4)	(4)	(4)	(4)	(4)
Specified Businesses and other sources	**(4)**	**(4)**	**(4)**	**(4)**	**(4)**	**(4)**
European Reg Dev Fund	(4)	(4)	(4)	(4)	(4)	(4)
Other Businesses	**110**	**110**	**131**	**131**	**150**	**150**
Environmental/ heritage	**0**	**0**	**0**	**0**	**0**	**0**
Recreation/ amenity/ tourism	**16**	**66**	**16**	**66**	**16**	**66**
Emergency Services	**0**	**0**	**0**	**0**	**0**	**0**
Transport	**0**	**0**	**0**	**0**	**0**	**0**
Agriculture	**0**	**0**	**0**	**0**	**0**	**0**

Table 10 also shows that the use of incremental NPV/Cg ratios in tables such as this can be misleading, as it depends on the order in which options are presented. While in many appraisals ordering on NPV may produce the same result as ordering on Cg, this is not always true. Table 11 shows the incremental ratios when the options are ordered on the basis of Cg rather than NPV.

Table 11: Incremental NPV/Cg

	Option 2	Option 3	Option 7	Option 4	Option 5	Option 6
NPV	771	819	1,119	926	974	1,052
Cg	90	92	101	101	103	118
NPV/Cg	8.6	8.9	11.1	9.2	9.5	8.9
Incremental NPV/Cg	*9*	*26*	*32*	*461*	*26*	*5*

Figure 3 shows the benefit: cost ratio metrics in graphical form. B/C is total benefits/total costs, while B/Cg is total benefits/ net exchequer costs. NPV(frm)/C(frm) is included to show the metric resulting from consideration of only flood risk management related benefits and the costs of flood defences only. NPV/ Cg – our recommended metric – is total net benefits/net exchequer costs, and the final metric, average B/Cg, is the metric used in the original project appraisal. As the figure shows, in this case study the ranking of the options is the same whichever metric is used, unless only the flood risk management aspects of the scheme are considered. For the latter case, NPV(frm)/C(frm),the third category in the figure below, the ranking of the options changes considerably, although Option 7 remains the option with the highest benefit: cost ratio.

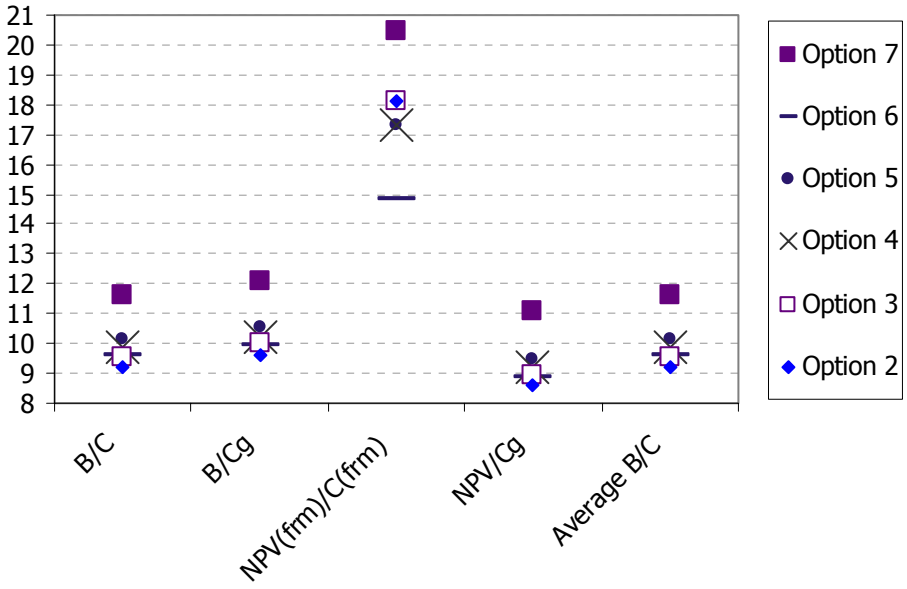


Figure 3: Case study C – benefits/ cost ratio metrics

Figure 4 shows the attribution of net benefits for this case study. The proportion of benefits accruing to households is similar for each option, but the disaggregated presentation shows clearly that the effect of applying distributional impact weighting is significant in this case. Excluding the effect of distributional impact weighting would reduce NPV/C_g from 11 to 7 for this case study.

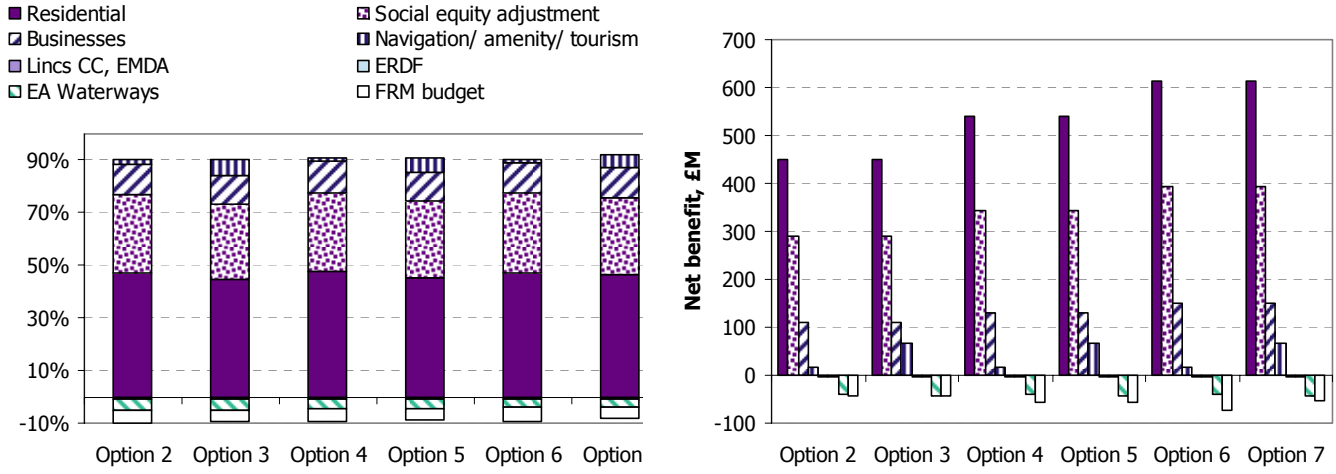


Figure 4: Case study C - attribution of net benefits

4.5.5 Learning points

Considering distributional impact weighting to take account of social equity issues highlights again that property ownership may be an issue (issues relating to property ownership are discussed further in Section 5.1). All flood damages have been increased by a factor of 1.64 in this appraisal. If all properties are owner-occupied this may be valid, but if properties are owned by wealthy private landlords or by the local authority than this may be overstating benefits. As noted in the multicolored manual (Penning-Rowsell *et al*, 2005), where a

significant proportion of housing is rented, any distributional weighting factor should be applied only to household contents damage and not to building fabric damage. Showing the adjustment on a separate line highlights its magnitude and may aid decision-making by providing additional information.

Further research following completion of the case studies shows that summary data on household tenure is available at ward level, derived from census data. This can be seen at http://neighbourhood.statistics.gov.uk. Current data refers to the 2001 census as its source, and so is a little out of date, but we consider this at least sufficient to provide an initial indication of the tenure mix in an area. Table 12, overleaf, shows summary data readily available on the Boston ward (note that this is only part of the area considered in the appraisal, and the table is shown only to illustrate the summary level data readily available). This shows that 37% of households do not live in owner-occupied housing. Some 22% of households live in local authority-owned accommodation.

The census collects tenure information at the individual household level; however, it is not clear whether this would be available for use in appraisals, given the confidentiality and non-disclosure policy regarding census data.

Table 12: Boston ward level data on household tenure, from 2001 census

	Count	% total households in Boston
All households	3,977	100%
Owner-occupier	2,493	63%
Social rented of which:	1157	29%
Rented from local authority	*893*	*22%*
Other social rented (e.g. housing association, registered social landlord)	*264*	*7%*
Private rented	212	5%
Living rent free	115	3%

As Figure 3 shows, considering only flood risk management related benefits and costs can result in different ranking of options compared with benefit: cost ratios that consider all of the costs and benefits associated with a potential scheme.

This case study highlights that in some instances European funding is available; this is public money but not UK exchequer funding and so the workbook was modified to include non-UK public money as a separate category.

4.6 Case study D – Old Goole

This area includes high grade agricultural land with a number of villages and other scattered properties. There are approximately 10,630 residential and commercial properties in the flood cell including Keadby power station. The flood cell as a whole is in land use band C for which the indicative standard for saline flooding is in the range 10 to 100 years. Frontages with villages (for instance Old Goole, Swinefleet and Reedness) immediately behind the defences are treated as if they are in land use band B for which the indicative standard of protection is in the range 50 to 200 years.

4.6.1 Economic interest groups

Economic interest groups for this case study are limited to households, an example business chosen from the list of commercial properties to illustrate the methods, other businesses, emergency services and the FRM Budget. Discussions with the contractor carrying out the original economic appraisal for this case study showed that in common with most economic appraisals carried out for flood management projects, property data is taken from the national property dataset. This does not appear to include information on property ownership; as for case studies A and C no information was available on property ownership in the flood risk area.

4.6.2 Social equity weighting

The economic appraisal of this scheme did not use any social equity weighting. Instead, in the table of key impacts included in the project appraisal report, an index of deprivation is stated (3,404), based on the wards of Snaith, Airmyn and Rawcliffe, and Marshland.

4.6.3 Data processing

Project costs and benefits were increased by 17.5 per cent to convert to market prices, except for agricultural benefits, which were not modified. For this case study, the adjustments to property damage were made at a level such that the effects of capping of damages can be seen.

4.6.4 Disaggregated presentation

The table below shows the monetised costs and benefits calculated for the options in this case study. Some unused lines have been omitted to aid inspection. Where yellow cells have no entry this indicates that no value was available from the data provided, or the item value was not calculated, or was included in another category and could not be disaggregated.

Table 13: Case study D – costs and benefits calculation

		Option 1 Do Nothing	Option 2 Do Min	Option 3 1 in 5	Option 4 1 in 10	Option 5 1 in 20	Option 6 1 in 50	Option 7 1 in 100	Option 8 1 in 200
		£ k	£ k	£ k	£ k	£ k	£ k	£ k	£ k
Monetised Costs									
Total monetised cost		**0**	**73,563**	**107,398**	**107,824**	**110,981**	**116,763**	**117,208**	**117,322**
Funded from:									
UK Public Agencies		0	73,563	107,398	107,824	110,981	116,763	117,208	117,322
FRM budget	FRM budget	0	73,563	107,398	107,824	110,981	116,763	117,208	117,322
EU bodies		0	0	0	0	0	0	0	0
Businesses and other sources		0	0	0	0	0	0	0	0
Business or Group 1	Example business	0	0	0	0	0	0	0	0
Monetised Benefits									
Total monetised damage		218,907	131,437	245,327	64,363	20,211	4,022	942	309
Total monetised FRM benefits		0	91,075	(33,156)	164,338	214,695	248,675	286,610	292,473
Total monetised benefits		**0**	**91,075**	**(33,156)**	**164,338**	**214,695**	**248,675**	**286,610**	**292,473**
of which:									
Reduced flood damage to/ abandonment of buildings ie damage avoided		**0**	**86,623**	**(22,818)**	**151,499**	**194,435**	**210,145**	**213,140**	**213,760**
of which:									
Residential damage avoided		0	51,910	(22,993)	116,274	144,281	154,745	156,290	156,562
Inventory damage avoided			51,910	(22,993)	116,274	144,281	154,745	156,290	156,562
social equity adjustment	Households								
Residential damage		156,691	104,781	179,684	40,417	12,410	1,946	401	129
Inventory/ damage	Households	156,691	104,781	179,684	40,417	12,410	1,946	401	129
Property owners 1		All residential damage included in inventory damage, above							
UK Public Agencies damage avoided		0	0	0	0	0	0	0	0
Businesses - damage avoided		0	34,713	176	35,225	50,154	55,400	56,850	57,198
Business or Group 1	Example business	0	(39)	(1,834)	17	424	714	718	718
Other businesses	Other businesses		34,753	2,010	35,209	49,731	54,686	56,132	56,480
Businesses – damage		57,371	22,658	57,196	22,146	7,217	1,972	521	173
Business or Group 1	Example business	718	757	2,552	702	294	4	0	0
Other businesses	Other businesses	56,653	21,901	54,644	21,445	6,923	1,967	521	173
Reduced flood damage to/ abandonment of agricultural land (damage avoided)		**0**	**847**	**(3,603)**	**3,045**	**4,261**	**4,740**	**4,825**	**4,838**
Damage to agricultural land		4,844	3,998	8,447	1,800	584	104	19	7
Reduced disruption to trade		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

		Option 1 Do Nothing	Option 2 Do Min	Option 3 1 in 5	Option 4 1 in 10	Option 5 1 in 20	Option 6 1 in 50	Option 7 1 in 100	Option 8 1 in 200
		£ k	£ k	£ k	£ k	£ k	£ k	£ k	£ k
(damage avoided)									
Business or Group 1	Example business								
Other businesses	Other businesses								
Disruption to trade (damage)									
Business or Group 1	Example business								
Other businesses	Other businesses								
Net impact on transport, utilities, emergency services (damage avoided)		**0**	**3,605**	**(6,736)**	**9,794**	**13,821**	**15,277**	**15,557**	**15,614**
of which:									
emergency services damage avoided		0	3,605	(6,736)	9,794	13,821	15,277	15,557	15,614
emergency services damage/ cost		15,642	12,037	22,378	5,848	1,821	365	85	28
Intangibles (households) - damage avoided	**Households**	**0**	**0**	**0**	**0**	**2,178**	**18,513**	**53,088**	**58,261**
Environmental/heritage value damage avoided		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Environmental/heritage value damage									
of which:									
historic environment									
landscape and visual amenity									
other									
Impact on recreational value/ tourism - benefits, damage avoided									
Development/ regeneration benefits									

The following table shows a summary of the above data, allowing comparison of the options considered.

Table 14: Case study D - Comparison summary table

	Option 1 Do Nothing	Option 2 Do Min	Option 3 1 in 5	Option 4 1 in 10	Option 5 1 in 20	Option 6 1 in 50	Option 7 1 in 100	Option 8 1 in 200
Gross benefit = B(total)	0	91,075	(33,156)	164,338	214,695	248,675	286,610	292,473
FRM benefits = B(frm)	0	91,075	(33,156)	164,338	214,695	248,675	286,610	292,473
Net benefit (net present value, NPV) =	0	17,512	(140,554)	56,513	103,714	131,912	169,402	175,151

	Option 1 Do Nothing	Option 2 Do Min	Option 3 1 in 5	Option 4 1 in 10	Option 5 1 in 20	Option 6 1 in 50	Option 7 1 in 100	Option 8 1 in 200
B(total) – C(total)								
Net FRM benefit (NPV(frm) = B(frm)-C(frm)	0	17,512	(140,554)	56,513	103,714	131,912	169,402	175,151
Total cost (PV, C(total))	0	73,563	107,398	107,824	110,981	116,763	117,208	117,322
Net exchequer cost = C(g)	0	73,563	107,398	107,824	110,981	116,763	117,208	117,322
Net cost to FRM budget = C(frm)	0	73,563	107,398	107,824	110,981	116,763	117,208	117,322
B/Cg = B(total)/C(g)		*1.2*	*(0.3)*	*1.5*	*1.9*	*2.1*	*2.4*	*2.5*
B/Cg incremental		*1*	*(4)*	*463*	*16*	*6*	*85*	*52*
B(frm)/C(frm) = B(total)/C(frm)		*1.2*	*(0.3)*	*1.5*	*1.9*	*2.1*	*2.4*	*2.5*
B(frm)/C(frm) incremental		*1*	*(4)*	*463*	*16*	*6*	*85*	*52*
NPV/Cg		**0.2**	**(1.3)**	**0.5**	**0.9**	**1.1**	**1.4**	**1.5**
								highest NPV/Cg
NPV/Cg incremental		0	(5)	462	15	5	84	51
NPV(frm)/C(frm)		*0*	*(1)*	*1*	*1*	*1*	*1*	*1*
NPV(frm)/C(frm) incremental		*0*	*(5)*	*462*	*15*	*5*	*84*	*51*

Assumed funding sources:								
UK public agencies of which:	0	73,563	107,398	107,824	110,981	116,763	117,208	117,322
FRM budget	0	73,563	107,398	107,824	110,981	116,763	117,208	117,322
EU funding sources of which:		0	0	0	0	0	0	0
Businesses and other sources of which:		0	0	0	0	0	0	0
Example business	0	0	0	0	0	0	0	0

Attribution of net benefits:								
Residential of which:	0	51,910	(22,993)	116,274	146,459	173,258	209,378	214,823
Inventory damage avoided		51,910	(22,993)	116,274	144,281	154,745	156,290	156,562
intangibles eg stress		0	0	0	2,178	18,513	53,088	58,261
Property loss – Households	all residential property damage included in 'Inventory damage avoided', above							
UK public bodies	0	(73,563)	(107,398)	(107,824)	(110,981)	(116,763)	(117,208)	(117,322)
FRM budget	0	(73,563)	(107,398)	(107,824)	(110,981)	(116,763)	(117,208)	(117,322)
EU public bodies								
Specified Businesses and other sources	0	(39)	(1,834)	17	424	714	718	718
Example business	0	(39)	(1,834)	17	424	714	718	718
Other Businesses	0	34,753	2,010	35,209	49,731	54,686	56,132	56,480

	Option 1 Do Nothing	Option 2 Do Min	Option 3 1 in 5	Option 4 1 in 10	Option 5 1 in 20	Option 6 1 in 50	Option 7 1 in 100	Option 8 1 in 200
Environmental/ heritage								
Recreation/ amenity								
Emergency Services		3,605	(6,736)	9,794	13,821	15,277	15,557	15,614
Transport								
Agriculture	0	847	(3,603)	3,045	4,261	4,740	4,825	4,838

The disaggregated presentation provides transparency not offered by the current appraisal system. For example, for the commercial property selected as an example business, the net benefits offered by options 2 and 3 are negative, and only for options 4 to 8 do positive net benefits occur. Options 6, 7 and 8 have similar impacts on residential property damage, with damage avoided varying by a little over 1 per cent between these options.

The ranking of the scheme options is the same as that in the original appraisal workbook provided, that is, use of the NPV/C_g metric does not change the ranking of the options. As all of the impacts identified, both benefits and cost, relate to FRM, all of the benefit: cost ratios presented result in the same ranking of options. The figures below show some of the information in the tables above, in graphical form.

Figure 5, below, shows the attribution of net benefits for each option. Note that Option 3 offers a lower standard of protection than Option 2. The disaggregated presentation makes it easier to see that the key difference between Option 6 and Options 7 and 8, in terms of net benefit, and therefore NPV/C_g, is the quantum of the benefit owing to household stress avoided, rather than in significant differences in the value of damage to property.

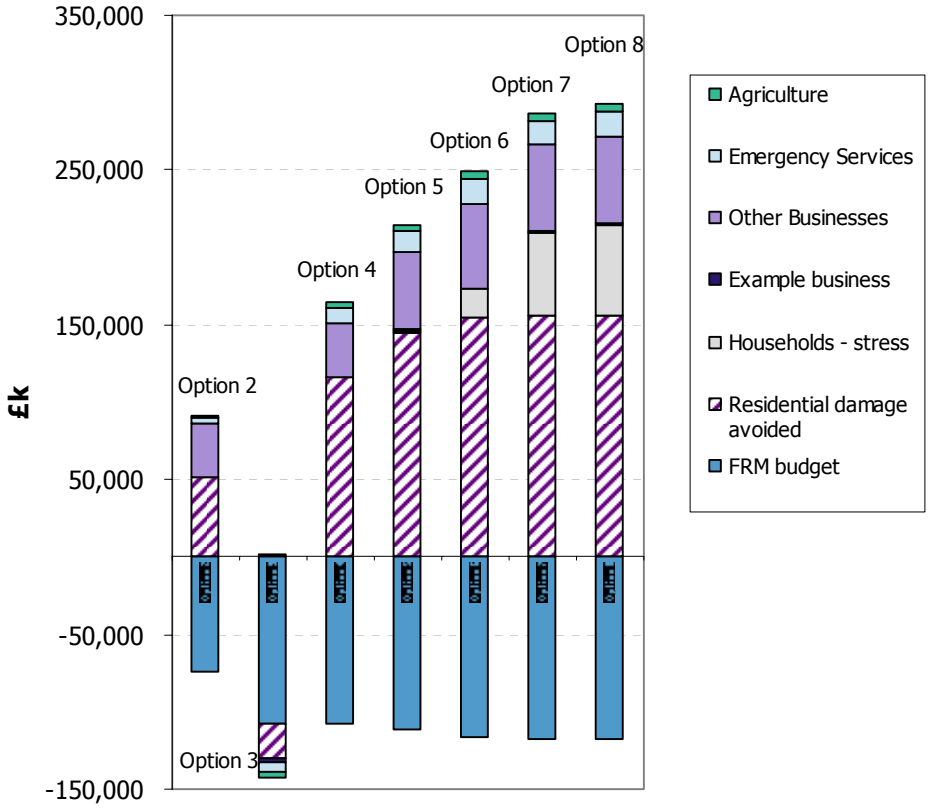


Figure 5: Case study D - attribution of net benefits

Figure 6, below, shows, for positive net benefits only, how the percentage of net benefits offered by each option varies, for options 4 to 8.

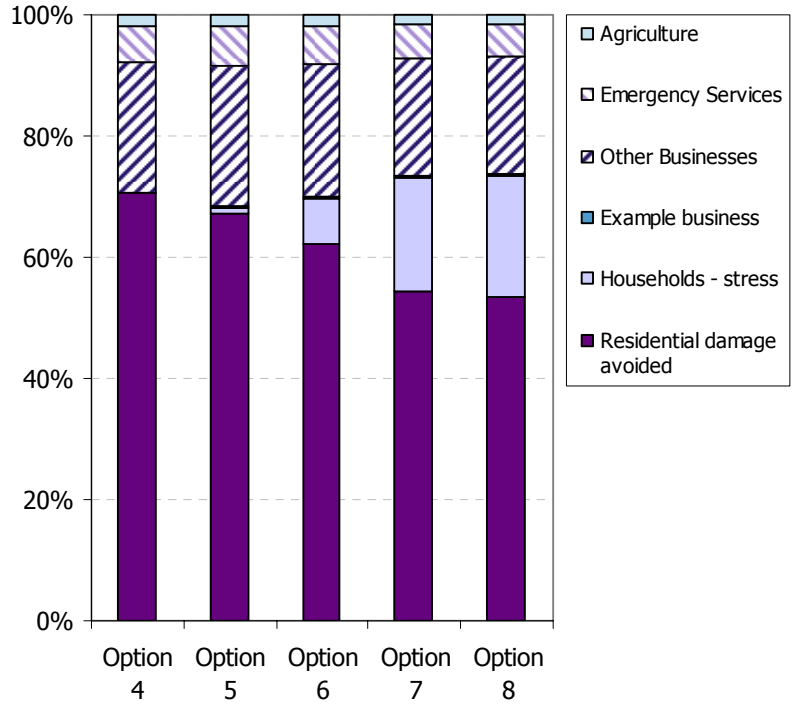


Figure 6: Case study D - positive net benefits options 4 to 8

4.6.5 Learning points

The key point arising from this study is that the value of impacts that do not appear to be monetised in all cases can affect the choice of options. In this case, the impact of household stress appears to be responsible for most of the difference between the 'preferred' (in terms of benefit: cost ratio) option and the next two most highly ranked options. The disaggregated presentation allows this to be seen clearly.

It may be that with time, more appraisals will include a monetised value for household stress, so that a consistent approach is used across all appraisals. However, this does highlight the potential for decisions regarding which impacts to monetise to affect the choice of option at scheme level. It may be (although it is outside the scope of this research to determine this) that such decisions might affect the priority scoring of schemes within the current framework, perhaps distorting overall decision-making at the programme level. If so, consideration should be given to ensuring improved consistency of approach. At the very least, we would recommend that at an early point in the proposal all identified impacts are documented, together with the decision taken on whether they are to be monetised, dealt with quantitatively, or addressed qualitatively, as detailed in 4.7.1, below..

4.7 Summary of the methodology

The key steps in the outline methodology for a disaggregated approach to flood risk assessment and appraisal developed through the case studies are:

- Identify items to be monetised and items to be dealt with in a wider MCA framework
- Identify economic interest groups
- Calculate costs and benefits for the economic interest groups identified for each option under consideration
- Enter data into summary workbook.

The following subsections outline a draft methodology for each of these stages.

4.7.1 Items to be monetised

CBA can be seen as part of a wider MCA framework for decision-making. In such a framework it is important to ensure that at the outset it is clear which items are to be monetised and which are to be handled within the wider MCA framework, either quantitatively or qualitatively. The chief advantage of ensuring this step is formalised and the outcome recorded is that it will reduce the possibility of double counting of costs or benefits that might otherwise occur. In particular such double counting is possible for intangible items.

Consideration should be given to including a generic list of impacts in appraisal guidance to inform context specific impact identification. Guidance might also

be provided on issues to be considered when making a decision on whether to monetise an impact, or to handle them quantitatively or qualitatively.

4.7.2 Economic interest groups

Testing of the method suggests a requirement for four categories within which economic interest groups should be specified by the appraiser:

1. UK public bodies
2. EU bodies
3. Businesses
4. Residential property owners

In addition to these four categories, some additional categories are included in the summary workbook. (As these are treated, for pragmatic reasons, as economic interest groups in their own right, there is no requirement to specify economic interest groups within these categories.) These include environmental and heritage value, tourism and recreation and amenity value, and development and regeneration benefits.

UK public bodies should always include 'FRM budget' as an item, as we expect that invariably, funding from the FRM budget will be included in the appraisal; otherwise the appraisal might not be necessary. In addition to this, any other UK public bodies that are affected or might provide funding should be listed, such as Environment Agency Waterways, Local Authorities, County Councils and Regional Development Agencies. EU bodies should include any potential sources of European funding such as the European Regional Development Fund.

Businesses should include any relevant business or group of businesses (e.g. a group of businesses on an industrial estate, or large businesses and small businesses) affected that might contribute financially to a scheme. Utilities and an 'other businesses' group should also be included. If 'disruption to trade/ loss of profit' is included as a cost category, then it may be necessary to include a line for businesses making a corresponding gain. In the calculus of social costs and benefits this would not be necessary as transfers within the economy would be netted out.

Residential property owners should always include households. If most households in the flood Risk area are owner-occupied, inclusion of this category alone may be adequate. However, if there is significant social housing or private rented housing then it may be necessary to include other economic interest groups such as local authority, registered social landlords and private landlords. Note that households and property owners (if different) must be kept separate for two reasons. Firstly, damage to household inventory items represents a loss to the householder, while damage to building fabric is a loss to the property owner (which may be a UK public body, for example a District Council). Secondly, if equity multipliers are used to reflect social mix, then this should only be applied to losses to householders, ie for rented accommodation, to household inventory losses. (This is not new but simply reflects Defra's

supplementary guidance and advice in the Multi-coloured manual.) A further issue that may be material in some instances relates to holiday lets. It is likely that such property is generally categorised as residential, whereas it might probably be categorised as commercial property.

In addition, there may be instances where it is appropriate to identify more than one household interest group, and to identify, e.g. more than one group of owner-occupiers. For example, it may be appropriate to identify different socio-economic groups, or different wards (where, say, one ward is a deprived area and others are not), or different geographical areas (where, say, different geographical areas have different standards of protection).

4.7.3 Calculation of costs and benefits

Costs and benefits should be calculated separately for each economic interest group identified and for each of the options under consideration. The data used to calculate the benefits of flood risk management (in particular, FHRC's MCM, Penning-Rowsell *et al* 2005) are available at a level of detail to allow benefits to be calculated at the level of disaggregation required. For example, damage data are available separately for household inventory items and damage to building fabric. The data are currently presented as factor costs but converting these to market prices in most cases simply requires the addition of VAT. Ideally, if this method were implemented widely, then damage data should be revised and presented in market prices.

The categories of costs and benefits included in the draft workbook are shown in Table 15, below, with methodological comments. Values are entered for each option under consideration, including a 'Do nothing' option.

Table 15: Costs and benefits

Monetised Costs	
Total monetised cost	Net present value of project costs, using the discount rates specified in existing guidance.
Funded from:	
UK Public Agencies	This section is used to enter known contributions, or assumed contributions from non-FRM budget sources. Alternative scenarios could be created using this.
FRM budget	
UK Public body 1	
EU bodies	
EU body 1	
Businesses and other sources	
Business or Group 1	
Increase in agricultural subsidies	
Total monetised damage	
Total monetised FRM benefits	Inclusion of this item is only necessary if the appraiser wishes to separate out FRM benefits from other benefits, or the appraisal methodology requires calculation of metrics taking account only of FRM benefits. This will require benefits to be 'tagged' in the worksheet

	as FRM benefits.
Total monetised benefits	
of which:	
Reduced flood damage to/ abandonment of buildings ie damage avoided	
of which:	
Residential damage avoided	the worksheet calculates damage avoided from the values for damage entered below
Inventory/ damage	
social equity adjustment	
Property owners 1	
Property owners 2	
Residential damage	
Inventory/ damage	Household inventory damage is included as a separate line because we assume that it is always householders who incur losses due to this damage, whereas building fabric damage is incurred by the property owner, who is not always the householder.
social equity adjustment	A separate line is included for any social equity adjustment made to improve transparency. This makes it clearer whether distribution of impact weighting has been applied to the monetised benefits, and makes it easier to to see the magnitude of, and so assess the effect of such weighting.
Building fabric damage - Property owners 1	As noted above the property-owner is not always the household and so the worksheet allows different economic interest groups to be entered here. Note that where a local authority owns residential properties it will appear as an interest group both for residential damages and for UK public agencies damage. This is because it seems appropriate, in the interests of transparency and to aid decision-making two shows the effect on residential properties separately. In the case studies completed for this work, inventory and building fabric damages were aggregated at an early stage in the calculation of damages. However, we do not believe that it would be onerous to present inventories and building fabric damages separately. This is discussed further in Section 5.1.
Building fabric damage - Property owners 2	
UK Public Agencies damage avoided	As above in the worksheet, these cells are calculated from the damages entered below.
FRM budget	
UK Public body 1	
Public Agencies damage	
FRM budget	The value of flood damage or abandonment of buildings due to flooding for UK public bodies should be entered here, for each UK public body identified.
UK Public body 1	

Businesses – damage avoided	As above in the worksheet backspace, these cells are calculated from the damages entered below.
Business or Group 1	
Other businesses	
Businesses – damage avoided	The value of the damage or abandonment of buildings due to flooding for any businesses should be identified here for each relevant economic interest group identified. While not implemented at present, there may be a need to separate occupation from ownership as for residential properties. This is discussed further in section 5.1.
Business or Group 1	
Other businesses	
Reduced flood damage to/ abandonment of agricultural land (damage avoided)	
Damage to agricultural land	There appear to be no additional methodological issues associated with this item.
Reduced disruption to trade/ loss of profit (damage avoided)	As the expert review in the companion report to this (Spackman, M and Jones-Lee, M, 2006) discusses, loss of profit is a cost to the disrupted business. Even if it were not counted as a net loss at the national or regional level, there would remain a case for recording it as a loss to one business, with another line recording a profit gain to other, non-flooded businesses. We have not investigated data sources for profits, but we would expect broad brush data such as national average figures for profit as a ratio to sales area (and/or possibly as a percentage of turnover) for business categories to be readily available and sufficiently accurate. Additional work may be necessary to determine whether such data are available, and whether the additional effort associated with including this category is proportionate to its contribution to improved decision-making.
Business or Group 1	
Other businesses	
Disruption to trade (damage)	
Business or Group 1	
Other businesses	
Net impact on transport, utilities, emergency services (damage avoided)	
of which:	
emergency services damage avoided	As above, in the worksheet, this cell is calculated from the damages entered below.
emergency services damage/ cost	There appear to be no additional methodological issues associated with this item.
transport users damage avoided	As above, in the worksheet, this cell is calculated from the damages entered below.
transport users damage	There appear to be no additional methodological issues associated with this item.
Public Agencies (damage avoided)	As above, in the worksheet, these cells are calculated from the damages entered below.
FRM budget	
UK Public body 1	
Public Agencies (damage)	These items are included to allow for any

FRM budget	damages to UK public agencies, in addition to those associated with transport or emergency services. Any benefits other than reduced damages are entered into the cells above.
UK Public body 1	
Businesses (damage avoided)	As above, in the worksheet, these cells are calculated from the damages entered below.
Business or Group 1	
Other businesses	
Businesses (damage)	These items are included to allow for any damages to businesses. Any benefits other than reduced damages are entered into the cells above.
Business or Group 1	
Other businesses	
Intangibles (households) - damage avoided	
Intangibles (households) – damage	This item is included to allow for intangible items for households such as stress.
Environmental/heritage value damage avoided	This category is treated as an economic interest group; while there is some overlap with other groups (eg householders), considering this category as applying to 'those benefiting from improvements in or reduced damage to the environment etc.' is a pragmatic and tractable approach.
Environmental/heritage value damage	
of which	
historic environment	
landscape and visual amenity	
other	
Impact on recreational value/ tourism/ amenity - benefits, damage avoided	As above, while in reality there is overlap between those benefiting from recreational value etc and other groups such as householders, treating those who benefit from tourism, recreation and amenity is a pragmatic and tractable approach.
Recreational value etc - damage	
Recreational value/ tourism – benefits	
Development/ regeneration benefits	The inclusion of development or regeneration benefits is a policy issue, and so beyond the scope of this study; however, inclusion of such benefits in a transparent manner is facilitated by the disaggregated presentation. In the Boston Strategy case study, while regeneration benefits are recognised in the project appraisal report, they are not monetised.
Business or Group 1	
Other businesses	

4.7.4 Data summary

Once the costs and benefits have been calculated for the economic interest groups identified and the options under consideration, entering data into the summary workbook is a straightforward exercise. The tables may be usefully complemented by the use of graphical presentation of some results.

5. Discussion and gap analysis

This section takes account both of the work reported in earlier sections and of discussions the Making Space for Water Steering Group regarding the work. We identify here a range of issues for further consideration, highlighting in the boxes particular points or questions that could usefully be addressed.

5.1 Advantages of the method

We find the approach has the following advantages:

- The method provides greater transparency and more information to aid decision making. With the previous "SCB" approach, whilst it would be possible to disaggregate results in many cases, some significant transfers between groups are not generally evaluated and these transfers are further hidden in the aggregation of resource costs and benefits.
- The approach supports both improved quality assurance of appraisals, and optimisation of option design, by making it easier to see which costs and benefits are the most important and to question these where appropriate
- It makes it clearer what has been monetised and included in the appraisal and what has not: for example whether a social equity adjustment has been made or not, whether allowance has been included for household stress due to flooding or not and what the impact of these is.
- It allows the benefit of schemes to individual businesses or groups of businesses to be identified and therefore may assist in negotiation of contributions from third parties.

5.2 Areas for further consideration

We have identified a number of areas where further research, or policy input, is required.

5.2.1 Data issues

The FHRC MCM data: These datasets, for residential and non-residential property, record the property located on floodplains in England and Wales and the losses to be expected for different types of property, according to the type of dwelling, its age and the social class of its occupants, as a result of flooding of different depths and duration. As noted earlier, FHRC have set out the assumptions underpinning the data in the MCM, included here at Appendix D, highlighting areas where data are acknowledged to be relatively poor (e.g. some areas of non-residential properties), and the use of secondary data sources. The data held are very sophisticated and appear to meet virtually all the needs of the disaggregated accounting approach to CBA.

It seems evident from these case studies that current practice is intended to be that all costs use the numeraire of 'factor cost' – that is market prices adjusted downwards to remove indirect taxes. The MCM data are currently largely recorded in the numeraire of 'factor costs'. However the WTP methodologies used to estimate eg amenity values almost certainly produce valuations at market prices. We recommend that 'market prices' are used throughout in future and that if this recommendation is adopted, the data are represented consistently in this format. As indicated in Appendix D, FHRC believe that this would be a straightforward change to make.

Gap: The use of market prices may result in unintended consequences. It is believed that in some transport scheme appraisals, options resulting in fewer miles driven and savings in driver time have appeared to result in lower net benefits than schemes resulting in more miles driven. This appears to be because their cost to central government has been higher, owing to lower revenues from fuel duty. It will be necessary to identify whether such counter-intuitive results might arise in the context of FRM appraisals, and to determine how these can properly be handled.

Other Numeraire issues: While this appears to be a relatively minor issue for most categories of cost and benefit there may be a need for more work in some areas including:

- agricultural issues (which were not a significant feature of the case studies). A review of the handling and valuation of agricultural and non-agricultural land use impacts may be needed.
- house prices and capping of damages.

Agricultural impacts - The current approach to estimating agricultural benefits focuses on agricultural output. However farm economies are now increasingly dependent on diversification. And much agricultural land use policy is now focused on environmental quality.

Gap: The handling of "agricultural" impacts in FRM appraisal (including but not limited to the CBA) should be reviewed, with an objective of incorporating all the economic, environmental and social consequences of the change in the potential uses of the land that would be provided by the FRM investment, which may include, for example, the opportunity for the farmer owner to diversify land into non-agricultural use.

House prices and capping of damages – the appraisal methodology caps damage to properties at the property value. We have recommended using market prices for damages rather than factor costs but we note that this will affect the point at which damages are capped:

- if damages are increased by VAT, capping will occur at reduced flood depths.
- Stamp duty and other transaction charges should also be added to the house value. Our view however is that it is probably not worth doing this as:
  - The effort will be disproportionate to the benefit
  - The stamp duties and transaction charges will be lower in percentage terms than the increases in damage values

- Property valuations will be subject to uncertainty.

It has been suggested that replacement costs could be used instead of economic cost. Our recommendation is that replacement costs are not suitable for use in CBA and that the appraisal process should continue to use economic costs, e.g. assuming that, on average, items lost will be halfway through their useful economic life.

Gap: More work is required to understand the significance of property and capping issues to decision making, particularly to coastal erosion, which is largely concerned with property values.

Property ownership: One area that may require additional work is identifying property ownership. Damage to inventory is incurred by householders, but damage to building fabric is incurred by the owner. It is desirable to identify property owners for residential properties, so that damage to building fabric can be attributed to the relevant economic interest group. Identifying ownership of residential properties also allows more appropriate use of distributional weighting factors.

Identifying ownership should be a feature of existing appraisals where distributional impact weighting is applied, to ensure that where properties are not owner-occupied, the weighting factor is applied only to the household inventory damage. Our limited sample of case studies does not demonstrate whether this is the case, but we understand that property ownership is not straightforward to identify.

The limitations of carrying out case studies based on information available from existing appraisals means that the work reported here could not explore in any detail how much property owners and property occupiers would benefit relative to one another, from a project or strategy. From the work completed, we would suggest identifying owners as householders, local authorities or other UK public bodies, registered social landlords and private landlords.

Gap: Further work would be useful to identify how significant residential property ownership issues might be, and what data sources exist that might be of use. Census data may be useful, and it has been suggested that collaboration with the NaFRA project may be helpful. Local authorities have databases that may be of use, particularly to social housing. Research might seek to answer questions such as:

- How best would residential property ownership be studied under the disaggregated approach?
- Can ownership be separated so that private households are considered, with commercial interests addressed separately?
- Can social housing be identified?
- Can second homes, holiday lets and buy-to-let properties be identified separately from other properties?
- How difficult, timeconsuming and costly is it to do this?
- How should these groups be considered in appraisal?
- What are the benefits of doing this?

5.2.2 Methodological issues

Choice of metric and contribution: The findings of the case studies, though based on a very limited number of examples, suggest that the choice of ratio, in particular the choice of whether to include wider benefits than the FRM costs and benefits can have a material impact on the ranking of options. Our view remains that the appropriate benefit:cost metric to use is NPV/ Cg taking contribution into account, to allow most benefit from the use of public money to be achieved.

While some non-FRM benefits, such as navigation benefits, are currently included in appraisals, regeneration and other broader benefits generally are not. Including wider benefits has two implications:

- The potential relationships between different strategies within a region can be explicitly recognised within the appraisal and decisions optimised over all objectives (FCM, regeneration etc).
- Resource allocation would be affected using the current approach as projects with contributions would get higher scores under the prioritisation system.

This in our view is the most defensible interpretation of Green Book principles. CBA should include all those social cost and benefits that can be valued in monetary terms (i.e. the NPV) and the relevant constraint, from the Government's perspective is total public spending – hence the use in Transport appraisal of a social cost of exchequer finance (SOCEF). Attribution of some benefits as non-FRM may have legitimate impact with regard to which department should pay for them, but not on the CBA. The FRM budget determines the total that can be spent on the FRM programme, but is not in national welfare (i.e. Green Book) terms relevant to the prioritisation of projects.

Gap: Further work should be carried out to determine the impact of a change in metric on the FRM programme.

Social Equity: We note that in the case studies the treatment of social equity has been addressed in different ways. While clearly recognised as an issue in three of the case studies, in two cases no adjustment has been made to the monetised benefits of flood risk management. Instead, ward deprivation indices have been noted in the project appraisal report. In one case study a monetary adjustment has been made within the economic appraisal. As a minimum, we suggest showing any monetary adjustment made on a separate line so that the impact can be identified clearly. However, we have recommended that the income distribution of household beneficiaries of flood protection might be handled in a fair and simple way by valuing flood damage to all domestic properties equally in the CBA using some appropriate average value. This would require additional work to confirm feasibility and determine appropriate values. A number of approaches could be taken. For example, a single average house price could be used, based on a region, a ward, a parish or a post-code area. Alongside use of an average, economic impact could be

disaggregated by use, for example, owner-occupied homes v. holiday lets, and buy to let properties.

Gap: Adoption of a simplified approach to social equity may or may not in the end be a technically and politically robust solution, further discussion of its merits, with some investigation of how it might work in practice is required, considering what average property value might be used, and whether disaggregation by residential property use would be appropriate.

Treatment of tourism: Currently tourism is considered as a separate class of benefit. However, tourists come from outside the immediate area. We suggest separating out hard economic tourism impacts to local businesses, from e.g. value of landscape, which is often less easy to establish, and attributing this latter benefit, as appropriate, to a separate economic interest group "tourists". It should be recognised however that amenity and landscape benefits are also of value to local people. If such an approach were adopted, care would have to be taken to avoid double-counting.

Disruption to trade/services: We have not seen any example where these are included in the appraisal. While it is recognised that private companies may move to a new location at lower risk of flooding, there will still be some disruption to trade associated with the move. Utilities cannot generally move and disruption of services can result in significant knock on and indirect impacts.

Gap: Work to establish the significance of the impact of disruption and the practicality of establishing values for inclusion in appraisals is recommended

5.2.3 Process issues

Quality assurance of appraisals: Appraisal calculations are subject to quality checks at the detailed level, however concerns have been raised about how some fundamental decisions are made about e.g. the costs and benefits to include in the appraisal, how to define the 'do nothing' option etc. We have found that presentation of the disaggregated information can prompt questions about the validity of underlying appraisal assumptions; processes are required to ensure that this scrutiny can be applied at an appropriate stage of the appraisal. .

Gap: There is a need to establish whether appropriate check points exist within the process at which the following can be reviewed:

- Identification of economic interest groups
- Costs and benefits to be monetised
- The 'do nothing' option

Emerging information about the significance of different costs and benefits

Accounting for additional information: Intra-scheme decision making is clearly helped by the disaggregated presentation which provides more information about what makes different options "tick". For example we have

found that benefits can build up at different rates for different interest groups depending on the level of protection offered by an option. The approach also makes clear the contribution of different types of cost and benefit (which may have different levels of confidence associated with their derivation) and can show whether one particular type of impact is dominating the cost: benefit ratio.

Gap: Research is required to explore how the additional information offered by the disaggregated approach can be taken into account in decision-making, both for choosing the best option for a particular scheme, and choosing between schemes.

Communication with Stakeholders: The greater transparency achieved by the method could have both positive and negative impacts in terms of communicating with stakeholders. The improved transparency will assist explanation of decisions that have been made and should, in the long term if handled well, help promote acceptability of decisions. However, additional transparency may provoke more questions and adverse comments by some stakeholders, especially those identified as 'losers'. This will particularly be the case if:

- the way in which decisions are made appears to take no account of the information from the disaggregated presentation (see above)
- the stakeholders believe that important economic groups, costs or benefits have not been included, or
- information provided by stakeholders appears not to have been taken into account

Gap: If the dissagreggated approach is adopted quidance will be required for analysts and decision makers both on how to conduct communications with stakeholders, and how to communicate what may be unwelcome news effetively, taking into account the dissagregated information.

MCA: Implementation of the CBA within an MCA framework has been suggested as a way of accounting for non-monetised benefits within the appraisal process. This is especially important because of the danger that improvement of the CBA may give even more emphasis in decision making to impacts that can be monetised at the expense of those that cannot. Care is required to ensure double counting is avoided both between the CBA and the rest of the MCA, and in the resource prioritisation process. An MCA process is currently being piloted by the EA. This pilot provides an ideal opportunity to test both the application of the disaggregated approach and its integration within the MCA. (Note that MCA is discussed in more detail in the companion report to this (Jones-Lee, Spackman 2006).)

Consistency of approach: The appraisal process serves two roles:

- to systematically explore and develop the various options for delivering a scheme, and
- to allocate scarce resources between different schemes.

The latter requires that the approach is applied consistently from scheme to scheme. The disaggregated approach makes it clearer which schemes benefit

e.g. from higher values derived from equity weighting and from higher valuations for amenity/ recreation/ environment. If some appraisals monetise environmental aspects, and some do not, some place a monetary weighting on social equity issues and some do not, how can a prioritisation process compare the metrics on a like for like basis? This is also an inherent difficulty for MCA approaches. How do MCA outputs feed into inter-scheme prioritisation?

Leadership and co-ordination: We found, in contrast to practice in Transport appraisal, that there is no single expert authority within government controlling FRM appraisal development, in consultation as occasionally appropriate with the Treasury, in the sense that control is exercised over the development of WebTAG. One of the areas where this is potentially an issue is in the development of a technically sound, workable and authoritative set of procedures to integrate the CBA and other aspects of FRM appraisal, including, most importantly, the prospective OP regime. This appears to be an issue of management structure more than resource availability.

Level of application: We have tested the disaggregated approach at the scheme appraisal and strategy levels. While in theory, the disaggregated approach can be used at other levels (eg catchment flood management plan (CFMP)/ shoreline management plan (SMP)), we have not tested the approach at these levels. The number of economic interest groups considered, and the level of detail of the economic appraisal may differ as one moves from CFMP to scheme appraisal. This may lead to different levels of aggregation at different levels of application, in the absence of specific guidance.

Gap: If the disaggregated approach is adopted, further thought should be given to the degree of disaggregation appropriate to different levels of appraisal. Consideration should be given to issues such as the value offered in terms of decision-making compared with the additional effort required, the level of detail of appraisal at different levels. Policy objectives and the requirements of programme-level decision-making frameworks should inform any such consideration.

Contributions, and multi-objective projects: The disaggregated approach appears to offer potential benefits when considering contributions and multi-objective projects. In both cases, it offers transparency, allowing the decision-maker to see the size of benefits and disbenefits accruing to potential contributors, and the various potential funders and beneficiaries of multi-objective projects. To achieve this transparency the appraiser must define the economic interest groups to include potential contributors, and for multi-objective schemes, potential funders and beneficiaries.

Gap: If the disaggregated approach is adopted, consideration should be given to what guidance should specify in terms of identifying potential contributors and co-funders. Any review of policy objectives should consider the extent to which potential contributions and issues surrounding multi-objective schemes should be taken into account in decision-making. We note earlier that further work would be desirable to determine the impact of a change in metric on the FRM programme. Any such work should take particular account of projects with

potential contributions and multi-objective projects, in comparison with 'standard' projects.

Terminology: We recommend that some further standardisation of terminology, such as the use, following Treasury convention, of appraisal to describe ex ante analysis and evaluation to describe ex post analysis, and a clear understanding of what by convention is included and not included in a "cost benefit analysis".

The Treasury has for many years encouraged the use in central government of "appraisal" to describe ex ante analysis and "evaluation" to describe ex post analysis.[3] However outside central government "evaluation" is often used more loosely, sometimes to describe either ex ante or ex post analysis (it often not being clear which) and sometimes in place of valuation (i.e. giving a monetary value). This loose usage, and associated confusion, occasionally creeps into central government. It could help communication in Defra and the EA if the Treasury convention were uniformly adopted.

5.2.4 Costs of implementation

Resource requirement and toolkit development: We explored with practitioners whether the disaggregated method would be more complex to apply and involve significantly more work. The conclusion was that in most cases it would not be. Discussions with practitioners have identified means by which existing damage calculators could be modified to allow data to be produced at the level of disaggregation required at modest cost. Excel is widely used, and lists of properties could be coded by economic interest group, with Excel functions such as "SUMIF" used to aggregate at economic interest group level. Further work is needed to understand how easily the MDSF model can be adapted. We understand this is used reasonably widely, particularly for strategy level assessments, and so further research on modifying MDSF could be beneficial, if this approach were adopted.

Costs of implementation: Since the data needed for the disaggregated accounting recommended by Sugden are already available, practitioners confirm that the process is unlikely to involve significantly more work. Therefore, as the other changes proposed are essentially presentational, we conclude that it is unlikely that the ongoing costs of adopting the principles advocated by Sugden would be significant. We note however the issues of property ownership, stakeholder communication and inclusion of broader contributions and benefits (e.g. regeneration) could add complexity.

Rolling out the new approach would of course incur costs, associated with ensuring that guidance materials were available, and practitioners understand the requirements for the new approach.

In addition, we find that the methodologies used for the calculation of different impacts vary in the level of detail applied and the confidence that can be placed

[3] See for example the current and previous editions of the Treasury Green Book..

in the result. The disaggregated approach, if applied iteratively at increasing level of detail, could help reduce the cost of appraisals by allowing early indication of the factors likely to be most important to the decision making process, therefore focussing effort where it is most useful. We suggest that the review should consider how and if iterative development in this way can be applied effectively to FRM appraisal to reduce costs

6. Conclusions

In this report we have tested and developed the approach recommended by Professor Sugden and we endorse the principle of making clear the various sources of funds and the distribution of benefits. We have developed an appropriate table of monetised costs and benefits and a consistent Appraisal Summary Table that would bring together the material for a final multi-criteria analysis. We have developed and tested templates for their use in appraisal. We find the approach has the following advantages:

- The method provides greater transparency and more information to aid decision making.
- The approach supports both improved quality assurance of appraisals, and optimisation of option design
- It makes it clearer what has been monetised and included in the appraisal and what has not.
- It allows the benefit of schemes to individual businesses or groups of businesses to be identified and therefore may assist in negotiation of contributions from third parties.

Data is generally available to support the application of the approach and practitioners confirm that the process is unlikely to involve significantly more work.

From discussions with the ABI (see Appendix B), it appears that there is now little cross-subsidy between premiums for dwellings at risk from flooding and those not at risk. We conclude that as the market is moving increasingly towards risk-based premiums there is no need for any line in the Appraisal Summary Table for the disaggregated approach to show cross-subsidisation by households not at flood risk of those that are flooded.

A number of issues were identified whose resolution requires further research, or policy input, or was outside the scope of this project, we have made recommendations for carrying these forward. They concern:

- Market prices – the recommendation to use the numeraire of market prices has implications for the FHRC MCM datasets and capping of damages.
- Identification of property ownership – this is required to support proper application of social equity weighting factors and allocation of impacts to the appropriate economic interest group.
- Treatment of social equity – we have recommended that the income distribution of household beneficiaries of flood protection might be handled in a fair and simple way by valuing flood damage to all domestic properties equally in the CBA. It may or may not in the end be a technically and politically robust solution, but we commend it as an approach meriting discussion on its merits, with some investigation of how it might work in practice.

- Other Methodological issues – we have made recommendations regarding the treatment of tourism, disruption to trade/services and agricultural losses. Further work is also needed to understand how easily the MDSF model, which we understand is used reasonably widely for strategy level assessments, can be adapted.
- Development of the appraisal process – this is required to optimise the quality assurance of appraisals and allow the additional information provided by the disaggregated approach to be accounted for in the decision making process, and reduce the cost of the appraisal process
- MCA - The interface of the cost benefit analysis (CBA) with the multi criteria analysis (MCA) framework suggested as a way of accounting for non-monetised benefits within the appraisal process and currently being piloted by the EA requires testing.
- Consistency – the consistency with which the appraisal approach is currently applied and implications for resource allocation across schemes
- Choice of metric – the impact of the choice of metric and treatment of contributions in the FRM programme.

Ultimately the choice of metric is a matter for policy as it reflects the objectives of the risk management programme i.e. is the flood risk management programme trying to achieve most value for each pound of government money spent, most houses protected etc? There is a need for clear Defra policy, agreed with HM Treasury, on the use of ratios in investment appraisal. Our clear recommendation is that the appropriate benefit:cost metric to use is NPV/ Cg, to allow most benefit from the use of public money to be achieved, including the benefit of private contributions.

We suggest there is a need for a single expert authority within government controlling FRM appraisal development, in consultation as occasionally appropriate with the Treasury. A particular area where this will be important will be the development of an MCA methodology. This will depend upon the MCA expertise in the Environment Agency and the economics expertise in Defra/EA working closely together and developing a good understanding of each other's field of expertise, preferably promoted by a strong Senior Civil Service lead. This is especially important because of the danger that improvement of the CBA may give even more emphasis in decision making to impacts that can be monetised at the expense of those that cannot.

7. Recommendations

We recommend that the disaggregated approach should be taken forward with further development as described below, key areas include the numeraire, metric, MCA and equity.

7.1 Implementation of the disaggregated approach

We recommend that:

1. The benefit:cost metric used should be NPV/ Cg, to allow most benefit from the use of public money to be achieved, taking into account the benefit of private contributions.
   Ultimately the choice of metric is a matter for policy. A consequence of the choice of NPV/Cg, which we believe is the most defensible interpretation of the green book, is that FRM expenditure may not be optimised in terms of FRM benefits. We suggest that some further work is carried out to assess the impact of this change of metric on the FRM programme (see recommendation 12 below).

2. The numeraire of 'market prices' should be used and the data represented in the FHRC MCM datasets consistently in this format.
   Some further investigation is required to identify any circumstances that could give rise to counter-intuitive appraisal results arising from this choice and establish methods for handling them (see recommendation 12 below).

3. The templates developed by this project, and guidance documentation should be further developed through a pilot application. This could cost-effectively be included as part of the current EA MCA pilot.

4. Guidance on its application should be incorporated in the MCM.

5. We recommend that a single expert source within government is considered to oversee appraisal development, in consultation as occasionally appropriate with the Treasury

6. To avoid confusion, we recommend some further standardisation of terminology, such as the use, following Treasury convention, of appraisal to describe ex ante analysis and evaluation to describe ex post analysis, and a clear understanding of what by convention is included and not included in a "cost benefit analysis".

7.2 Methodology development

7. We have suggested that the income distribution of household beneficiaries of flood protection might be handled in a fair and simple way by valuing flood damage to all domestic properties equally in the CBA using some

appropriate average value. Additional work should be carried out to confirm the feasibility of this approach and determine appropriate values. As a minimum any monetary adjustment made for social equity should be shown on a separate line in the AST so that the impact can be shown clearly.

8. Implementation of the disaggregated approach to CBA within an MCA framework should be included within the current EA MCA pilot.

9. Further work is needed to understand how easily the MDSF model can be adapted. We understand this is used reasonably widely, particularly for strategy level assessments..

7.3 Review of processes

10. A process review should be carried out to establish:

    a. Whether appropriate check points exist within the appraisal process at which the following can be reviewed:
       - Identification of economic interest groups
       - Costs and benefits to be monetised
       - The 'do nothing' option
       - Emerging information about the significance of different costs and benefits.

    b. Whether, and how, additional information emerging from the disaggregated approach can be taken into account within the current appraisal decision making process. This information includes the rates at which benefits build up for different interest groups depending on the level of protection offered by an option, the most significant factors contributing to an appraisal and the level of certainty associated with their derivation.

    c. The feasibility of developing a more iterative approach to appraisal to help control the costs of appraisal further the components of appraisal costs compare with the corresponding components of appraisal in Highways and possibly other capital intensive public service programmes.

11. The impact of the greater transparency achieved on the process of communication with stakeholders should be assessed and training developed for practitioners.

12. A sample of appraisals should be examined and further work carried out regarding:
    - the impact of the change of metric
    - the handling and valuation of agricultural and non-agricultural land use

- the costs and benefits of routinely identifying residential property ownership and holiday lets
- potential counter-intuitive impacts of adopting market prices
- how the use of market prices for damages rather than factor costs will affect the point at which damages are capped and the significance of this to decision making
- the costs and benefits of adding stamp duty and transaction costs to property values; we expect that the costs will outweigh the benefits
- the impact of business disruption to private businesses and utilities, and the potential knock-on impacts of the loss of utilities, and the practicality of establishing values for inclusion in appraisals.

Such a review could also usefully examine the consistency with which the current appraisal process is being applied it this is not being assessed through the current review of the evidence base for appraisal. It could also examine in more detail the use of replacement costs in place of economic values in appraisals, although note that we do not recommend their use in CBA.

8. References

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Appendix A – Engagement workshop output

Engagement Workshop held 4th November 2005 at the National Liberal Club

Attendees:

Josh Arnold	Environment Agency
Michelle Boath	Risk Solutions
Chris Bown	Black and Veatch
Richard Clarkson	DfT
David Cotterell	Environment Agency
Bryan Curtis	LGA
Ian Dickie	RSPB
Stavros Georgiou	UEA
Karl Hardy	Defra
Michael Jones-Lee	ORRA
Gary Lane	Environment Agency
Andy Parsons	Defra
Edmund Penning-Rowsell	FHRC
David Richardson	Defra
Sara Ring	Risk Solutions
Adam Schofield	Halcrow
Michael Spackman	ORRA
Terry Thomson	ORRA
Tony Verran	HM Treasury
Richard Walker	Environment Agency
Bill Watts	Environment Agency
Helen Wilkinson	Risk Solutions
Phil Winn	Environment Agency

A1 Introduction

The workshop held on Friday 4th November 2005 was intended to raise awareness of the research work currently being undertaken by Risk Solutions and Oxford Risk Research and Analysis (ORRA). In addition, we intended to gather the opinions of the wide range of participants and provide guidance on the implications of the Sugden approach.

A1.1 Morning Session

During the morning session, background information on the project and issues surrounding it was provided:

Objectives of the Sugden project	Karl Hardy, Defra
Aim and scope of the project	Risk Solutions
Environment Agency perspective	Bill Watts, EA
DfT experience	Richard Clarkson, DfT
Data for the Sugden Project	Edmund Penning-Rowsell, FHRC

The presentations were followed by group discussion of the current approach, which generated ideas regarding what works well, what could be improved, any data issues etc. The discussions were wide ranging and highlighted several issues and concerns. These have been summarised in the final section of this note.

A1.2 Afternoon Session

Phase one of the project aims to identify and assess the implications of the Sugden approach. The afternoon session of the workshop was focused on the implications identified by Defra/EA in the project documentation. A brief overview of the issues was presented by Oxford Risk Research & Analysis (ORRA). This was followed by a group discussion session to identify and debate the relative importance of issues and also to identify any additional areas for consideration.

A2 EA Perspective – Bill Watts

Two main issues were highlighted as being of significant importance for the project; transparency, and the calculation of BCR. Bill's comments are summarised below.

A2.1 Transparency

- Remove the 'Black Box' that is currently a feature of project economic appraisal.
- Identify the winners and losers in schemes, particularly for multi-function projects
- Equity – more easily identify schemes and projects where there are lots of beneficiaries i.e. lots of individual households, and also where there are limited numbers of beneficiaries i.e. one or two large industrial/retail units. This is an area concerned with the 'public good' – are the proposed works helping the community as a whole, or just limited individuals?

A2.2 Calculation of the BCR

The NPV/K metric is not new in economics terms, as it has been used in other government departments for a number of years. Bill's view is that it should be possible to maximise the net benefits and handle contributions in a more effective manner.

A2.3 Other Issues/Concerns

How are disadvantaged communities dealt with, and is the equity multiplier guidance being applied appropriately (see PAG3 additional guidance and the HMT Green Book for further info)?.

A3 DfT Experience – Richard Clarkson

Richard was speaking from the perspective of a department that has already implemented a 'Sugden' approach to economic appraisal.

A3.1 Implementation of the Process

Based on Sugden's original report in 1999, the DfT have now rolled out the revised appraisal process across the country. The general feeling about the rollout stage was that it went smoothly. Comprehensive guidance and dedicated appraisal software were provided to practitioners to show the correct method of application. Not many issues or areas were left to the discretion of practitioners.

A3.2 Benefits of Disaggregating Costs & Benefits

Two particular examples of where disaggregation of costs and benefits has been seen are:

- Road User Charging – this involves large transfers between users and the government. Under the SCB system, these would have been largely disregarded. Using the Sugden method, these transfers have been more effectively captured, so are more transparent.
- Public Transport Schemes – these are often provided by private sector firms and the true distribution of costs was difficult to resolve. Use of the Sugden method has enabled these to be costed more accurately.

A3.3 Issues

Which summary statistic should be used? DfT currently uses the 'broad' definition of the statistic. This has raised some issues in the media, in particular regarding indirect tax revenues i.e. increased fuel consumption, leading to higher fuel duty revenues for the government. In some cases, the changes in tax are greater than the cost of the scheme itself, resulting in a negative BCR.
DfT are now considering whether use of the 'Narrow' definition may be more appropriate.

A4 Implications of the Sugden approach

Without losing sight of the overall aim of improving transparency in appraisal and considering the gainers and losers, the purpose of the Expert Review phase (phase 1) of the project is to:

- explore more specific implications arising from this WTP calculus approach;
- consider a balanced view of the advantages and disadvantages associated with the approach; and
- build on the issues and initial concerns raised by Prof Sugden's papers.

During this phase, implications arising from the Sugden approach are to be considered in two discrete, but linked areas, referred to as the general implications and specific implications. For each, implications should be considered from the viewpoint of Defra, the operating authority and the appraiser. It will also be important to identify the various impacts upon current policy and practice in order to understand how best to manage such impacts, but this will be further explored the Stage 1 Gap Analysis that follows this review. The workshop considered the specific implications.

The specific implications were grouped into what Defra considered to be 'Essential' and 'Desirable' in terms of research importance, as a guide to the scale of time and effort thought necessary in considering each of these impacts. The afternoon workshop break-out sessions aimed to test this ranking with the participants and to identify areas that require more or less attention. The results are summarised below.

A4.1 Essential items

The workshop participants confirmed the importance of all of the 'Essential'[4] implications. The following additional comments were made:

- **Consideration of private contributions; windfalls; developer benefit additionality; multi-objective scheme appraisal** – considered to be an area of high importance and by some, to have relatively low state of knowledge. This was an area where it was considered important to lay out all the issues clearly, but deciding how these should be tackled, if at all, was a matter for policy makers
- **Research on residential/commercial/other trade losses, including implications for existing datasets used within the industry; factor costs and market prices; capping of residential/non-residential property losses** – the issue was considered to be of high importance to the work. A difference of opinion between the two groups; one group felt there was a low state of knowledge concerning the implications for

[4] Implications considered 'Essential' by Defra/EA at the time of writing the project specification are highlighted in green. 'Desirable' implications for analysis are highlighted in red.

Sugden in this area; in the second group, one invitee felt there was no real issue with the data as it is disaggregated and in a format easily adaptable to the requirements of the potential new approach.

- **Consideration of equity, income and distributional effects** – both groups felt this issue should be treated with high importance. With regard to the current state of knowledge, workshop participants felt that while there was a large body of academic work, but application of the theory was an area of lower knowledge at present. • Relationship to Multi Criteria Analysis – this essential implication rated as being of 'middle' importance with the groups, with one group being slightly more concerned about MCA issues. The project documentation specifically mentions the potential for integrating the Sugden and MCA approaches and describes a starting point for its consideration.
- **Recognising the wider policy need for optimal use of the flood plain** and the need for long term resilience to potentially increasing flood events – an area of high importance, but a high state of knowledge should exist, or it is an area for policy and should not be explored in too great a depth. This point was originally combined with the first essential implication (Consideration of private contributions…), but was separated by one of the groups as it was considered to be a wider policy issue.

A4.2 Desirable items

- **Water Framework Directive (WFD) implications** – some concern was expressed that the implications of the WFD were not automatically considered to be essential impacts. The WFD is likely to have wider impacts on overall policy, therefore is an area to be considered but in less detail that the original 'Essential' implications. The potential implications and issues with respect to Sugden should be laid out clearly.
- **Intangible benefits including: environmental (e.g. wetlands), heritage, recreational and human health** – the two groups expressed polarity of views on the importance of this issue, with one considering it to be of high importance and worthy of consideration particularly in relation to the MCA aspect. The second group appeared not to consider this an issue. The conclusion has been drawn that this is an important issue that deserves some attention, and should be considered alongside its relationship with MCA. The following categories were considered to be of lower importance than those described above; while they should be investigated, less effort is warranted than for the other items listed.
- **Agricultural losses** – there was a difference of opinion between groups on the importance of this issue. One group felt that changing land use implied that this should be treated as 'impacts on rural landowners', or possibly as 'rural versus urban issues'. On balance, it is considered to be equally as important as the 'Competitive Insurance Market' category.

- **Competitive insurance market** recognising the significant contribution that the wide availability of insurance cover can play in management of flood risk – of equal importance with Agricultural Losses.
- **The appropriate treatment of tax revenues and subsidies** – another difference of opinion between the groups. One group felt it would not need significant effort, when compared with other items, as DfT had carried out considerable work on this issue and the implications for FM were considered to be of less significance. However, the second group felt that the impact on the issue of contributions would have to be explored.

A5 Other areas of interest

During the workshop discussions other points of interest were raised that may warrant further consideration. These have been arranged according to whether it was felt the application of the Sugden approach could help with the issue or whether the approach would struggle to improve things. Any areas that were considered to be mainly Policy-related (and thus outside the scope of this project to attempt to resolve, our remit being to expose the issues) are highlighted in blue, resolving broader process related issues and implications are also outside the scope of the project. These are highlighted in red.
Areas where Sugden would be likely to help:

- Transparency of appraisal
- Identification of costs and benefits to funding streams
- Stakeholder communications – this could also be made more difficult particularly with those classified as 'losers' in a scheme
- Multifunctional projects
- Decision criteria – against which projects are appraised
- Prioritisation of projects

Areas where Sugden may struggle to improve on the current approach

- Environmental aspects – potential for double counting in the current '3 pillars' approach (economic, environment & social scores)
- Impact of rising sea levels, Climate Change issues
- Impact on commercial enterprises and Regional Development Agencies/Funding
- Intergenerational issues – or future impact accountability, relating to the impact of decisions made now on future generations
- Negotiation – providing some basis for negotiation ie to acquire additional funding

Other areas of interest identified:

- Usability of an appraisal structure that includes both Sugden's approach and MCA – relationship between the two
- Risk perception – how people perceive the risk of flooding and whether this can be influenced by a more transparent approach to appraisal
- Planning in the floodplain – wider issues along the line of whether areas at risk of flooding should be considered for development at all
- Using the experience of DfT while appreciating that the issues associated with highway appraisal are different to FCERM.

A6 Case studies

Attendees discussed criteria that might be used to help select case studies that would test the potential new approach, and a number of schemes and strategies were suggested that might be worthy of further investigation. These are summarised in the table overleaf.

		Aspects												
Scheme Location	**Description and comments**	**Borderline / Marginal**	**Contributions**	**Deteriorating defence**	**Environmental**	**Future Development**	**High No. of Beneiciaries**	**Intangibles**	**Low No. of Beneficiaries**	**Multifunctional Multi-Departmental**	**PFI**	**Political Pressure**	**Regeneration**	**Ease of gathering information**
Examples from the initial Defra Post Approval Evaluation Audits	Projects to be evaluated have not yet been advised													
MCA Pilots	Pilot projects not yet advised, timescales not known													
Boston Strategy	Cited as 'socially ideal'.												y	
Dagenham	Single major beneficiary								y					
Dungeness Strategy	May be too high level									y		y		
Fluvial Trent	High consequence, low probability events; contributions													
Freiston	Managed realignment program			y?	y									
Hereford	Developer contributions issues and how to present these.	y	y			y?								
Hexham	A few key potential contributors and beneficiaries								y					
Humber schemes	Several to choose from covering a range of issues		y ?			y		y					y	y
Knottingley					y									
Lewes	Cited as featuring in recent R&D projects and pilots. C&B didn't provide an equal standard of defence, some parts were not viable now or in future. Also some minor secondary flooding caused, consequential to the solution.													
Pevensey	Cited as a coastal scheme for a design, build, finance and operate type case study										y			

		Aspects												
Scheme Location	**Description and comments**	**Borderline / Marginal**	**Contributions**	**Deteriorating defence**	**Environmental**	**Future Development**	**High No. of Beneiciaries**	**Intangibles**	**Low No. of Beneficiaries**	**Multifunctional Multi-Departmental**	**PFI**	**Political Pressure**	**Regeneration**	**Ease of gathering information**
Pickering	Low priority score project.	y										y ?		
Rotherham										y		y	y	y
Shoreham														
Stratford Marsh														
Thames	Use of the Thames methodology may rule this out?													
Tidal Trent/Nottingham	Nottingham has many at risk people/properties (c.20,000+) and is progressing. Links with LA and LEA - wider community benefits.		y	y			y			y			y?	

Appendix B – Summary of discussions on insurance

The Association of British Insurers - Matt Crossman, then Policy Adviser, Natural Perils (on secondment from Defra) and Federico di Pace, Economist – explained to us many aspects of the current situation on insurance against flood risk.

Matt Crossman (MC) was familiar with the literature known to the Risk Solutions team, in particular the papers by Huber and by Crichton.[5] He explained that, in England and Wales, 2.3 million out of a total of about 26 million properties were located in flood plains. Of these over half are thought to be at "low risk" (once in 200 years or more), just under a quarter "medium risk" (between once in 200 years and once in 75 years) and about quarter at "significant risk" (more than once in 75 years). There is however considerable uncertainty in the national scale assessments; the Environment Agency has a flood risk map, but this is not at individual property scale (although the Agency will provide information to householders to help in dealing with insurers).

Individual ABI Members, especially the larger ones, have their own commercial data, but the ABI do not hold area-specific data.

The severe autumn and winter floods of 2000 had led to increased debate among the many institutions affected, and in 2002 the ABI issued a Statement of Principles, to the effect that it would continue generally to insure properties at flood risk, subject to sufficient government activity to reduce flood risks. In October 2005 the ABI produced an "Anniversary Report" on "Revisiting the Partnership Five Years on from Autumn 2000" and in November 2005 the ABI published an updated Statement of Principles agreed with Government.

These updated Principles explain that for areas with a flood risk of once in 75 years or less flood cover will continue to be available as a standard feature of household and small business policies. For areas at higher risk, but with improved defences planned within five years to reduce it to one in 75 years or less, cover will generally be maintained. The premiums charged and other policy terms, such as excesses, will reflect the risk.

For areas at this higher risk but with no flood defence improvement planned the risks will be examined case by case. The larger insurers in particular are now starting to look at improving incentives for households and businesses to make their higher risk properties insurable against flood risk. As a contribution to this the ABI and the National Flood Forum have jointly produced a booklet on "Repairing your home or business after a flood – how to limit damage and disruption in the future", designed mainly to help make properties insurable

[5] Huber, M (2004), "Reforming the UK Flood Insurance Regime: The Breakdown of a Gentleman's Agreement", CARR Discussion Paper 18, January; Crichton, D (2005), "Flood Risk Insurance in England and Wales: Are there lessons to be learned from Scotland?", Technical Paper 01, Benfield Hazard Research Centre.

against flood risk, by improving flood resistance (keeping water out) and/or flood resilience (reducing damaged caused by flooding inside the property).

We were told that very few properties at flood risk have no buildings cover. MC referred to an ONS report (Family Spending 2005: A report on the 2004/05 Expenditure and Food Survey), which provides a breakdown on insurance take-up by income decile.[6] He felt that the current UK system of flood insurance, with premium levels increasingly based on risk, provides better incentives to avoid flood risk than those typical of other countries. In France for example premiums are paid into an emergencies fund and in the Netherlands the government provides the cover.

MC also commented, on a personal basis, on accounting for income distribution, noting in particular that income distribution in a flood risk area may well change markedly over the lifetime of any flood protection works. He saw merit in the Risk Solutions suggestion of a uniform valuation of flood damage to a household, dependent on flood depth but independent of specific property (or contents) value. He suggested however that there seemed little case for such a value varying by region, since the costs of restoring flood damage (in contrast to property values) varied little between regions.

He was personally doubtful about the feasibility even in the long term of charging household beneficiaries for flood protection works, given the diversity of households and of the differing levels of risk often faced by different properties within a given flood protection scheme, and the fact that often significant benefits fell to others – for example those travelling across the area. He saw however much more potential for charging for coastal erosion protection, where the benefits to particular properties could be more easily understood.

We have not explored in depth the many potential aspects of insurance in this field, but to the best of our understanding:

- Insurance against flood can now be regarded as broadly competitive;
- The availability of insurance reduces the welfare impact of flooding mainly because it protects against extreme losses. This does not call for any adjustment in the CBA. An adjustment of some kind would however be needed if be needed if some of those affected did indeed face catastrophic losses.

[6] MC subsequently reported that the ONS data shows that, for house buildings insurance, 85 per cent of the lowest income decile of households buying a home with a mortgage have buildings insurance compared with 90 per cent of all such households. In the lowest income deciles, 85 per cent of households owning their home outright have buildings cover compared with 89 per cent of all outright home owners. In terms of contents cover, some (primarily social) landlords provide insurance with rent schemes that cover the home contents, but the ABI have no statistics on this. The ONS statistics suggest that 45 per cent and 58 per cent of the households in the two lowest income deciles respectively have home contents insurance, compared with an average 77 per cent for the UK population as a whole.

- An efficient insurance market should also reduce the impact of flooding by its influence on the insured parties to improve their protection against flooding and against flood damage. We assume however that as such impacts became significant they would be reflected in the damage cost estimates used in the CBA.
- Property loss from coastal erosion is generally excluded from insurance cover. This raises the question of the circumstances in which it is reasonable or not reasonable for the taxpayer to compensate property owners for the loss or prospective loss of property from this cause. This is beyond the terms of reference of the current project, but we understand that Defra have recently commissioned some work on social justice that may address this issue.

Appendix C - Coordination of the Analysis of Monetised Costs and Benefits with the Appraisal Summary Table

The Sugden MCA report recommends (paragraph 2.9) that "it seems highly desirable to retain as much as possible of the structure of CBA within a broader appraisal framework which allows non-monetary impacts to be registered." To achieve this Sugden proposes the complementary use of an Appraisal Summary Table (AST) and an Analysis of Monetised Costs and Benefits. We endorse both the objective of retaining as much as possible of the structure of CBA within a broader appraisal framework and the achievement of this by the use of an AST and an Analysis of Monetised Costs and Benefits (or MCB table).

As Sugden recommends, the categories in the AST need in this case to be chosen so that, "as far as possible, they correspond with a mutually exclusive and exhaustive classification of cost and benefits that, in principle, are relevant for a CBA". This, as Sugden notes, "avoids double counting and preserves the option of expanding the range of factors that are given monetary value as CBA methodology advances and as data that can be used for benefit transfer[7] accumulate". As he further notes, it also ensures that the monetised entries in the AST are the constituent parts of the CBA.

As Sugden further notes, tables so designed "are features of the current appraisal framework for transport projects".

We present below suggested structures for these two tables. The proposed Analysis of Monetised Costs and Benefits table is based on the "CBA spreadsheet" presented in the Sugden main report. The proposed Appraisal Summary Table is based on Table 2.3 of the Defra/EA R&D Technical Report FD2013/TR of November 2004 on *Evaluating a multi-criteria analysis (MCA) methodology for application to flood management and coastal defence appraisals*, referred to in the Sugden MCA report, and here, as *Evaluating MCA*.

C1 The Analysis of Monetised Costs and Benefits

Table C1 is based on that at the end of the Sugden main report and refined in the following ways.

- The costs include an explicit listing of sources of funds.
- The tabulation of benefits identifies explicitly, as in the Sugden main report, those benefits for which it may be reasonable to seek financial contributions from beneficiaries. However these are listed under their appropriate main heading (e.g. transport enhancement, which might reasonably be funded, if at all, by the Transport Department is

[7] Benefit transfer is the derivation of monetary values by use of experience from other applications.

listed under “Net impact on transport, utilities, and emergency services”.) This replaces the listing of such benefits in the Sugden main report under a separate main heading of “non-FCD benefits”. This is for two reasons. One is that it greatly simplifies the table and so improves transparency. The other is that it also much better distinguishes between the presentation of social costs and benefits and the presentation of data to assist in the negotiation of funding, both of which are important, but which are different functions.

- The “Impact on environmental/heritage value” is disaggregated into whichever sub headings in the AST are covered in the CBA.

In practical application the table would be applied to alternative options, for example with and without the enhancement by widening of a new road bridge. The comparison of the options would reveal the benefits and the extra costs and would provide the basis for a settlement, between the Environment Agency and the Transport Department, of whether the extra work should be undertaken and the funding of the extra cost.[8]

One feature which does not appear in either this table or that in the Sugden main report, although the text of the Sugden report implies that it might do, is the impact on national insurance premiums. If many houses protected from flooding had previously had subsidised insurance premiums, the insurance companies will receive a benefit because now, with no change in premiums paid for those houses, they are faced with less risk. This benefit will most probably filter through to other households, nationwide, via a very small reduction in national premiums. However it is seems doubtful that would be material value to decision making in undertaking a numerical estimate of the total reduction in expected costs to insurance companies. (There may be political importance in making houses that were previously uninsurable insurable, but this is primarily a political issue, to include in the Appraisal Summary Table.)

The table includes, in the calculation of the net exchequer (or public expenditure) costs, an item for the change in indirect tax revenue. This might fairly often be a material item for major transport projects, but for FRM schemes this would not be expected to be material in any but very rare cases, if any. However it is retained for completeness.

[8] The funding at issue in this case should of course be the extra cost, not the extra transport benefit, which might be much greater. The situation is different in the case of negotiating contributions from developers or other private sector beneficiaries, where the negotiation will be on the basis of the private sector partner contributing a share of the benefit which it enjoys.

Table C1: Analysis of Monetised Costs and Benefits (MCB table)

Monetised Costs	
Total monetised cost	C(total)
of which	
Construction and maintenance	C(c&m)
Funded from:	
FRM budget (Defra, LAs, IDBs)	*C(pub1)*
Public funding partner 1 (highway authority: government)	*C(pub2)*
Business funding partner 1 (developer: non-government)	*C(bus1)*
Business funding partner 2 (property-owner: non-government)	*C(bus2)*
Monetised Benefits	
Total monetised benefits	B(total)
of which:	
Reduced flood damage to/ abandonment of buildings	B(buildg)
of which:	
households	*B(buildg-hous)*
businesses	*B(buildg-bus)*
of which business funding partner 2	***B(buildg-bus2)***
public agencies	*B(build-pub)*
Reduced flood damage to/ abandonment of agricultural land	B(agric)
Reduced disruption to trade	B(trade)
of which business funding partner 2	***B(trade-bus2)***
Net impact on transport, utilities, emergency services	B(util)
of which:	
households (e.g. as transport users)	*B(util-hous)*
businesses	*B(util-bus)*
public agencies	*B(util-pub)*
and	
of which the enhancement element is	***B(util-pub2)***
Reduced intangible costs	B(intan-hous)
Impact on environmental/heritage value	B(env-hous)
of which	
historic environment	
landscape and visual amenity	
etc. [using AST headings, where values are available]	
Impact on recreational value	B(rec-hous)
Development benefits	B(dev)
of which project funding partner 1	***B(dev-bus1)***

Net benefit (net present value, NPV) = B(total) – C(total) = B(net)
Net exchequer cost = C(exch)
[C(exch) = C(pub1)+C(pub2) – B(build-pub) – B(util-pub) + C(subs) – ∆indirect tax]
B/Cg = B(total)/C(exch)

Table C1 (continued): Analysis of Monetised Costs and Benefits (MCB table)

Attribution of benefits by initial incidence
Households
B(hous) = B(buildg-hous) + B(util-hous) +B (intan-hous) + B(env-hous) + B(rec-hous)
Businesses other than funding partners
B(bus-non-partners) = B(buildg-bus) + B(trade) + B(util-bus) – B(buildg-bus2) – B(trade-bus2) - B(util-bus2)
Business funding partner 1
B(dev-bus1) – C(bus1)
Business funding partner 2
B(buildg-bus2) + B(util-bus2) – C(bus2)
Agriculture
B(agric)

C2 The Appraisal Summary Table

Table C2 is based on Table 2.3 of Evaluation MCA, but modified in the following ways, mainly following the recommendations in Section 4 of the Sugden MCA report.

- A column has been added, listing the components of the CBA calculation, allocated to their appropriate category in the AST.
- The previous category of "Development benefits" has been replaced with a narrower category of "Regeneration benefits", applying only to areas with exceptionally high unemployment. As the Sugden MCA report explains, the original category as described was not altogether consistent with Treasury and ODPM guidance. In particular local employment creation by FRM schemes should not be presented as a net social benefit. The alternative "Regeneration benefits" category as described is consistent with the practice adopted in Transport.
- In the description of the "Economic" type of impact the words "that can be easily valued" have been omitted. This is because, as noted in Section 2 of the main text, 'economic" should not be equated with "can be valued". CBA is not specifically about 'economic' impacts. It will make use of monetary values wherever a sufficiently reliable willingness-to-pay methodology can be developed. These are often environmental or social impacts, as for example with the valuation of time, or risk of death, or recreational values, or sometimes environmental impacts.
- Under the Economic type a new category has been added of "Public accounts". The AST needs to incorporate the financial costs of the project to taxpayers as well as all its subsequent consequences.
- Under Health and Safety the words "posed by flood or erosion" have been inserted to avoid potential confusion and double counting

among users who might seek to include under this heading health and safety benefits from other consequences of the project, such as better access for emergency services, which come under the separate category of "availability and accessibility of services".

- Under Availability and accessibility of services the words "to the extent that theses impacts are not fully covered under Transport or Assets" have been added, to reflect the concerns properly raised in the Sugden MCA report (paragraph 4.7) of the dangers of double counting here.
- The description of the Equity category has been modified to include the important qualification that some equity issues have already been covered within the CBA, and thus are already covered in the quantified component of the Assets category, and possibly other categories. It has also been modified to include the issue of reducing the number of uninsurable properties, and to explain the reference to social tensions in terms of the possible resentments that may arise from conspicuously different treatments of different stakeholders - such as residents on either side of a river.
- "Sense of Community" at the end of the Social types of category has been deleted, because we share the view in the Sugden MCA report (paragraph 4.9) that it is hard to see issues here meriting inclusion in decision making advice that are not better covered under other categories.

One aspect which is not included in the table, but may be of substance, perhaps under the category of equity, is that of local political popularity.

Table C2: Components of an Appraisal Summary Table for Flood Risk Management projects

Types	Categories	Category Description	Monetised costs and benefits
Economic Reflect impacts that affect that affect the local, regional and national economy.	Assets	Includes flood damages and/or losses relating to (permanent and temporary) private and public property such as residential, industrial and/or commercial property, caravan parks, public buildings (for example, schools, hospitals) sewage and water supply networks, pipelines, etc.	B(buildg)+B(trade)
	Land use	Includes flood damages to land used for agricultural, industrial, urban, forestry, commercial fisheries purposes.	B(agric)+B(dev)
	Transport	Includes impacts to roads, bridges, railways and navigation.	B(util) (part)
	Regeneration benefits	Includes any contribution which the scheme makes to local regeneration plans in an area of exceptionally high unemployment.	
	Public accounts	Net public expenditure cost of the scheme.	C(exch)
	Physical habitats	Includes impacts to terrestrial (including coastal), aquatic and marine habitats and	B(env-hous)(part), if available

Types	Categories	Category Description	Monetised costs and benefits
		biodiversity, its conservation designations, and its flora and fauna.	
Environmental Reflect impacts that affect the natural and built environment.	Water quality	Includes impacts on biological and chemical quality of surface and groundwaters. Important indicators to consider include: chemical and biological GQA grades; river quality objectives; consented and un-consented discharges; and designated bathing waters.	B(env-hous)(part), if available
	Water quantity	Includes impacts on the water levels and water supplies (such as drainage and runoff).	B(env-hous)(part), if available
	Historic environment	Includes impacts on heritage, archaeological and geological features.	B(env-hous)(part), if available
	Landscape and visual amenity	Includes impacts on the appearance of the land (its shape, colour, and particular features), its landscape designations as well as its agreeable nature.	B(env-hous)(part), if available
	Natural Processes	Includes impacts on flow dynamics, sediment transport, geomorphology, etc.	
Social Reflect impacts that affect the general public and their way of life.	Recreation	Includes impacts on the processes or means of entertainment. It includes angling, informal recreation (walking, sunbathing, picnicking, sitting, swimming, etc.) and formal recreation (sports and other activities that require specific equipment).	B(rec-hous), if available
	Health and safety	Includes impacts such as risk posed by flood or erosion to life or serious injury, stress and anxiety (mental health and livelihood) and other health effects, such as those created during the construction phase of the project (noise and air pollution, for example).	B(intan-hous)
	Availability and accessibility of services	Includes impacts on availability and accessibility to public services such as education, housing, emergency and cleaning services, health, cultural facilities, to the extent that theses impacts are not fully covered under Transport or Assets.	B(util)(part)
	and the	Includes any important distributional impacts not captured on the monetised costs and benefits - e.g. large reduction in number of uninsurable properties; unusual impacts on vulnerable groups (the elderly, children, etc.); social tensions because of local distribution of costs and benefits	

Appendix D – Data sources and assumptions behind flood damage and loss data

This appendix was produced by Edmund Penning-Rowsell and colleagues at FHRC, Middlesex University, who carried out work on the assumptions behind the data in the MCM to support this project.

The following table gives a 'blow by blow' list of the assumptions behind the data collected in the Multicoloured Manual. As such it serves as a context to that volume, and in some respects a 'health warning'.

If there are some generalisations about this table, then they are the following:

1. Much of the data is collated from case studies, and the normal limitations apply (representativeness, applicability elsewhere, etc). This particularly applies to non-residential properties (Chapter 5) and emergency costs (Chapter 6).
2. Some of the data sets rely heavily on secondary sources of data (e.g. the residential flood damage data – Chapter 4) and involve a synthesis of this data.
3. Some data areas are liable to change in the future (e.g. the data sets on agricultural impacts of floods and flood) but the basic assumptions are liable to remain the same as here.
4. In some areas the data we have is acknowledged to be poor (e.g. some areas of non-residential properties (Chapter 5)), and we have been as honest as possible about their limitations.
5. The most important differences between the data sets as described here and those needed for a "Sugden" analysis appear to be the lack of VAT on the prices used to compile the Multicoloured Manual datasets. This is a trivial difference and one that it would be easy to correct.
6. In addition, however, it should be noted that all the Multicoloured Manual data describes the national ***economic*** impacts of floods and coastal erosion.

<u>Index of Multi-Coloured Handbook and Manual Chapters and data categories</u>

4. Residential properties

5. Non-residential properties (NRPs)

6. (a) Road and Rail Traffic benefits
   (b) Emergency services costs

7. Coastal erosion losses/benefits

8. Recreation losses/benefits

9. Agricultural benefits

Chapter 4
Sector: Residential properties

Data items	Principal data sources	Primary assumptions	Secondary assumptions	Comments
Property types and floor plans	▪ Fieldwork observation ▪ Building surveyors ▪ Architects' manuals	That all properties can be represented by these (average) measured sizes	Age is the major determinant of property dimensions, other than property type (semi; detached; etc)	The averages have not been determined by sampling and statistical averaging
The numbers of the different inventory items	▪ Market research firm data on ownership patterns ▪ Family Expenditure Survey ▪ Common sense (i.e. one boiler per dwelling)	▪ The quantity and quality of items is related to the social class of the occupants and the type of property involved. Some judgements made here.		See Box 4.1 (Penning-Rowsell et al, 2003: 47).
Inventory item value	▪ Catalogues (IKEA; Argos, etc) ▪ Guides (Which? reports, etc)	▪ The value of items are related to their inferred quality ▪ VAT is excluded	▪ The quantity and quality of items is related to the social class of the occupants and the type of property involved. Some judgements made here.	
Inventory item depreciation/Average Remaining Value (ARV)	The same as for the number of inventory items, above	▪ ARV = 50% for the majority of household items ▪ Only items new on the market within the last 5 years have higher ARV values (e.g. DVD players)	▪ Some 'old' items may have low ARV values	▪ This is a major assumption affecting the value of flood losses. ▪ A financial database would have different values
Inventory/Building fabric item susceptibility	▪ Data and information from Ark and similar salvage/repair firms ▪ Fieldwork and case examples going back many years ▪ Some common sense applied	▪ Susceptibility gauged as a % of depreciated value, factored by flood depth ▪ Basic flood duration < 12 hours ▪ The costs of salvage are not included (removal; storage; etc) [Some storage costs are	▪ Damage mechanisms exclude the structural failure of walls, etc ▪ Only ground floors considered	It is this variable that gives the shape to the depth/damage curves (this and the stored height of items). See Box 4.3 for Inventory item susceptibility assumptions (in Penning-Rowsell et al, 2003: 49). See Box 4.2 for Building fabric

Data items	Principal data sources	Primary assumptions	Secondary assumptions	Comments
		included in clean-up costs]		susceptibility assumptions (in Penning-Rowsell et al, 2003:48-49)
Building fabric repair items	Professional building surveyors employed especially for this task	Repair is to pre-flood condition or better. Costs are not differentiated by quality which is deemed to be standard. No ARV concept used	▪ Little structural failure is likely; some failure of doors and windows ▪ Only ground floors considered	Some betterment is unavoidable (i.e. the whole room redecorated/replastered etc. when part is flood damaged) 50% of the redecoration costs have been taken to represent an average true cost of flood damage. Labour costs remain the same irrespective of material costs.
Building fabric repair item cost	Professional building surveyors employed specially for this task	▪ VAT is excluded		
Long duration flood impacts	Professional building surveyors employed specially for this task	Repair is to pre-flood condition or better. No ARV concept used	▪ Little structural failure is likely; some failure of doors and windows ▪ Only ground floors considered	
Clean-up costs	▪ Data and information from Ark and similar salvage/repair firms	▪ VAT is excluded	Average costs based on actual damage experiences and costs, exclusive of VAT are used.	See table 4.4 and 4.5 (Penning-Rowsell et al, 2003).
Damages in curtilage	Professional building surveyors employed specially for this task	▪ VAT is excluded		This data goes back a long way (to 1977) and may not be very reliable.
Extra damage for London	Professional building surveyors employed specially for this task	▪ VAT is excluded ▪ The costs are averaged and do not reflect regional variation. An increase of 20% is recommended for London.		This data goes back a long way (to 1977) and may not be very reliable.
Damage reducing effects of warnings	Social surveys of flood victims	▪ People were asked what they could/had moved ▪ The value of what they moved was taken from the inventory valuations, above	VAT is excluded	This is a complex piece of research, and the full set of assumptions cannot be encapsulated here.

Data items	Principal data sources	Primary assumptions	Secondary assumptions	Comments
		▪ See the main warnings report for the full range of assumptions		
Extra effects of sea water damage	Professional building surveyors employed specially for this task	Repair is to pre-flood condition or better. No ARV concept used		

Chapter 5:
Sector: Non-residential properties

Data items	Principal data sources	Primary assumptions	Secondary assumptions	Comments
Property types	Field surveys or the EA's National Property Dataset (NPD)	The type of NRP is not well differentiated in the NPD, which relies on the Focus codes.		
Sample of properties to be the subject of the 'Head Office' surveys	Numbers of NRP properties on the indicative floodplain and the new floodplain outline	Our sample needs to match the properties at risk		This had to be done in two stages, which were different, owing to the new floodplain data becoming available in 2004. The differences are small.
Building fabric and structure value and susceptibility	'Head Office' surveys of 85 companies with properties located in floodplain areas	VAT is excluded. No depreciation taken: re-build cost data sought	That this information is accurately obtainable from a one-off 2 hours meeting	No warnings allowed for in the base data. Upper and lower bounds obtained for sensitivity analysis
Stock value and susceptibility and vertical distribution	'Head Office' surveys of 85 companies with properties located in floodplain areas	VAT excluded. No depreciation taken: replacement values sought	As above	No warnings allowed for in the base data. Upper and lower bounds obtained for sensitivity analysis
Moveable equipment value and susceptibility and vertical distribution	'Head Office' surveys of 85 companies with properties located in floodplain areas	VAT is excluded. Depreciated values taken	As above	No warnings allowed for in the base data. Upper and lower bounds obtained for sensitivity analysis
Services value and susceptibility and vertical distribution	'Head Office' surveys of 85 companies with properties located in floodplain areas	VAT is excluded. Depreciated values taken	As above	
Fixtures and fittings and susceptibility and vertical distribution	'Head Office' surveys of 85 companies with properties located in floodplain areas	VAT is excluded. Depreciated values taken	As above	No warnings allowed for in the base data. Upper and lower bounds obtained for sensitivity analysis
Effect of warnings on loss reduction	'Head Office' surveys of 85 companies with properties located in floodplain areas	That NRP property owners would do what they say they could do!	As above	Not much good data here.
Effect of sea water	'Head Office' surveys of 85 companies with properties located in floodplain areas	That extra damage would be caused	As above	Not much good data here.

Data items	Principal data sources	Primary assumptions	Secondary assumptions	Comments
Disruption caused by flooding	'Head Office' surveys of 85 companies with properties located in floodplain areas	That this can be measured in days of lost activity.	As above	Quite a lot of information on > 22 types of NRP.
Loss of production/trade	'Head Office' surveys of 85 companies with properties located in floodplain areas	Only loss of value added included	As above	Only sparse good data here; interviewees found this very difficult. The evidence is that not much damage would be saved.
Weighted annual average damage by standard of protection	Several dozen case studies (undertaken by John Chatterton)	That these are reasonably representative of floodplains in England and Wales		
Property ground floor area	Field survey for a particular scheme or a complex pri9cedure via rateable value	That this is at all accurate without field checks.		This remains a problem area

Chapter 6
Sector: Other flood losses

(a) Traffic and rail disruption

Data items	Principal data sources	Primary assumptions	Secondary assumptions	Comments
Road disruption: traffic volumes	Origin and destination surveys or field surveys or local authority data	That the road in question matches the data that is obtainable		
Road traffic: extent of resource and delay costs	Traffic models; alternative route paths; origin and destination surveys; speed-flow equations (DoT)	▪ Fuel taxes are excluded from the DoT values. ▪ That this type of disruption can be accurately modelled.	That speed and cost are correlated.	This is a very difficult area. Fuel taxes are excluded from the DoT values.
Road traffic: value of resource and delay costs	DoT data			Roads are important 'first victims' of floods, but this approach to assessing values seems rather abstract.
Rail traffic: flows	The number of passengers affected by the break in a rail link caused by a flood: data from rail franchisees and/or Network Rail			Rail tracks are, in fact, rarely flooded, but the Autumn 2000 event saw widespread disruption.
Rail traffic: extent of compensation costs	Standard compensation payment systems (Network Rail)			

(a) Emergency costs and utility costs

Data items	Principal data sources	Primary assumptions	Secondary assumptions/issues	Comments
Emergency costs of flood events	Bellwin claims; Severe Weather Payment claims; case studies (North Yorkshire); Environment	Only marginal costs allowed (e.g. overtime payments)	The secondary effects are not measured: overtime done by police staff given non-flood duties because	Some fuel tax items could not be excluded

	Agency costs		staff are on flood duties	
Utility outages in flood events	Case studies (South Wales)	Only marginal costs allowed (e.g. overtime payments)	Some repair and replacement items are not really marginal: e.g. the relocation of electricity transmission opines	This data is only for extreme events and therefore is of less use than most MCM data.

Chapter 7.
Sector: Erosion benefits (properties)[9]

Data items	Principal data sources	Primary assumptions	Secondary assumptions	Comments
Land use/property affected	Field surveys			Need to survey properties some way back from the erosion line, as these will benefit from the delay caused by scheme implementation.
Erosion contours	Historical records of erosion rates	Erosion rates in the past are a guide to the rates that would occur ion the future		Need to decide the time period over which historical records are used.
Erosion probability profiles	Historical records of erosion rates	Erosion rates in the past are a guide to the rates that would occur ion the future	Some safety margin is usual; Defra advise 2 years' worth of erosion	PAG spreadsheets employ this method.
Property values	Local estate agents; regional statistical summaries; Land Registry database	The values should assume no erosion risk		Inflated prices for properties with "sea views" should be avoided.
Scheme life	The scheme's design			Erosion rates are assumed to recommence/continue after this time period

[9] Open land, recreation resources, and agricultural land are treated in the same way as for flood alleviation benefits

Chapter 8
Sector: Recreational benefits

Data items	Principal data sources	Primary assumptions	Secondary assumptions	Comments
Data on: • access • types of use: - informal or - specialised e.g. boating, golf courses • types of visitor: - local, - day or - staying	• Site visits • Local authority lists of community activities and clubs • Local authority information on local tourism/recreation	• Current access is important and may be affected by erosion • Specialist uses may require separate/special assessment and yield higher values • Local, day and staying visitors may yield different values and may require different survey strategies: on site or residents survey • Current use/users only, not new/increased uses and users are evaluated by the methods	Sources can produce reliable and accurate information on uses and visitors as these can vary over time e.g. from year to year	
Adult visit numbers per year WTP beneficiaries	• Secondary source data e.g. car parks numbers, visits to a related site, tourism and specialised facilities managers (see Table 8.1) • Manual counts of visits conducted as part of a CV survey • Infra-red or other counter data for site • Number of adult residents in the catchment area for resource for WTP beneficiaries	• Visit number data can represent the total exposure of the resource to recreators • Only adult visits can be valued: children's visits are excluded • WTP beneficiaries can be identified (given that non-use as well as use value may be involved).	• Secondary source data can be converted to accurately represent site use • Count data are accurate and technical and human failures can be avoided • Counter data can be converted to adult visits via manual calibration counts • Missing count data (manual or infra-red) can be extrapolated	This is a particularly difficult area. Secondary source data are generally patchy and limited. Data collection on site via counters or manual counts is difficult and expensive to mount. Such data collection needs to be arranged well in advance and to cover a substantial period of time if excessive extrapolation from short term counts is to be avoided.
Data on seasonality	• Data on year round	• Seasonality measured	• It is possible to	Seasonal variations in visiting are very

Data items	Principal data sources	Primary assumptions	Secondary assumptions	Comments
of visits where only short term count or other data on visits are available for the site	visits at comparable locations, tourist attractions or wildlife sites (Appendix 8.4)	at other types of location will reflect that of visits to resource being valued	extrapolate from short term data to yield an annual visit figure	different for different types of site and sources of year round data are limited
Value of Enjoyment (VOE) per adult visit	• Some data/values derived from previous surveys • Site specific data from a survey on site and/or in residents' homes on VOE under varying conditions	• VOE measures the loss and the gain in utility from changes in the resource with and without FCERM interventions	• Respondents can answer VOE questions and surveys yield sensible VOE averages • Those who participate and answer VOE questions are representative of users • Survey scenarios are neutral and can accurately represent changes etc • VOE measures only the use value under varying conditions • VOE survey methods avoid 'biases' common in CV method applications	Some data are available from past surveys but VOE values vary from site to site in ways that cannot as yet be systematically explained. Therefore applying this data to new/comparable sites and scenarios is problematic. Designing and conducting CV surveys (both VOE/WTP) is a particularly difficult and demanding application of the survey method requiring well trained and supervised interviewers and care and expertise in survey and questionnaire design and analysis.
WTP values per visit/per annum	• Limited data/values derived from previous surveys • Site specific WTP data from a survey on site and/or a survey of beneficiaries in their homes	• WTP measures the change in utility with changes in the resource with FCERM interventions	• Respondents can answer WTP questions and surveys yield sensible WTP averages • Those who participate and answer WTP questions are representative of beneficiaries • Survey scenarios are neutral and can accurately represent changes etc • WTP surveys which	Limited WTP data are available from surveys Above comments on survey methods apply to WTP surveys

Data items	Principal data sources	Primary assumptions	Secondary assumptions	Comments
			cover use and non-use values can avoid double counting values (e.g. property loss values) counted in other ways • WTP values are not 'biased' by payment vehicle e.g. taxes, entry fees and other features of WTP survey methods	
With VOE, the numbers transferring to different sites	• Data on average gains and losses in VOE from previous surveys are adjusted to take account of transfer visits • VOE surveys include questions on changes in visit frequency and transfer to alternative sites under varying conditions	• That people can judge on the basis of survey scenarios, whether or not they would rather move than stay at the site with erosion and with the scheme options	• People have sufficient information about alternative sites	• This is on of the trickiest aspects of the VOE approach
The VOE values for these different sites	• Data on average gains and losses in VOE from previous surveys are adjusted to take account of transfer visits and VOE at alternative sites and the differences in costs associated with a visit to the alternative site compared with the current site. • VOE surveys include questions to elicit this information	• That people can judge their VOE and visiting costs at the alternative site		This is a particularly demanding task for survey respondents and one of the trickiest aspects of the VOE approach

Data items	Principal data sources	Primary assumptions	Secondary assumptions	Comments
Survey information on characteristics, behaviour, attitudes and preferences of respondents so that the validity of the VOE/WTP values can be tested.	• Questions in VOE/WTP surveys	• Visitor/residents characteristics, behaviour, attitudes and preferences are factors that may explain WTP or VOE valuations		In most cases, these factors have only explained a small proportion of the variance in the VOE/WTP values offered by individuals in surveys.

Chapter 9
Sector: Agricultural Benefits

(a) Secondary source (strategic) assessments

Data items and data types	Principal data sources	Primary assumptions	Secondary assumptions	Comments
Land area affected by surface flooding and/or waterlogging: Ha of 'benefit area' subject to surface flooding and waterlogging over which flood defence works exert influence	EA and IDB maps of floodplain and flood event records and river water levels. Aerial and other photographs Other records	Benefit area adequately defines area of potential benefit. Benefits directly linked to flooding and waterlogging regimes in this area	May include areas linked to extensive tributary systems, and downstream effects. Could include lowland areas potentially affected by highland carriers	Critical assumption defining boundary of benefit assessment. Varies according to magnitude of event and as a consequence of factors such as changes in catchment hydrology and climate. Possible treatment as special case if of strategic or social importance
Flood defence and land drainage infrastructure and related costs: Types of infrastructure eg embankments, pumping stations, drainage networks, field drains: design specifications and unit costs	EA/IDB/contractor records and cost estimates for capital, operations and maintenance works	Designs and costs vary according to standards of service and local conditions. Vat is excluded	Possible economies of scale Relationship between capital costs and operating costs Systems are maintained	Considerable variation in costs according to design standards. Possible additional costs to 'engineer' environmental gain into flood defence projects
Flooding regimes; Aerial extent of flooding by return	EA and IDB maps of floodplain and flood event records and river water levels. Aerial and other	Flood regimes are a major determinant of land use type, productivity and economic performance. Flooding affects land use	Changes in flood regime are associated with changes in land use and management. Changes in flood and water level regimes linked to Defra	Under the prevailing agric policy regime, there is likely to be little call for enhanced protection for agriculture, rather assessment of justification for retaining or possibly reducing existing

Data items and data types	Principal data sources	Primary assumptions	Secondary assumptions	Comments
periods, seasonality, duration, depths	photographs Other records Modelling/flood routing Other records	options and damage to crops Seasonality and duration are critical	appraisal scenarios	standards (the latter including implications for environmental options).
River/water course levels : River/ditch water levels at various recording frequencies	EA/IDB level records Hydraulic/hydrological modelling	River/ditch levels determine standards of service for 'free' and artificially drained soils, less so for heavy undrained soils	Influence of river/ditch reduces with distance	Important element of standards of service, affected by capital works and maintenance programmes
Soil-water regimes (field water levels) Field water levels at various recording frequencies	Limited data sources, usually linked to research/habitat management sites	Soil water conditions critical determinant of land use options and productivity	Artificial drainage needed in heavy soils. Changes in flood and water level regimes linked to Defra appraisal scenarios	Mainly determined by farmer/land and water management decisions
Agricultural Land Classification (ALC) and soil types Grades 1 through to 4 Soil Series/associations	ALC map maintained by Defra (statutory) National Soils map: 1:250,000	ALC grade broadly linked to land use types: 1 intensive arable through 4 grassland Soils map indicates land use suitability and management prescriptions	General correlation between ALC and Soils type at broad scale	Correlation likely to weaken due to reductions in agricultural support. Some grade 1 land may suit wetland habitat creation Some land may be of strategic importance
Land prices £/ha sale prices by grade and tenure Rental values, £/ha Quantities sold/let	Defra, RICS and land agents: Farm management pocketbooks (eg Nix, ABC, SAC),	Land prices can be used to estimate value of benefit stream from agricultural land where assumed permanent loss of total output	Adjustments made to remove agricultural subsidies assoc with single payments and agri-environment	Evidence suggests tenuous link between land prices and value of future benefit stream from agric production
Major land uses	CEH land cover maps Aerial photos	Land use types indicate value-added from agricultural	Higher value land use requires higher standards of	Generally good correlation between land use type and flood/drainage

Data items and data types	Principal data sources	Primary assumptions	Secondary assumptions	Comments
Types: horticulture, intensive/extensive arable, intensive/extensive grassland Other: recreation/woodland	Agric Census results Reconnaissance Field Observations Agricultural advisors Historical land use	production: strongly associated with estimates of agricultural benefits	flood defence and land drainage. Heavier wetter soils mainly down to grass	condition in farmed areas. Bio fuels could be important future option
Farming systems physical/technical data: Dominant farm types and sizes, cropping patterns, livestock types, crop and livestock yields, stocking rates, irrigation, employment 'alternative' farming'	Regional Farm Business Management Surveys, Farming press Agric Census results, Farm management pocketbooks (eg Nix, ABC, SAC), EU (NUTS) sources, CAMS	Typical farming systems can be drawn up to represent major types of benefit scenarios. They are an important part of the narrative of land use	Agricultural Benefits are defined at the farm scale, aggregated to the scale of a benefit area	Important to identify and explain past and likely future trends in farming systems, especially during period of policy and structural adjustment. For long term projects should consider technology change (and yields)
Farming systems data – financial and economic data: prices (*see agric commodity prices below), gross margins, fixed costs, net margins	Regional Farm Business Management Surveys, Farm management pocketbooks (eg Nix, ABC, SAC) EU (NUTS)	Farming systems are an important unit of assessment for the estimation of agricultural benefits. Gross margins and net margins are the appropriate units of accounting, as per Defra guidance.	Critical links with farmer motivation and behaviour	Important to identify trends in farming systems, especially during period of policy and structural adjustment
Agricultural commodity prices	Defra Agric Stats Market reports Farm business surveys and management books	Mean annual price series, excluding subsidies (simplified post 2005) Follow Defra guidance	Defined within prevailing policy regime (currently post 2005 CAP reform).	For long term projects should consider plausible commodity price changes

Data items and data types	Principal data sources	Primary assumptions	Secondary assumptions	Comments
Farm gate prices for crop and livestock products	Research/modelled predictions/forecasts (Defra/EU)			
Take –up rate of potential benefits Rate of change of farming practices	Research literature on uptake of drainage benefits, uptake of environment options	Uptake varies according to a mix of drivers, farmer motivation and perceived benefit	If farmers perceive benefit they will change behaviour, including env. options	Considerably uncertainty at the moment about farmer responses to policy change
Environmental aspects: habitats Presence of or potential for SSSI/protected habitats Incentives	English Nature/Natural England Designations, NGOs including FWAG, RSPB	Flooding and soil water regimes vary according to environmental objectives.	Regime requirements for protected habitats need to be prescribed	Likely to be an important driver of flood defence in floodplains
Agri-environment options Existing or potential Environmental stewardship options. Payment regimes Management agreements	Defra Regional Development Service Defra publications Farm management pocketbooks Evaluation studies NE, FWAG and others	Agri-environment options may require different standards of flood defence. Env benefits included in benefit assessment	Scope for designing flood/waterlogging compatible with environmental options	Important element of an integrated approach to flood risk management in rural areas. Env and ecosystem benefits should be included in options appraisal. This needs further attention.
Runoff control/storage interventions Type, scale of control measures	EA/Defra/IDBS CFMPs	Water retention/storage impacts on land use and farming practice	Catchment scale issues	Important element of integrated approach, especially re WFD and links to diffuse pollution
Agro-climatic conditions Rainfall,	Defra and Met office sources	Required for field drainage and water level design	Local variation is not critical	Potential impacts of climate change

Data items and data types	Principal data sources	Primary assumptions	Secondary assumptions	Comments
temperature, agro climatic zone				

(b) Field/farm survey based assessments

Data items and types	Principal data sources	Primary assumptions	Secondary assumptions	Comments
Secondary data sources as above				
Farm level data Farm size, proportion of farm in benefit area, topography, major soil types, and agro-climate. Cropping pattern (crops by area) Livestock types, numbers, ages, systems. Tenure, Farmer age Number of family and hired workers Major changes in farm circumstances and practice over past five years Current development proposals Environmental stewardship Participation/eligibi	Secondary farm business management sources as above. Farmer interview survey. Local sources: advisors, farm secretaries, land agents, farmer groups/associations	Insights into past trends and observations of present provide basis for future predictions. Possible classification in 'less favoured area'	Farm/farmer level factors are critical in shaping agricultural and related benefits.	Rapidly changing policy environment may mean past is not good basis for predicting future

Data items and types	Principal data sources	Primary assumptions	Secondary assumptions	Comments
lity				
Field level data /blocks of fields with similar characteristics Field size (ha), soil type, slope tenure, location, drainage type/system and condition, evidence of flooding/waterlogging, field boundary and ditch conditions, compliance requirements, eg field boundaries	As above, corroborated by farmer interview, and field observation	Field level characteristics define type and extent of potential change COGAP compliance may apply at field level	Possible to aggregate fields/ blocks of land at the farm level into 'management units'	Useful for identifying hydraulic cells with similar flood regimes. Note compliance requirements
Grassland Grassland site class, Grass type, risk of surface damage Nitrogen use (kgN/ha), Grass conservation. Stock types and performance, Grazing season	As above, corroborated by farmer interview, and field observation	Farming practices provide basis for benefit assessment	Changes in practices provide basis for assessing likely change in benefits	Changing technologies and policy environment may mean past is not good basis for predicting future
Arable Crop type, crop yield (t/ha), Crop rotations. (	As above, corroborated by farmer interview and field observation	Farming practices provide basis for benefit assessment	Changes in practices provide basis for assessing likely change in benefits	Changing technologies and policy environment may mean past is not good basis for predicting future
Farm level	As above, corroborated by	Major changes in farming	Permanent changes in	Significant changes are occurring in the

Data items and types	Principal data sources	Primary assumptions	Secondary assumptions	Comments
financial data Gross margins, fixed costs and net margins: Fixed costs assumptions; labour, machinery, buildings: will any changes in flood defence affect 'fixed costs' such as labour machinery, buildings, use of contractors	farmer interview, mainly using typical prices and cost estimates.	practice and land use will affect the fixed costs structure of the farm business. Implications of single payment regimes, agri-environment schemes and	flood defence likely to affect net margins at farm level Apply Defra guidance	structure and management of farms, associated with for example changes in policy, markets and technology, with implications for benefit assessment

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