C   Socio-economic appraisal & sensitivity testing

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C.1   Introduction

A review of economic viability is required for the Preferred Plan in order to make a broad assessment of the economic robustness of the preferred policies. The economic review therefore determines whether or not the policy under consideration is:

- clearly economically viable

- clearly not economically viable, or

- of marginal viability (and therefore may be in need of more detailed assessment at a later date, e.g. as part of a strategic plan, although some commentary on this is provided within this report).

It must be recognised however that the justification for a particular policy is not necessarily dependent on economic viability, as impacts on other benefits may be considered more important (e.g. holding existing defences to sustain a designated habitat).

A number of strategy and scheme assessments have been developed for the coast over recent years and these contain detailed information on assets, benefits, and management costs. It is recommended that this information be used where it is directly applicable, and it may probably be the best source of information for the immediate and medium term economic viability assessments.

However, the justifications in these previous studies are only appropriate if all other aspects are the same, i.e.

- the timeframe: many strategies have looked at economics over only 50 years and use different discount factors to those now required by Treasury

- the area determined to be at risk: the SMP may have a modified assessment of the area that could be affected by erosion or flooding

- the preferred option matches that from the strategy: the SMP may be advocating a change from previous policy or management practice.

While some of the conditions above may not be met, some of the raw data from the strategy or scheme could still be useful in validating or modifying information from a broad-scale SMP assessment described in the following sections.

C.2   Generation of new data

Where there is not existing information that can be used directly to confirm robustness of the SMP policy, new economic data can be derived through application of the Modelling and Decision Support Framework (MDSF) tool (which consists of a customised GIS (ESRI ArcView) and a data management toolkit). This 'Broad-scale Economic Review', described below, uses nationally available information on property locations and values, and is described in detail in Section C3 and Annexes C1 to 3.

C.2.1 Determining damages and benefits

The benefits are the damages averted or deferred by the Preferred Plan, i.e. the difference in losses between implementing the preferred plan and No Active Intervention (NAI) scenario. These can be calculated for each epoch by assessing those assets at risk from loss for the periods 0 to 20, 20 to 50 and 50 to 100 years. Using the erosion lines developed from the baseline assessments overlain with the property location/value data it is possible to calculate potential economic losses and economic benefits for the NAI scenario and the Preferred Plan scenario.

In calculating damages and benefits for the preferred scenario, no account need be taken of the potential for short-term accelerated or delayed losses down-coast compared to NAI, other than the total adjustment in shoreline position at the end of each epoch. The SMP does not take account of *standards of protection* as it is only defence management policy that is being determined, whereas standards of protection relate to implementation (which will be determined at strategy level).

C.2.2 Benefit values

In using MDSF only those losses and benefits based on residential and commercial property values can be calculated. Other assets, such as utilities, highways, and intangibles, such as recreation, impacts upon the local economy or environment, can not been valued or included. Exclusion of these factors will robustly confirm economic viability, as these would provide added value.

MDSF is populated with the Combined Property Dataset (CPD), which identifies the location of residential and commercial properties. This has been produced by combining the OS 'Address Point' and Valuation Office 'Focus' datasets. The Address Point data identifies the location of all known postal addresses, and the Focus data is then used to identify which of these are commercial properties. For the residential properties, current average prices (based upon recent sales) can be obtained from various websites, for example landregistry.gov.uk or upmystreet.co.uk, which provides property price statistics by postcode (no value is assigned to residential properties in the CPD). For non-residential properties, rateable values held within the Focus dataset are multiplied by an appropriate factor to derive an equivalent capital value, which is included within the CPD. (Further guidance on these datasets is provided in Annex C2.)

Using the 20, 50 and 100 year erosion contours, MDSF is used to calculate the Capital Value (CV) and discounted Present Value (PV). For the flood risk areas (generally defined by the coastal and tidal/fluvial Flood Zones), GIS can be used to simply sum the CV for all built assets within the flood area, using the same data as above. This is based upon the assumption that under NAI, all properties at risk would be "written off" once defences failed. This is taken as an indicative figure for the assets potentially protected by defence structures.

C.2.3 Generation of new defence cost information

Future coastal defence management approaches for each Policy Unit are developed as part of the policy assessment and the Preferred Plan. Thus the broad replacement and maintenance requirements and costs for each epoch can be determined.

Where there is no existing information relating to future defence costs for an area, e.g. from a strategy, costs can be generated using other nationally available information.

(a)   Cost Rates

Replacement costs for general defence types can be taken from the recently developed Environment Agency database. This suggests average replacement costs for linear structures (e.g. revetments, seawalls) as £2.7million/km and costs for beach management schemes at £5.1million/km. Groyne field costs are taken as £0.6million/km. However, these figures may need to be adjusted for local factors.

Maintenance costs can be taken from the Defra National Appraisal of Defence Needs And Costs (NADNAC) study (2004). This used annual maintenance costs for linear structures and for groyne fields at £10,000/km, and for beach schemes £20,000/km.

(b)   Cost Calculations

Guidance is given that the following be assumed for the cost calculations:

- full scheme reconstruction required (i.e. design life) is at least once every 100 years for linear defences such as seawalls,

- every 50 years for beach schemes and

- every 30 years for groynes.

However, these periods may become more frequent for areas where erosion potential is high. Maintenance can be assumed to be the same rate every year throughout the life of the scheme; however, in reality, this will be less in early years and will increase in later years of the scheme's life.

Allowance should be made for the increase in costs due to climate change, based upon factors developed for the NADNAC study (2004). This takes account of the need to make structures higher, deeper, and more resilient to increased exposure. These assumptions include:

- no cost increase for the 0-20 year epoch;

- costs factored up by 1.5 times present day rates for the 20-50 year epoch;

- and costs factored up by 2.0 times present day rates for the 50-100 year epoch.

Optimism bias in accordance with most recent Defra guideline should also be applied to all costs (at 60%) to reflect uncertainty in broad level analysis at the SMP scale.

C.2.4   Comparison of costs and benefits

As a full economic assessment is not undertaken, a formal benefit-cost assessment using BCR <u>is not required</u>; rather, the information available has been used to review robustness of the preferred plan.

In comparing likely benefits and likely costs for the policies for an individual location over the full 100 year period it is, however, still useful in some instances to be able to consider these in terms of Present Value (PV).

Present Value is the value of a stream of benefits or costs when discounted back to the present day using the latest factor provided by Defra for assessment of schemes.

For calculation of PVdamages and PVbenefits, the approximate timing of property losses can be determined using MDSF and corresponding discount factors can be applied accordingly. For calculation of PVcosts for defence replacement, the average discount factor for each epoch should been used, the actual timing of works being uncertain at present. The year-on-year maintenance PVcosts can be calculated using the total of the discount rates for that epoch.

C.2.5 *Economic sensitivity assessments*

At selected locations, namely at locations which are currently defended, but where full protection is not part of the preferred long-term plan, the economic viability of continuing to defend long term can be tested as a sensitivity to the plan.

Tables C1 and C2 present examples of outputs from these economic assessments.

Table C1: Economic assessment summary

The Table below provides a summary of the economic review of the preferred plan for each Policy Unit; it outlines any information used in this review, including benefits (**property only**) and costs, together with a statement on economic robustness. This table could also be used to present any economic sensitivity analysis.

Supplementing these tables are summary pages setting out the economic damages for No Active Intervention and the Preferred Plan, together with a calculation sheet identifying the build up of defence costs; these are included in Annex H1.

Location		Calculation of Damages and Benefits		Assumed Defence Works & Costs			Comments
				Broad-scale Economic Review			
		Previous Studies	Broad-scale Review (this SMP)	Years 0 to 20	Years 20 to 50	Years 50 to 100	
3b02	Sheringham	Strategy study in progress – no data currently available.	**_NAI Damages:_** By 2025: none By 2055: up to £1.8m By 2105: up to £106.9m **_Preferred Plan Damages:_** By year 2025: none By year 2055: none By year 2105: none	Extend linear defences. Maintenance of all structures. Cost: £1.8m See details for years 50 to 100	Extend linear defences. Reconstruct groynes. Maintenance of all structures. Cost: £7.3m See details for years 50 to 100	Reconstruct linear defences. Maintenance of linear defences. Cost: £14.0m The plan for this Policy Unit to hold the present line over 100 years is **Economically Robust**. Whilst the PVbenefit of up to £8.1m compares to a PVcost of £5.0m, the capital value of property protected is £107m, compared to a cost over the same period of only £23m, a ratio of nearly 5:1.	*It is possible that under NAI the seawall along the main frontage could fail earlier than anticipated which would increase the PVbenefit.* *It should also be noted that only property benefits have been considered and that inclusions of other assets could increase the PVBenefit.*

Table C2: Supporting economic data

Summary Table

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
POLICY UNIT	YEAR	ASSET VALUE LOSS PER EPOCH (DAMAGES)		CUMULATIVE PROPERTY DAMAGE / LOSS (PV)		MANAGEMENT COST PER EPOCH (PREFERRED PLAN)	PREFERRED PLAN		SENSITIVITY ANALYSIS	
		NAI	PREFERRED PLAN	NAI	PREFERRED PLAN		PROPERTY DAMAGES AVERTED (PV)	COSTS (PV)	BENEFITS (PV)	COSTS (PV)
3b02 Sheringham	**20**					£1.8m		£1.2m		
	50	£1.8m		£0.4m		£7.3m	£0.4m	£3.6m		
	100	£106.9m		£8.1m		£14.0m	£8.1m	£5.0m		

Cost Calculations

(a)	(b)	(c)	(d)	(e)		(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)
POLICY UNIT	PERIOD	NOTES	REPLACEMENT			MAINTENANCE			TOTAL COST			PV COSTS		
			LENGTH		COST	LENGTH		COST	TOTAL COST	WITH OPTIMISM BIAS	CUMULATIVE TOTAL	REPLACEMENT	MAINTENANCE	CUMULATIVE PV TOTAL
			B	L	G		B	L	G						
3b02 Sheringham	**0 - 20**			0.2		£0.54m		1.3	1.5	£0.56m	£1.10m	£1.76m	£1.76m	£0.61m	£0.64m	£1.25m
	20 - 50			0.4	1.7	£2.10m		1.5	1.7	£0.96m	£4.59m	£7.34m	£9.10m	£1.59m	£0.73m	£3.57m
	50 - 100			1.3		£3.51m		1.7		£0.85m	£8.72m	£13.95m	£23.06m	£1.18m	£0.28m	£5.03m

C.3   The Modelling and Decision Support Framework

C.3.1   Introduction

The Modelling and Decision Support Framework (MDSF), originated in a Broad Scale Modelling (BSM) Defra/EA R&D Theme proposal for a demonstration project on the use of GIS, Digital Elevation Models (DEM) and other databases in assessing the impacts of flooding and the effect of Flood and Coastal Defence (FCD) management measures, extending across catchments, estuaries and coasts. The system was initially developed for use by the Environment Agency and their consultants on the Catchment Flood Management Plan (CFMP) programme. The objectives of this were to ensure a consistent national approach to flood impact assessment, to avoid the duplicated effort that would be involved by each consultant setting up their own system and gathering their own data, and to ensure relevant research and best practice were utilised on the CFMP programme. The system provides a consistent framework to manage the vast amount of data that is consistently available throughout England and Wales and produces clear graphical representations of risks.

The potential benefits of this system to the development of Shoreline Management Plans, and indeed Coastal Strategies and Schemes, have been recognised, and a version suitable for application to coastal environments has been developed from the existing CFMP version of MDSF.   Access to the national datasets, used by the MDSF system, for application to SMPs is currently being reviewed.

Parts of the functionality of MDSF described in this section may not be required for many SMPs where detailed quantification of assets at risk is not deemed necessary by the Client Steering Group, however the use of MDSF will provide a consistent platform upon which data can later be applied in strategies and schemes (which may utilise the fuller functionality).

Ongoing development of MDSF will doubtless further enhance its functionality for coastal applications in the future, at which time application should not be limited to uses described in this appendix.

C.3.2   Benefits of the MDSF for SMPs

The overall aims and objectives of SMPs are intended to be the same as those for CFMPs, although there are inevitably some differences in the levels of detail required reflecting the different scales of river and coastal analysis. The CFMP MDSF provides the basis of the system that has now been developed for SMPs, which will also be suitable for further application during the subsequent development of more detailed Strategy Studies and Schemes.

Whilst identifying what the MDSF can provide to SMPs, it is also important to stress what it does not do. In particular:

- it is not a decision making tool, i.e. it does not optimise solutions;

- it is not a hydraulic/hydrological/hydrodynamic/erosion model, i.e. such items are generated externally to the MDSF; and

- it is not a new GIS, i.e. it consists of a customised GIS (ESRI ArcView) and a data management toolkit.

It is a decision support framework to provide common approaches and tools, particularly for the assessment of economic and social impacts of policy options.

The key features of the SMP MDSF that may be used in developing/revising SMPs are:

- **Consistency and flexibility** – standard data management tools ensure consistent, and replicable, outputs within (and between) SMPs, with flexibility over the level of detail of both input data and output results.

- **Data storage** – there are a number of standard datasets, which are to be used for SMPs (see separate appendix). The MDSF database is designed to request these as standard. The database is also capable of storing additional 'local' data that is collected/identified for a particular area – a key aspect of the SMP review process. This ensures that, as a minimum, all SMP consultants will be able to use the system in SMP preparation using 'standard' (nationally available) datasets, however with the ability to supplement this with other data available locally.

- **Metadata** – it is particularly important that the origins and background of data collected/stored is known to ensure transparency of the process. This is an integral aspect of the MDSF database.

- **Flood mapping using the new national DTM** – improved accuracy of topographic data used in flood mapping. The baseline scenario for SMPs will need to include for the recommended Defra sea-level rise rates (i.e. 4-6mm/yr).

- **Calculation of flood damages** – these are based upon flood event data imported from available flood modelling, with damages calculated from national asset databases and 'The Benefits of Flood Control and Coastal Defence: Techniques and Data for 2003' (Middlesex University, 2003) standard damage data. (It is proposed that existing RASP HLM data is used if local modelling has not been undertaken: for definition of RASP HLM see Appendix C1. It is important to note that the RASP methodology considers both overtopping and defence failure (breaching) depending on its condition and standard and this should be reflected in any alternative analysis.

- **Calculation of socio-economic impacts of flooding** – using flood scenarios and the Social Flood Vulnerability Index (Middlesex University, 2003).

- **Calculation of erosion damages** – these are based upon input erosion contours (based upon coastal process analysis) with damages calculated from national asset databases and available asset valuation data.

- **Economic implications of intervention options** – the reduction in damages associated with various standards of protection can be appraised very rapidly, by simply changing defence standards for a frontage. For erosion situations this can be based on Extension

of Life factors.

- **Ability to deal with multiple risk areas** – SMPs cover large lengths of coast, possibly containing a number of discrete risk areas (flooding and erosion), which would need to be considered separately.

- **Ability to handle a variety of geographic data** – enables review of other coastal assets, e.g. environmental designations, historic sites, etc, against the risk areas defined, to assist in appraising the impacts on these features.

- **Mapping of outputs** – linked to the above, the GIS component can be used to create mapping for the SMP.

- **Ability to incorporate defence residual lives for 'do nothing' calculations** – calculate flood damages assuming defences are lost/fail at a given point in time, or that erosion is delayed until a certain time.

- **Encourages assessment of uncertainty** – through consideration of error margins of input data.

Other benefits that use of the MDSF system will provide include:

- **Consistency with Estuary Plans and CFMPs** - a consistent flood risk impact toolkit will ensure that coastal, fluvial and estuarine risks are assessed in a consistent way, leading in turn to consistency of investment decisions.

- **Value for money and consistency between different SMPs** - it is commonplace now to use GIS in shoreline management planning. On CFMPs, one of the key drivers of the MDSF was the wish to avoid each consultant "reinventing the wheel" and setting up their own GIS systems.

- **Tiering down to Coastal Strategies** – the datasets (and analysis techniques) promoted for use on SMPs are sufficiently detailed as to be used subsequently in strategies and schemes. MDSF will permit a rational focussing down of detail within these datasets, such that the MDSF system (and datasets) developed for an SMP could later be used for these more detailed studies.

- **Secure storage of data** - the MDSF uses full metadata and includes a database of all scenarios tested and data used.

- **A simple to use flood spreading tool suitable for planning-level use** - raster-based models are capable of rapid estimation of flood outlines with little manipulation. Moreover they give directly the flood depth grids that are needed for the impact estimation.

- **Exploitation of new/locally available data sets** - the system can use new or locally improved datasets (provided they are in an appropriate format) to ensure the best available risk estimates.

- **Best Practice** – the MDSF makes best practice tools available across the SMP programme.

C.3.3   Application of the MDSF in SMP Development

As stated above, the primary role of the MDSF is in the definition of economic and social impacts of policy options. However, this is not limited to simply calculating the monetary value of damages (to readily valued assets) for various policy options. The MDSF provides a toolkit to appraise the extent and nature of areas potentially at risk from flooding and erosion, this can be used to describe the features at risk, enumerate (i.e. number of features) or evaluate them. The following identify the stages of SMP development at which MDSF should be used (Part 1 Chapter references are given for the full description of these tasks). (Fuller details of the datasets are given in Annex C2.) A system diagram of the SMP MDSF is shown in Figure C1.

The core data for each SMP is loaded into a customised GIS data management and analysis system. Metadata (i.e. data which describes the contents, format and origin of each data file) is used to ensure long-term data integrity. The GIS is provided with a user interface that enables users to run and keep track of "what-if" cases consisting of different combinations of climate, land-use change and shoreline management, and present the results in graphical and tabular formats.

A full 'User Guide' for the MDSF system is available and will be distributed with the software. This gives details on how to use the system.

A dedicated website also exists [www.mdsf.co.uk] with information on the system and details of any further developments.

The following sections outline the SMP development Tasks for which MDSF can be applied, where necessary.
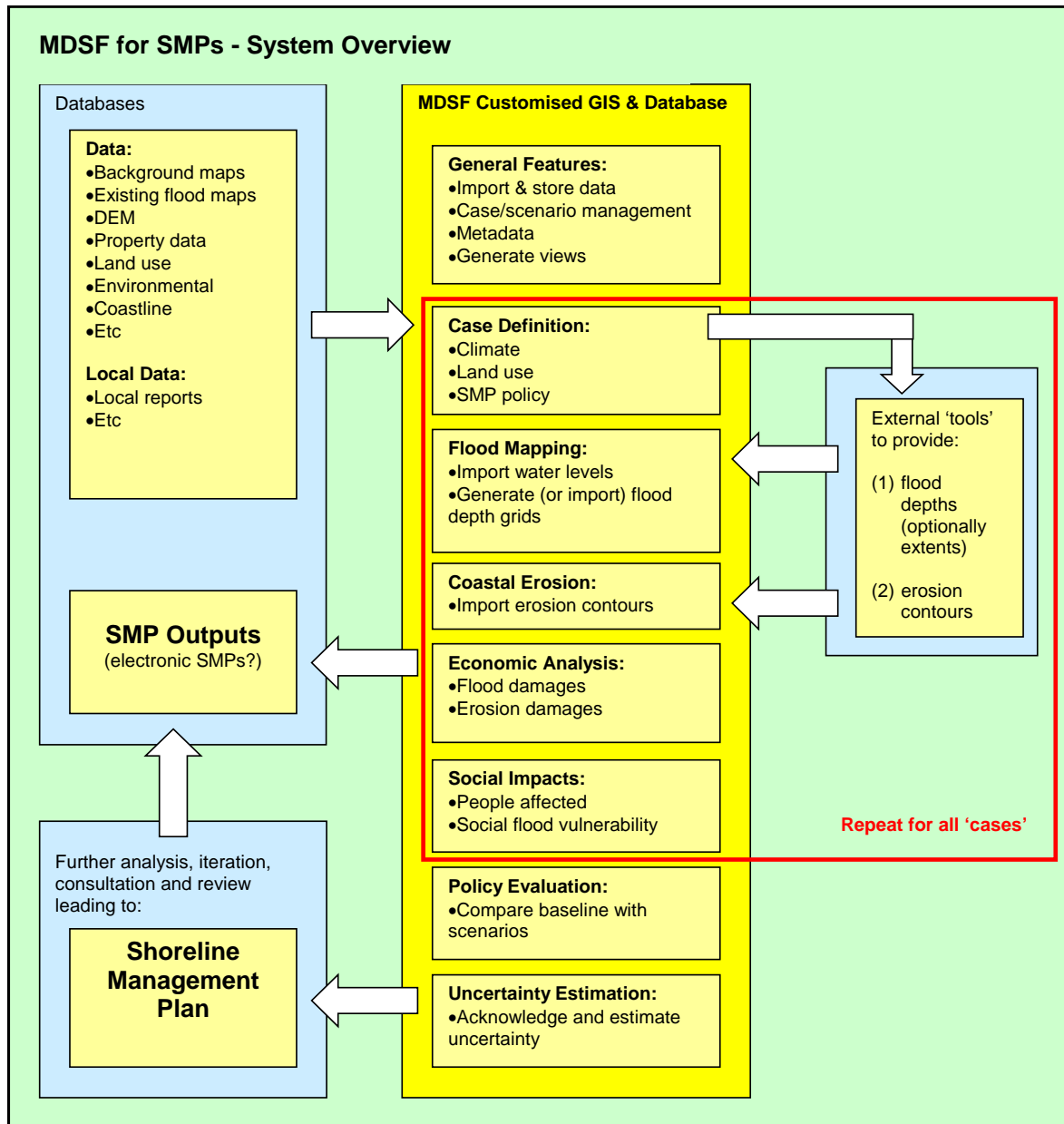
Figure C1. MDSF system diagram

(a)   Mapping of Hazard Areas

A key consideration in SMP development is the assessment of the flooding and erosion hazards present along the coastline. For areas prone to flooding, the hazard areas may be derived from existing data sets such as:

- Indicative tidal floodplain map (IFM).

- Extreme Flood Outline (EFO).

- Flood extents generated for coastal strategy studies.

In addition, use can be made of pre-calculated flood hazard data sets such as the National Appraisal of Assets at Risk from Flooding and Coastal Erosion (Halcrow et al, 2001) and the RASP High Level Method (Sayers et al, 2002) to identify high-risk areas (further details of the RASP output are included in Annex C1).

Erosion hazard areas will be developed through the shoreline processes appraisal (Stages 2.1 and 2.2).

Output from any of these approaches will be input into MDSF as flooding or erosion hazard areas.

(b)   Objective Setting

The identification of issues and, from that, the definition of objectives is based upon a review of the human and natural environments, and an appreciation of the potential risks to them from flooding and erosion.

There is clearly a role for MDSF in defining the potential risks by overlaying the 'hazard areas' on environmental (human and natural) datasets. MDSF can assist in identifying the extent of the risks to features that provide a certain benefit that can then be appraised alongside the overall availability of that benefit to assess its scarcity, etc.

(c)   Definition of Risks

As part of the policy appraisal process it is important to more formally identify the extent of risks to features along the SMP frontage. A ranking of the risks will require an understanding of both the likelihood and impact of either flooding or erosion. MDSF can be used to appraise both aspects of the risk.

An initial assessment may simply consist of recognition of the requirement to protect critical 'at risk' assets (e.g. power stations or hospitals) or may involve counting numbers of assets and/or summating market values of assets (e.g. count of commercial and residential properties within the 'at risk' polygon).   MDSF can assist in the assessment through plotting of 'hazard' polygons overlain on OS mapping or on other data sets of assets (e.g. properties, environmental sites, recreational areas, etc). Through available georeferenced property data, the MDSF can be used to count properties or sum market values for properties that lie within the hazard areas. Also, it is expected that RASP High Level Method results will be provided with the MDSF data sets to enable the identification of high-risk areas.

A more detailed analysis of the impact on assets may be required for specific areas within the SMP for which the selection of SMP policy is not obvious. A more detailed analysis may include use of the MDSF to estimate flood damages at the broad scale based on depth-damage data. This analysis will require depth-damage curves (provided with the MDSF software), flood depth data, georeferenced property location/type data and agricultural land data.

The MDSF system may be used to appraise the economic and social damages associated with policy options. An illustration of a minimum level of appraisal that could be undertaken to evaluate these impacts is outlined below.

For the '**no active intervention'** scenario it is possible to assume that all properties are "written off" within the flood risk area following defence failure. SMP consultants should validate available flood areas (e.g. EA Flood Zones) against a Digital Terrain Model (e.g. new national DTM available from EA), and possibly check against available extreme water level data. The DTM could be used to identify significant 'islands' within the flood plain that should be excluded from the "write off" calculations. Defence residual life information would be extracted from the NFCDD (or CPSE/SDS), and property values obtained from sources outlined in Annex C2.

It should be noted that the "write-off" of all property in the flood risk area is likely to be an overestimate of the actual damages (Multi-coloured Manual states "write-off properties flooded by 1 in 3yr event"). What should preferably be used for the "write-off" is a 1 in 3-year flood plain, with the remainder of the floor risk area as repeat flooding unless AAD of repeat flooding is greater than capital value (in which case damages are capped at their capital value). (See recommended methodology for writing off property, in Annex C3.4b and the Middlesex / FHRC Handbook).

RASP HLM (see Annex A2) output can be used to give the economic flood damages, associated with current defences and climate. These outputs can be considered an approximation of the '**hold the line'** scenario damages, for the SMP. The RASP HLM also provides a flood depth-probability grid that can be transformed to standard return periods. This would allow the calculation of economic and social damages within MDSF.

Approaches developed for the NAAR review (2001) identify the future increase in damages resultant from climate change, i.e. an effective reduction in Standard of Protection (SoP). These increases are linked to three generic defence types: vertical wall; earth embankment; and shingle ridge. These factors have recently been updated as part of the ongoing Foresight project (Office of Science and Technology) and are included in Annex C3. Application of these factors, based on the defence types identified in NFCDD, could be used to factor up the RASP results for future conditions.

Using the 1km results grid from RASP (or the individual properties used in MDSF) it should be possible to estimate the damages associated with the '**managed realignment'** option.

It is envisaged that damage associated with **'advance the line'** could be estimated from the 'hold the line' damages.

Erosion damages (see C.4 below) will be calculated for all scenarios through the development of future erosion contours (for time steps reflecting the appraisal epochs of 20, 50 and 100 years) by the consultants, based on their shoreline process analysis. From these, the SMP MDSF is able to calculate damages associated with the **'no active intervention'** scenario, and the benefits associated with any delay to those damages through alternative options.

This approach, or more detailed appraisals where improved flood hazard data is available, will facilitate the consistent calculation of damages for the generic SMP options, based on nationally available datasets.

C.3.4   Erosion Loss Calculation in MDSF

The major development of the MDSF, from the existing system used on CFMPs, is the inclusion of erosion loss calculation tools. The methods used are standard to economic appraisals, making best use of the available datasets (see Annex C2). The calculations described below can be applied to any shoreline features for which a capital value can be generated, such as residential/commercial property, infrastructure assets, agricultural land, etc.

(a)   Erosion Formula

As with other evaluations, economic losses due to erosion should be calculated by considering the difference in value with and without intervention.   In its simplest form, where year of loss without a scheme can be estimated then the benefit of maintaining a defence line to delay erosion for a defined number of years can be calculated, using the market values, as the **difference,** between the two formulae presented below:

$$PV_{wos} = MV(1-1/(1+r)^p)$$

minus

$$PV_{ws} = MV(1-1/(1+r)^{p+s})$$

Where: PV_{wos} = present value without scheme

PV_{ws} = present value with scheme

MV = Market Value of property

r = treasury discount rate (3.5% with reductions in later years)

p = year property is lost

s = life of scheme

The MDSF uses the above calculations to generate both Present Values of erosion losses for the baseline (no active intervention) scenario, and also the erosion damages avoided by alternative policies.

(b)   Recommended Methodology for Writing Off Property Assets

In coastal environments it is common to find large tracts of land and property which would flood with frequencies more than the annual event, if coastal flood defences were abandoned, removed or breached.   If a breach was not repaired then the ingress of tidal floodwater into the flood impact zone would render social and economic activity impossible and the 'walkaway' scenario would be invoked. In these circumstances, the repeated damages would normally exceed the 'write-off' value and this should be used to cap the losses incurred.

In any case the economically efficient response to any situation where repeated damage would exceed current market value is abandonment so the following rule should be applied.

If the present value of property damages for any flood scenario is greater than the market value of all the property in the defined impact zone then the PVd for property is capped at the total market value.

Market values should be derived using the data sources identified for the evaluation of the benefits of coastal erosion.

C.3.5   MDSF Standard Views and SMP Mapping

During the development of 'cases' within the MDSF, a series of standard views are generated in the GIS component of the system. These are intended to provide clear visualisations of both the input data and MDSF generated damage data, together with appropriate 'context' datasets (e.g. OS mapping).

The population of these views with the 'standard' datasets is predefined, however it is possible to include additional data layers to assist in the assessment of potential impacts. Table C4 identifies the MDSF views together with the data layers that will, or could be included in them.

Table C4. Standard MDSF views and possible data layers.

MDSF View	Data Theme	A, O, C*
Coastal Processes	Sediment Exchange	C
	Sediment sources/sinks	C
	Topography	A
Coastal Form	Foreshore/Backshore Morphology	C
	Geology	C
	Existing Defences	C
	Topography	A
Flood Extent and Depth, and Erosion Areas	Indicative Flood Plain	A
	Flood Areas	A/O
	Flood Depths	A/O
	Erosion Contours	A
	Topography	A
Economic	Properties	A
	Agricultural Land Classification	A
	Property values	A
	Flooding Damages	O
	Erosion losses	O
Social	Flooding Impacts	O
Environmental	Designated Sites	C
	Ecology	C
	Land Use	C
	Heritage sites	C
	Amenity areas	C

* A= Input data for analysis; O= Output from MDSF; C= Context data.

There is clearly potential to use these standard views as the basis for creating mapping outputs for the SMP, with relevant frames, titles, etc created within the ArcView GIS as would be normal.

Annex C1: Overview of the risk assessment of flood and coastal defence for strategic planning (RASP) high level methodology (HLM) outputs

The RASP High Level Methodology

To ensure all SMP consultants are able to generate flood data to input to the MDSF system, capabilities to use the output from the RASP High Level Methodology (HLM) have been incorporated into the system. The data available are outlined below.

The 2002 application of the RASP[1] High Level Method via the National Flood Risk Assessment has provided an evaluation of the risk of flooding within the 2000 Indicative Floodplain Map (IFM). This measure of risk is reported as a value (£) of Estimated Annual Damages (EAD) per Impact Zone. Impact Zones have been defined by the superimposition of a regular 1km over the IFM, hence the maximum size of any impact zone will be 1km^2, though the majority are of a smaller area.

The derivation of the risk value is based on the generation of a flood depth / probability curve for each impact zone, combined with the flood depth damage characteristic of the properties identified within them. The revised Multi-Coloured Manual (2002, Middlesex University) has been used as the source of depth / damage values, and for each impact zone upper and lower bands of EAD have been calculated, along with a best estimate.

Flood defence data contributing to the calculation of the probability of risk has been drawn from asset information within the NFCDD. The estimation of flood depth within each impact zone for each considered return period event has been made only by reference to a simplified classification of valley type, valley width, slope and distance from defences. The depth is therefore unrelated to actual topography / ground height of the impact zones or predicted water levels at specific defences.

RASP HLM Data

The key points to note about the RASP HLM output are:

- Results are produced for 1 km^2 impact zones within flood areas.

- Built property data within the impact zones is established from a FOCUS/ Addresspoint database.

- Agricultural land within impact zones is characterised by Agricultural Land Classification grades 1 to 5.

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[1] See RASP project documentation for further details of the project, alternatively paper 04-04 (Sayers, *et* al) of the 2002 Defra Conference of River and Coastal Engineers proceedings.

- Probability of failure and overtopping (flood risk) of existing defences is determined through 'fragility curves' based on asset condition and current standard of protection.

- The depth of flooding following an event is pre-determined from

    1) Statistical analysis of median depths for sequence of event from modelled flood events

    2) Geometry of the flood plain

- Economic damages derived using conventional depth damage (built) and impact likelihood concepts, and broad scale estimates of agricultural flood losses, to establish Estimated Annual Damage (EAD) in £ values.

- EAD characterised for each 1km impact zone (high to low risk categories).

- Social vulnerability of impact zones is also categorised

Fuller information on the output from the RASP HLM is contained in the following paper:

Sayers P, Hall J, Dawson R, Chatterton J & Deakin R (2002) *Risk assessment of flood and coastal defences for strategic planning (RASP) – a high level methodology*. Proc 37th Defra Conference of River and Coastal Engineers, Keele.

Annex C2: Guidance on flood/erosion risk and asset data

This Annex outlines some of the key datasets that are (or can be) used by the MDSF, and how they should be applied to maximise their benefit.

Flood Depth Data

Potential sources of appropriate flood depth data include:

- Flood depth grids generated from the RASP High Level Method intermediate results (requires transforming of the tables of depth-probability into grids of flood depth for the MDSF standard return periods of 5, 10, 25, 50, 100, 200).

- Use the MDSF tools to convert existing flood hazard mapping polygon data (e.g. Indicative Flood Plain or Extreme Flood Outline) to a depth grid (requires use of digital terrain model).

- Use the MDSF flood mapping tools to generate flood depth grids using imported georeferenced point flood water level data (again requires use of digital terrain model).

- Flood depth grids generated from modelling packages (obtained from either previous studies such as coastal strategies, or from modelling undertaken for the SMP).

- Use of other methods to generate flood depth grids from point water level data (e.g. use of the simple constant level approach or volume spreading approach).

The approach for obtaining the flood depth data should be to select the least cost source that provides acceptable accuracy for selecting between SMP policies. Note that certain of the above flood extent/depth data sets will only be available for one of the SMP policy options. Also, if average annual damages or PV of damages are required then a suitable range of 'return period' flood extents will be needed (e.g. 5, 10, 25, 50, 100, 200 years).

Residential Property

The Address Point dataset identifies the location of residential properties, and is recommended for use in SMPs. The MDSF uses weighted mean of short duration flooding for residential property, i.e. property is not distinguished by type, age or social class of occupant, depth-damage data from the Multi-coloured manual (Middlesex University. 2003) to estimate flooding damages to residential properties.

In line with the recommendations in FDCPAG3, market values of properties used for analysis should generally reflect average 'risk free' valuations for the area and it will often be sufficient to take the valuations for the mid range of the appropriate council tax band uprated for regional house price inflation from the price datum of 1993. Specific factors affecting market value such as location,

amenity and environmental factors, should generally be ignored since if a cliff top property is lost any benefits of the view and location will generally transfer to the next property back without any net economic loss.   Market Values are only used in the calculation of Extension of Life Factors (erosion) and write-off of frequently flooded property.

Possible alternative sources of current average property prices are:

- www.proviser.com, and

- www.upmystreet.co.uk

The latter allows property price statistics for a greater level of postcode detail than the former i.e. B13 9 rather than B13. However the former allows access to regional statistics. For whole SMPs, county statistics are the correct level of detail whilst for individual Policy Unit application statistics for the constituent towns may be more appropriate. In the calculation of erosion damages to residential properties, unless actual property values are specified, the MDSF defaults to an average property value of £146,130 (latest average house price in England & Wales [July to September 2002] from www.proviser.com, based on H.M. Land Registry data).

Commercial/ Non-residential Property (NRP)
The Address Point dataset combined with the Focus database (from the Valuation Office) of non-residential property commercial values, can be used to identify and value the commercial property within a flood or erosion zone. Each Focus record has a rateable value, essentially based on rental value, from which market value can be factored (see multi-coloured manual). However, as erosion zones are certainly far less extensive than the coastal Indicative flood plain, use of this data would be extremely volatile. The Focus database is notorious for perceived errors in detail, however is adequate when used in a global perspective (e.g. at SMP level). For example, recorded rateable values show apparent under valuations within the lower quartile of the distribution of the dataset for IFP properties.

Valuing non-residential properties
A suggested method for identifying non residential economic values utilising the statistics on floor space and rateable values for districts within England and Wales from the Office of the Deputy Prime Minister, 2000 (see www.planning.odpm.gov.uk statistics) is given in the example below. The procedure is as follows:

- Derive (from Focus) numbers of Retail, Offices, Warehouse, Factories, Non specific within limits of coastal erosion

- Access Table 4 (from ODPM website) *Total floorspace and number of hereditaments by bulk class: districts*

- Access Table 6 *Total rateable value and average rateable value of hereditaments by bulk class: districts*

- Select District/districts appropriate to SMP or possible Policy Unit, e.g. Hartlepool

- Derive RV/ square metre for Retail, Office, Warehouse, Factory and all bulk classes from Table 6

- Derive mean floor area for Retail, Office, Warehouse, Factory and all bulk classes from Table 4

- Derive mean rateable value per unit for Retail, Office, Warehouse, Factory and all bulk classes from Focus database

- Divide result by the appropriate yield on rent to convert Rateable value to market value.

Table C2-1: Example value commercial / non-residential properties (Hartlepool)

NRP class	Retail MCM category code 2		Offices MCM category code 3		**Factories** MCM category code 8		**Warehouses** MCM category code 4		All **Bulk** Class Other MCM categories	
Rateable Value	*RV ('000's)*	*RV (£/m2)*	*RV ('000's)*	*RV (£/m2)*	*RV ('000's)*	*RV (£/m2)*	*RV ('000's)*	*RV (£/m2)*	*RV ('000's)*	*RV (£/m2)*
	17,236	67	3196	42	10,627	16	3,315	16	34,333	29
Floor space	*No.*	*Area ('000's m2)*	*No.*	*Area ('000's m2)*	*No.*	*Area ('000's m2)*	*No.*	*Area ('000's m2)*	*No.*	*Area ('000's m2)*
	1,101	259	245	75	434	655	185	210	1965	1199
Mean floor space (m2)	235		306		1509		1,135		610	
RV/unit (£)	15,745		12,852		24,144		18,160		17,690	
Yield (North East)	6·5%		8·9%		10·0%		10·0%		10·0% (Assumed)	
MV/unit (£)	242,230		144,400		241,440		181,600		176,900	

Clearly, the ascribed values may not always be relevant to individual properties, for example, specific supermarkets which may have a higher value than the retail mean, but this approach should be adequate for the SMP level of analysis/planning. Note that up to date rates and factors for the SMP area need to be used, not those in the example above. For more information on valuing NRP's refer to the Multi-Coloured Manual (MCM) and handbook.

Infrastructure

Infrastructure can be categorised as:

- Integral to the coastal zone e.g. roads and promenades

- Infrastructure serving coastal zones (roads, water, electricity etc.)

- Infrastructure traversing coastal zones which serve erosion free areas

If it is of particular significance there may be a need to locate and classify the location of major utilities (national gas supply pipelines, electricity transmission gridlines and nodes – including major transformer stations).

(a)   Promenades

Many sea walls also deliver recreational and amenity benefits as promenades. However, their prime function is the avoidance of loss of land and property in the protected areas. Counting the full value of the structure as well as the benefits accruing to the protected area can therefore result in double counting. In detailed project appraisals the recreation and amenity facilities that they provide can be valued using a Contingent Valuation Method but this is costly, site specific and largely inappropriate to high-level strategic studies. Where appropriate, estimates of recreational loss may be made using the figures in chapter 8 of the Middlesex Manual but care will be needed in matching the situation to the case studies quoted and ensuring that there is likely to be real loss in the scenario considered.

(b)   Infrastructure integral to properties at risk from erosion

If infrastructure only services properties at risk then there is no additional loss other than to those properties at risk. However a property cannot function without its services and if the services are cut (e.g. roads) before the properties themselves then the year in which the property is effectively lost should be brought forward as it is directly linked to its access.

(c)   Infrastructure serving areas outside the coastal erosion zone

In detailed assessments, alternative capacity (roads, electricity etc.) should be considered where this provides a least cost solution. Generally, at the Strategic SMP level this would be an inappropriate level of detail, but it should be recognised where the relative importance of severance is high. Examples of strategic significance are on the South Wales coastal flood plains between the Severn and Cardiff where the Wentlooge and Caldicot levels provide the corridor for not only the M4 motorway but the Paddington - South Wales mainline railway and the National Grid's transmission of two-thirds of South Wales' electricity demands.

Land classifications

Agricultural land

Agricultural land comprises all land used for any form of agricultural production. It is divided into land classes that represent its potential use.

Other open space land

Clearly coastlines attract recreation and amenity and the loss of these facilities can be significant. For project appraisal and detailed assessments then the 'inferential methods' or 'expressed preference methods' as detailed in MCM are recommended. These are generally not applicable to SMP evaluations.

In the SMP a clear statement of the likely losses involved with and without intervention should be catalogued, and their timing identified. In presenting these potential losses it should be recognised that the coastal margin will not be lost but its character may change and this may change the nature of the amenity provided. Where necessary and significant a minimum value of amenity land may be obtained by applying agricultural land valuations on the basis that roll-back of coastal amenity facilities will ultimately displace agricultural production.

Agricultural Land Valuations and Assessment

Strictly the value to society of agricultural land is the economic margin arising from the agricultural production that it sustains. However, for SMP studies the economic loss of agricultural land can be adequately represented using market value adjusted for subsidies.

The following simple method is suggested:

- Estimate the Agricultural Land Classification grades in hectares within the erosion zones for each loss period.

- The value of land for each grade is calculated using FPD Savills land price index (MDSF includes data from June 2002 which will be adequate for most SMP studies).

- To capture the subsidy element in land values, a 45% multiplier should be applied to all land values, as recommended in FCDPAG3

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Current Initiatives on coastal flood risk analysis

There are two current initiatives that may prove beneficial to the SMP policy assessment process: raster routing and RASP intermediate level method. Raster routing is an approach for routing overtopping and/or breaching flows through low-lying coastal areas to estimate flood depth grids. Two papers (Wicks et al 2003, and Dawson et at, 2003) have reported on testing of the raster routing methods of Bates and De Roo (2000) for coastal inundation modelling. The conclusions of the papers

are that raster routing may provide the most convenient approach for generating the flood depth grids discussed in the preceding paragraphs. However, it is suggested that further testing is required to confirm the initial findings.

The RASP intermediate level method is currently being developed under the Defra/EA joint R&D programme and it is expected to be integrated within the MDSF software. The RASP approach will provide a systematic methodology for inclusion of probabilistic concepts of defence failure within the calculation of flood risk. This has the potential to provide more complete information on flood risk for use during the SMP policy assessment process. Again it is suggested that the new approach is tested before being recommended for routine application on SMPs.

Annex C3 Reductions in standards of service due to climate change

The following Table (C3-1) was developed for the Foresight future flooding project (Office for Science and Technology) by HR Wallingford. It was developed based on a comparison between Defra stated sea level rise estimates used in NAAR 2001 (see Figure C3-1) and those provided in the scenarios used for Foresight. Both forecasts for sea level rise were regionalised, therefore in applying the factor between the NAAR work and the current scenario predictions, the figures were compared for corresponding geographical regions.

It is important to note that this will be of use only for assessing those options where it is assumed that current guidance on adaptation to climate change is not applied and there will be no increase in defence levels in anticipation of climate change.

Table C3-1 Current SoS and derived 2075 equivalents (All table entries are return periods in years).

Present SoS	2075 SoS				
Vertical Wall					
	East Coast	South East	South West	Mid West	North West
2	<2	<2	<2	<2	<2
5	<2	<2	<2	<2	<2
10	2	<2	<2	<2	2
20	3	<2	5	<2	3
50	10	2	15	2	10
100	15	4	40	3	20
200	40	10	100	10	30
Embankment					
2	<2	<2	<2	<2	<2
5	2	<2	<2	<2	<2
10	3	<2	<2	2	2
20	5	<2	3	3	3
50	10	2	15	5	10
100	25	3	40	10	20
200	70	5	80	15	60
Shingle beach					
2	<2	<2	<2	<2	<2
5	2	<2	<2	<2	<2
10	3	<2	<2	2	2
20	5	<2	3	3	3
50	10	2	15	5	10

| 100 | 30 | 3 | 40 | 15 | 20 |
| 200 | 80 | 5 | 80 | 20 | 50 |

East Coast: North of Sheerness; South East Coast: East of Portsmouth and South of Sheerness; South West Coast: West of Portsmouth, and east of Lands End; Mid West Coast: Lands End to mid Cardigan Bay (Aberystwyth); North West Coast: mid Cardigan Bay (Aberystwyth), Northwards
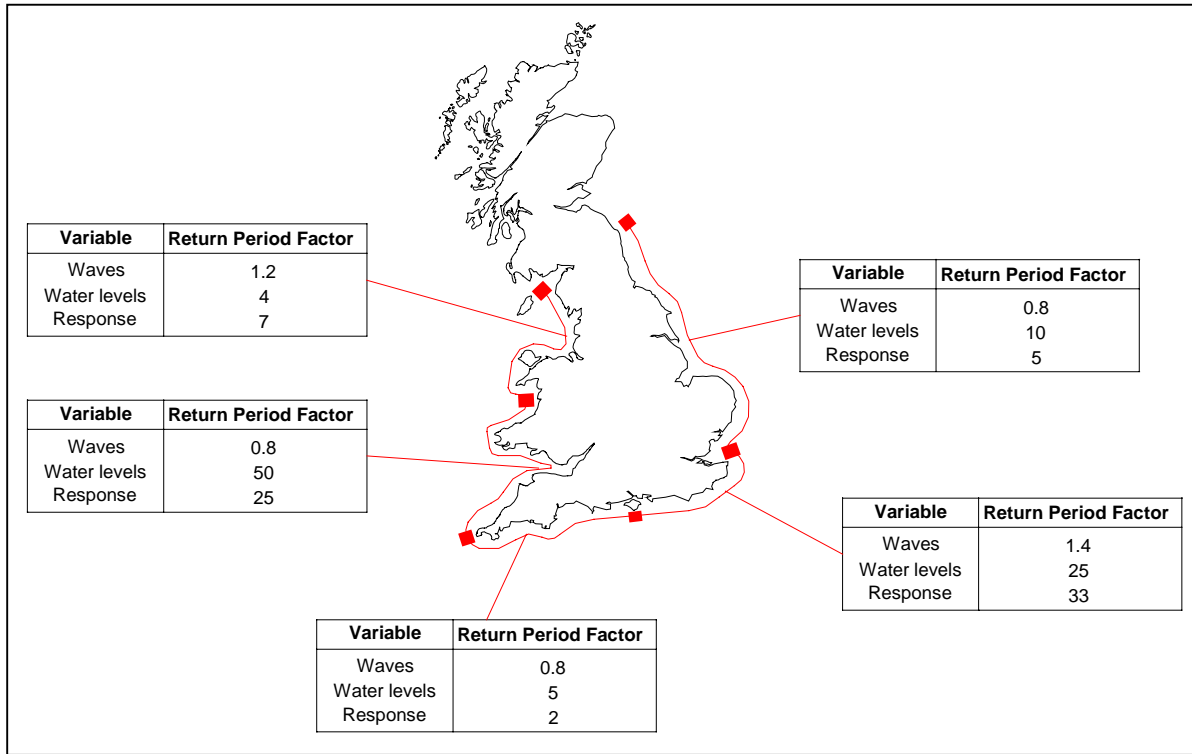

Figure C3-1 Regions defined for tidal climate change impact assessment (NAAR 2001)