Sustainable Flood Risk Management in European Estuaries

N. I. Pontee*, B.A. Hamer and P.D. Turney

*Corresponding author, Senior Coastal Scientist, Halcrow Group Ltd, Burderop Park, Swindon, SN40QD, UK,
ponteeni@halcrow.com
Technical Director, Halcrow Group Ltd, Burderop Park, Swindon, SN40QD, UK
Coastal Engineer, Halcrow Group Ltd, Burderop Park, Swindon, SN40QD, UK

ABSTRACT: In many European estuaries, flood risk management needs to balance the conflicts generated by rising sea levels, eroding shorelines, limited capital/maintenance budgets, and the desire to protect people’s property, whilst conserving natural habitats that are protected under national or international law. In the UK, Flood Risk Management Strategy Plans provide a strategic estuary wide approach to the delivery of flood defence. These plans are long term (up to 100 years) and identify flood risk management options that are:

- hydrodynamically, technically, economically and socially sustainable in the light of climate change;
- compliant with all statutory obligations arising from national and international nature conservation designations and legislation;
- provide opportunities for environmental enhancement; and,
- prevent the ad hoc development of local schemes, which have been responsible for larger scale estuary-wide impacts in the past.

Such plans combine the withdrawal of defence provision and creation of wetlands with the provision of improved flood defences in appropriate locations. Due to the timescales involved, the benefits of this approach may not be realised for many years. However, this approach should ultimately result in a reduction in both maintenance and capital costs, due to reduced hydrodynamic stresses on constrained points of the estuary, and more appropriately designed future flood risk management works in key areas.

Key words: defences, maintenance, advantages, disadvantages

1 INTRODUCTION

Estuaries can be defined as:
‘semi-enclosed bodies of water which have free connection with the open sea and within which sea water is measurably diluted with freshwater derived from land drainage’ (Pritchard, 1967).

The European coastline is dissected by a large number of estuaries that differ markedly in their physical characteristics and the range of management issues that they face (e.g. Pontee and Cooper, 2005). Many European estuaries are subject to an increasing number of economic, technical, environmental and social pressures at present (Table 1). Of particular importance, in terms of flood risk management, are the conflicts generated by rising sea levels, eroding shorelines, limited capital/maintenance budgets, and the desire to protect people’s property, whilst conserving natural habitats that are protected under national or international law. Balancing these requirements leads to the concept of sustainability, which can be

Table 1: Pressures facing European estuaries

<table>
<thead>
<tr>
<th>Category</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>the cost of flood defence maintenance requirements to protect certain assets presence of port developments presence of infrastructure developments presence of agricultural land</td>
</tr>
<tr>
<td>Technical</td>
<td>the provision of suitable flood defence types, standards and condition rising sea levels increased storminess ongoing habitat loss</td>
</tr>
<tr>
<td>Environmental</td>
<td>maintenance of public access maintenance of recreational uses</td>
</tr>
</tbody>
</table>
defined as meeting the needs of the present generation, without compromising the needs of future generations.

In UK estuaries, a strategic approach to the management of flood risk is being developed in order to prevent the ad hoc development of local schemes, which have been responsible for larger scale estuary-wide impacts in the past. This paper outlines this approach, which involves the production of Strategic Flood Risk Management Plans for individual estuaries (here referred to as ‘strategies’). The paper explains the benefits of working with natural processes wherever possible in terms of defence life, expenditure and habitat conservation. The concept of considering the far-field economic consequences (both costs and benefits) of local intervention measures is described, together with an explanation of how this has been evaluated in practice. Mention is also made of approaches to flood risk management in other European estuaries. The paper concludes with a summary of the key lessons for the sustainable management of flood risk in estuaries. The approach which is outlined in the paper is applicable to the sustainable management of flood risk in other parts of the world.

2 ESTUARY CHARACTERISTICS

European estuaries display a number of physical characteristics including, inter alia: extensive inter-tidal areas, semi-diurnal tidal regimes, bi-directional saline tidal flows, wave shelter, water stratification and mixing, temperature and salinity gradients, sediment suspension and transport, high proportions of fine grained cohesive sediment, and complex sediment transport pathways. Importantly, there are strong inter-relationships between estuary morphology and hydrodynamics. This means that although the size and shape of an estuarine channel are a response to tidal processes, the tidal discharge is itself dependent on the morphology of the estuarine channel, since this determines the overall tidal prism. This feedback between morphology and process emphasizes the need to consider the estuary as a system, in which seemingly independent local actions can potentially lead to cumulative estuary wide impacts (Pontee and Townend, 1999).

Estuaries are dynamic environments and are likely to become more dynamic in the future due to the affects of climate change and sea level rise. These changes mean that more areas are likely to become vulnerable to erosion and flooding, which will affect people’s properties and livelihoods, as well as the natural estuary habitats. Whilst flood defences may be necessary in some key areas, they are usually only able to prevent flooding for limited periods under a scenario of rising sea levels and the landward transgression of shorelines. Ultimately, trying to hold retreating shorelines in one position is expensive and can result in the loss of intertidal habitats due to coastal squeeze (Figure 1). Although ever larger defences can be built (given unlimited funds), this does not remove the risk of erosion or flooding under extreme events. In fact, the construction of larger defences in the past has led to an expansion in residential development in the flood plain and consequently increased the flood risk. Natural intertidal habitats, such as mudflats and saltmarshes, dissipate wave and tidal energy around estuary margins. The narrowing of the such areas in front of defences places the defences themselves, and the assets behind them, at increased risk. Furthermore, defences can have wider impacts on sites elsewhere in the estuary (Pontee and Townend, 1999). For these reasons, areas should only be defended where there are no other options.

Figure 1: Illustration of coastal squeeze, whereby rising sea level cause habitats to migrate landwards. (a) when no defences are present and land levels rise gently, then habitats are able to transgress landwards. (b) when defences are present then the landward transgression occurs, but results in a loss of habitat.
In estuaries, the sustainable flood risk management policies must:

- consider the various aspects of sustainability – economic, environmental, social and technical;
- consider the whole estuary system, rather than isolated frontages, since actions in one part of an estuary system can affect other locations (both up and downstream (Pontee and Townend, 1999)); and,
- consider a suitably long period of time.

3 FLOOD RISK MANAGEMENT STRATEGIES IN THE UK

3.1 Introduction

In England, the overall responsibility for flood and coastal erosion risk management policy has been devolved by Central Government to Defra (Department for the Environment, Food and Rural Affairs). In Scotland, Wales and Northern Ireland, the responsibility has been devolved to the respective government departments of the Scottish Executive, Welsh Assembly and Northern Irish Government. Defra’s responsibilities include setting coastal flood and erosion risk management policies to reduce the threat to people and their property, whilst delivering the greatest environmental, social and economic benefits.

In England, Defra’s coastal flood and erosion risk management policies are implemented by the Environment Agency, Internal Drainage Boards and Local Authorities. There are a number of implementation stages from large scale plans (known as Shoreline Management Plans), through Strategy Plans to detailed Scheme Detailed Designs (Figure 2). The aim of the latest Defra guidance for the production of Shoreline Management Plans (Halcrow, 2003a), is to “promote sustainable management policies for the coastline into the 22nd Century, which achieve long-term objectives without committing to unsustainable defences”. However, the guidance also states that there needs to be “recognition of present-day objectives and acceptance that wholesale changes to the existing management practices may not be appropriate in the very short term”.

In the estuaries of the UK, a strategic approach to the management of coastal flood and erosion risk is being developed in a series of Estuary Flood Risk Management Strategy Plans (www.essexestuaries.org.uk). To date plans are being developed by the Environment Agency for UK estuaries including: the Humber, the Blyth, the Alde and Ore, the Deben, the Stour, the Orwell, the Colne, the Blackwater, Hamford Water, the Roach, and the Crouch (Thomas and Turney, 2004; Cooper, et al., 2003). The overarching purpose of these strategies is to:

- take a broad scale view of the estuaries and the wider environment in terms of the technical, environmental, social and economic issues;
- provide flood risk management solutions which maximise the benefit of public investment; and
- seek opportunities for environmental enhancement and ensure compliance with all statutory obligations arising from national and international nature conservation designations and legislation.

The following sections describe the approach that has been adopted in the development of the flood risk management strategies in Essex, England, in terms of the method for choosing appropriate flood risk management options and the supporting studies that are required.

3.2 Selection of preferred flood risk management options

The selection of flood risk management options for an estuary area can be simplified if the estuary hinterland is divided into a number of independent flood compartments, called Flood Management Units (FMUs). These are areas of equal flood risk, where if they were to be flooded, then the flood waters would be constrained by higher land or
Strategic flood risk management involves taking a holistic approach to the appraisal of economic, environmental, social and technical issues within the estuary area. However, since these issues may vary between each FMU, the appraisal of flood risk management options must take account of both FMU specific and estuary-wide issues.

A transparent decision making process is necessary in order to inform stakeholders and the general public how the preferred flood risk management options have been selected. The process of appraising flood risk management options for the Roach and Crouch Flood Management Strategy (Halcrow, 2003b) was broken down into several stages (Figure 3). For the purpose of this paper, the appraisal process will refer to FMU 26 on the River Crouch (Figure 4).

The key objectives of the Roach and Crouch Flood Risk Management Strategy were as follows:

- to prepare a flood risk management strategy in accordance with Government guidelines;
- to develop towards a more hydrodynamically sustainable estuary shape; to avoid pollution of controlled water;
- to ensure compliance with Conservation Regulations;
- to maintain access to the sea; and,
- to enhance salt marsh generation.

These objectives were assessed against the flood risk management policies of No Active Intervention, Hold the Line, Managed Realignment and Advance the Line, using a matrix based approach for each FMU (see Table 2). This stage functioned as a coarse filter to eliminate the flood management policies that were least likely to comply with the strategic objectives. It can be seen from Table 2 that no single policy would comply with all of the objectives in FMU 26 on the River Crouch and therefore two policies were selected, Hold the Line and Managed Realignment (as identified by the shaded boxes).

Flood risk management options of maintain, sustain or improve the standard of protection of the existing defences and realign the existing defences were identified as those that would successfully implement the preferred policies for FMU 26 (i.e. Hold the Line and Managed Realignment). Each of these ‘Do Something’ options were appraised against an economic base case of ‘Do Nothing’ and a series of key economic, technical, hydrodynamic, social and environmental issues using a simple matrix approach (see Table 3 – for the purpose of this paper only a limited number of options and issues have been presented).

The economic viability of maintaining the existing flood defences forms part of the decision making process and is used to decide either a ‘Do Something’ or ‘No Active Intervention’ policy. In most cases, this sets the long-term vision for flood management within an FMU, which should be worked towards over the lifetime of the strategy (100 years). The technical feasibility, environmental acceptability and hydrodynamic sustainability of the most economically robust flood management option(s) are then appraised as part of the options selection process, in order to identify the preferred flood management option(s) for each FMU.

Many of the estuaries in England are located in rural countryside and consequently there are often insufficient assets (e.g. residential, commercial and industrial buildings) to provide economic justification to continue maintaining the existing flood defences. During the development of the Roach and Crouch Flood Management Strategy, the Environment Agency identified that further guidance would be required from Defra and English Nature regarding the short-term management of uneconomic flood defences in order to meet the Environment Agency’s obligations under the Conservation (Natural Habitats, &c.) Regulations 1994 (Habitats Regulations).
Figure 3: The Strategic Flood Risk Management Option Appraisal Process

- Identify Strategic Objectives
- Identify Flood Risk Management Policies (e.g., Hold the Line, Managed Realignment etc.)
- Assess Flood Risk Management Policies against Strategic Objectives for each FMU (only those that meet the objectives pass through to the next stage)
- Identify Flood Risk Management Option(s) that would successfully implement the preferred policy (or policies) for each FMU
- Economic Appraisal of Flood Risk Management Options
- Technical Appraisal of Flood Risk Management Options
- Environmental Appraisal of Flood Risk Management Options
- Identify the most Economically Viable, Environmentally Acceptable and Hydrodynamically Sustainable Preferred Flood Management Option(s)

Figure 4: Location Plan for FMU 26 on the River Crouch, Essex
Table 2: Strategic Objectives versus Flood Management Policy Appraisal Matrix

<table>
<thead>
<tr>
<th>STRATEGY OBJECTIVES</th>
<th>NO ACTIVE INTERVENTION</th>
<th>HOLD THE LINE</th>
<th>MANAGED REALIGNMENT</th>
<th>ADVANCE THE LINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEVELOP TOWARDS A MORE HYDRODYNAMICALLY SUSTAINABLE ESTUARY SHAPE</td>
<td>P</td>
<td>x</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>PROVIDE EFFECTIVE FLOOD MANAGEMENT FOR THE PROTECTION OF PEOPLE’S LIVES AND PROPERTY</td>
<td>x</td>
<td>✓</td>
<td>P</td>
<td>✓</td>
</tr>
<tr>
<td>AVOID POLLUTION OF CONTROLLED WATER</td>
<td>x</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>ENSURE COMPLIANCE WITH CONSERVATION REGULATIONS</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>MAINTAIN ACCESS TO THE SEA</td>
<td>P</td>
<td>✓</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>ENHANCE SALT MARSH REGENERATION</td>
<td>P</td>
<td>x</td>
<td>✓</td>
<td>x</td>
</tr>
</tbody>
</table>

✓ A tick denotes where the option is considered to meet the objectives
x A cross denotes where the option is considered to not meet the objectives
P Partly meets objective
? Where there is uncertainty over applicability, this has been indicated by a question mark

Consequently, Defra published guidance in 2004 that sets out a clear approach to the classification of sea flood defences. The four categories of sea defence are:

1. defences for which there is a clear economic case to continue maintenance;

2. defences that are uneconomic to maintain, although there is justification to protect internationally designated environmental features from the damaging effect of tidal flooding;

3. defences that are uneconomic to maintain, although there is justification due to the uncertain and unacceptable risk associated with withdrawal of maintenance (e.g. hydrodynamic, contamination, fisheries); and,

4. defences that are uneconomic to maintain and protect low risk flood compartments.

Therefore, where it is identified that the continued defence of an FMU is uneconomic, but there is potential for significant impact on freshwater habitats within designated sites (Category 2), or estuarine morphology (Category 3), if the defences fail; then the short-term policy would remain as ‘Hold the Line’. In the case of impacts on estuarine processes, the longer-term view would be to adopt a policy of ‘Managed Realignment’ or ‘No Active Intervention’, but only once better information has been gained from detailed monitoring of the earlier schemes. With regard to the loss of freshwater habitats, the medium to long-term view would be to seek guidance from English Nature regarding whether suitable habitat could be recreated elsewhere or whether a ‘Hold the Line’ policy must be adopted.
## Table 3: Key Issues versus Strategic Flood Management Options

<table>
<thead>
<tr>
<th>ISSUES</th>
<th>NO ACTIVE INTERVENTION (OPTION 1)</th>
<th>STRATEGIC OPTIONS – FMU 26</th>
<th>MANAGED REALIGNMENT (OPTION 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MAINTAIN (1:5 TO 1:1 YEARS RP) (OPTION 2)</td>
<td>IMPROVE TO A HIGH INDICATIVE STANDARD (1:100 YEARS RP) (OPTION 4B)</td>
</tr>
<tr>
<td>ECONOMIC</td>
<td>• Not economically viable</td>
<td>• Not economically viable due to high flood damage values.</td>
<td>• Economically viable if in conjunction with Option 4B.</td>
</tr>
<tr>
<td></td>
<td>• Loss of urban and agricultural assets</td>
<td>• Economically viable</td>
<td>• Highest B:C ratio</td>
</tr>
<tr>
<td></td>
<td>• May reduce stress and maintenance costs on other flood defences in estuary</td>
<td>• Justified by urban and agricultural assets and the contaminative land removal costs</td>
<td>• Best Value option</td>
</tr>
<tr>
<td></td>
<td>• Potential contamination clean-up costs.</td>
<td>• Economically viable</td>
<td>• May be economically viable at specific sites and undertaken in conjunction with an Improve option.</td>
</tr>
<tr>
<td>EFFECTS ON ESTUARY HYDRODYNAMICS</td>
<td>• Potential improvement to sustainability</td>
<td>• No significant hydrodynamic changes</td>
<td>• Potential improvement to sustainability</td>
</tr>
<tr>
<td></td>
<td>• Potential release of sediment into estuary</td>
<td>• Reduced sustainability with sea level rise</td>
<td>• Potential release of sediment into estuary</td>
</tr>
<tr>
<td></td>
<td>• Increased frequency of property flooding</td>
<td>• Agricultural land may be written off in the medium to long-term due to sea level rise.</td>
<td>• Potential loss of agricultural land or properties</td>
</tr>
<tr>
<td></td>
<td>• Loss of properties, agricultural assets and Public Rights of Way</td>
<td>• No loss of agricultural land or properties</td>
<td>• Potential loss of agricultural assets and Public Rights of Way</td>
</tr>
<tr>
<td>EFFECTS ON HUMAN ENVIRONMENT</td>
<td>• Loss of improved pasture, permanent grassland, arable reversion and seawall habitats and associated BAP species</td>
<td>• Potential loss of salt marsh due to coastal squeeze and rising sea levels</td>
<td>• Potential loss of some improved pasture, permanent grassland, arable reversion and seawall habitats and associated BAP species</td>
</tr>
<tr>
<td></td>
<td>• Potential regeneration of mudflats and salt marsh</td>
<td>• Partially preserve ESA and historical landscape features</td>
<td>• Potential regeneration of mudflats and salt marsh</td>
</tr>
<tr>
<td></td>
<td>• Loss of some landscape features</td>
<td>• Partially preserve ESA and historical landscape features</td>
<td>• Loss of some landscape features</td>
</tr>
<tr>
<td>EFFECT ON NATURAL ENVIRONMENT AND CONSERVATION</td>
<td>• Potential reduction in shear stresses on neighbouring FMUs</td>
<td>• Potential increase in stress attributable to sea level rise.</td>
<td>• Potential detrimental effect on the neighbouring FMUs</td>
</tr>
<tr>
<td>IMPACT ON ADJACENT FMUs</td>
<td>• Potential increase in stress attributable to sea level rise.</td>
<td>• Potential increase in stress attributable to sea level rise.</td>
<td>• Potential detrimental effect on the neighbouring FMUs</td>
</tr>
</tbody>
</table>
Consideration also needs to be given to the estuary-wide economic implications of implementing a combination of flood management options. For the Roach and Crouch Flood Management Strategy, the impacts of adopting a Hold the Line or Managed Realignment policy in any one FMU within this sensitive estuary complex, may have significant hydrodynamic impacts on neighbouring FMUs (near-field effects) or in other reaches of the estuary (far-field effects). The near and far-field effects may be particularly evident where there is high confidence that the estuary form is constrained by flood defences. In such locations, the existing flood defences are subject to higher hydrodynamic stresses, and the natural tendency is for the estuary shore to realign landwards. Consequently, implementing a Managed Realignment option at these locations may relieve the hydrodynamic stresses leading to reduced flood defence capital maintenance costs on neighbouring FMUs (near-field economic benefits) or in other reaches of the estuary (far-field economic benefits). Implementing managed realignment in some locations may also lead to reductions in water levels elsewhere in the estuary, potentially leading to a reduction in flood defence costs.

The implementation of such areas, known as Flood Control Areas, is being considered in a number of European estuaries, including the Humber in the UK (Pygott et al., 2004).

In the Roach and Crouch, an economic appraisal technique was developed to provide a best estimate of the near and far-field economic benefits associated the implementation of Managed Realignment options at key locations throughout the estuary. This analysis was based on contemporary bed shear stress values from hydrodynamic modelling studies and the assessment of the most sustainable estuary morphology. This data was used to identify the potential reduction in flood defence maintenance costs that may be achieved through implementing Managed Realignment options at locations where there is high confidence (greater than 50%) that the natural position of the estuary shoreline lies further landwards. The results of this analysis demonstrated that by considering the estuary processes and economics holistically, the total maintenance costs for the 50 year life of the strategy could be reduced by approximately £8m if the existing stresses on the flood defences are reduced to acceptable values through the implementation of Managed Realignment options, where the estuary needs to naturally realign landwards.

The Habitats and Birds Directives also play a key role in driving the selection of the preferred options through the need to ensure the maintenance or enhancement of environmentally designated areas including salt marsh and freshwater habitats.

The final stage of the option appraisal process involved reviewing the information presented in the ‘Key Issues versus Strategic Flood Management Options’ matrix (Table 3) and the detailed supporting studies to identify the most economically viable, environmentally acceptable and hydrodynamically sustainable preferred flood management option(s) for the short (0-20 years), medium (20-50 years) and long-term (50-100 years).

3.3 Supporting studies
In order to appraise flood risk management options, a range of supporting studies are required, including data collation, defence condition analysis, a baseline environmental review, a review of estuary processes, and economic assessments.

Data collation
This exercise is required at the outset of a strategy study in order to identify the data that exists, the cost of obtaining the data and the requirement for additional data (Table 4).

Defence condition and performance
In order to implement a successful flood risk management policy for an estuary complex, the existing and future standards of protection afforded by the existing flood defences, need to be determined. In some areas of the UK, this defence condition information exists in a National Flood and Coastal Defence Database (NFCDD). However, for many areas such information does not exist and it is necessary to survey the existing defences, to determine crest heights, potential failure modes and to define the residual life and the risk of failure under existing conditions. Care needs to be taken to ensure that any assessment of defence condition takes account of ongoing maintenance programmes. This information can then be used to assess the performance of defences under future conditions, as well as the type and cost of any required improvements.
Strategy development also requires an assessment of the costs of implementing the flood risk management options for each FMU, taking account of existing construction, maintenance, management and monitoring procedures. Within the UK, Central Government provides guidelines for the economic appraisal of coastal flood and erosion risk management schemes (Defra, 2000). Scheme costs and benefits arising from schemes under the ‘Do Something’ options need to be compared with those of the ‘Do Nothing’ scenario, which provides a baseline from which these options can be assessed. Benefits from these schemes are calculated by examination of the economic losses avoided by carrying out the proposed works in comparison with the losses under the Do Nothing scenario.

Halcrow has developed a GIS (Geographical Information Systems) based tool known as MDSF (Modelling and Decision Support Framework) in order carry out these time consuming calculations. This system combines information on flooding levels, and land and property values to calculate economic damages for specified extreme storm event return periods and the annual average damages for residential, commercial and industrial properties and agricultural land. Flood levels can be predicted using a hydrodynamic model; either a 1 dimension model such as ISIS, or a 2/3 dimensional model such as Delft 3D. Preliminary information from these models assists in the identification of FMUs (see Section 3.2).

Environmental Appraisal

European estuaries contain a number of nationally and internationally designated sites. Strategies therefore need to identify the extents of such sites and the reasons for designation. Flood management strategies need to identify those habitats that must be protected from saline inundation, and those that may be compensated for by the creation of similar (or improved) habitats further upstream, where they will be more sustainable in the long-term.

In addition to the important nature conservation aspects, studies also need to consider other environmental issues including water quality, fisheries, recreation and tourism, historic and built environments, archaeology and cultural heritage, landscape and visual amenity. A baseline environmental study provides an overview of these issues within the strategy area, lists the key concerns of stakeholders and establishes strategic environmental objectives. More specifically the baseline study:
- identifies specific environmental constraints, such as the presence of contaminated material in or behind sea walls;
- identifies nature conservation assets that may be lost or significantly affected by erosion or flooding;
- identifies archaeological or other cultural heritage sites that may be affected by erosion or flooding, and recommendation of measures for recording them;
- identifies other environmental assets, including those relating to recreation and tourism, that may be affected by erosion or flooding;
- consults with relevant statutory bodies and other organisations with an interest in the coastal zone.
- develops environmental objectives for the study area that will be used to define and appraise strategic defence/ realignment options.

Estuary Processes and Geomorphology

The derivation of sustainable flood defence options within the estuarine system requires a sound understanding of contemporary estuary processes and geomorphology. The complexity of estuarine systems, coupled with the uncertainties associated
with individual techniques, means that understanding estuarine morphodynamics requires the synthesis of results from a variety of approaches including hydrodynamic models, literature reviews and regime analysis (EMPHASYS Consortium, 2000; Defra, 2002). Being able to predict future erosion allows the identification of areas where existing defences may come under increased wave action and therefore require improvement. Identifying where the estuary may be restricted by flood defences may identify areas where managed retreat could be undertaken to allow the estuary to adopt a more natural configuration. This information assists in the identification of flood risk management options that work with natural processes rather than against them.

Consultation

Different parties need to be involved at various levels during the development of the strategy and it is necessary to identify all interested parties at the outset of the study and determine the level of cooperation, consultation and communication that will be necessary. In the UK, such parties include statutory consultees (e.g. the Environment Agency, Defra, English Nature), key stakeholders (e.g. local authorities, conservation groups, boat users, landowners, business owners) and the general public and the media. Various media are required for a successful communication strategy including steering groups, newsletters, consultation booklets, websites (e.g. www.essex-estuaries.co.uk), public displays, oral presentations and newspaper articles.

It is important to involve local stakeholders early in the development of an estuary strategy to reduce the probability of objections and delays later in the project and to enable the strategy to address the key issues. However, ongoing consultation is likely to be required throughout the subsequent stages of a project. Appropriate communications helps ensure that local stakeholders to understand the recommendations of the flood risk management strategy. Table 5 gives examples of typical issues raised during the consultation process.

The provision of a steering or stakeholder group can be useful for assisting with the decision making process and ensuring that the project is complying with the latest national and European legislation and guidance. This group should be composed of individuals with relevant expertise and should contribute directly to the development of the project objectives. The involvement of the Steering Group members also assists communication with consultees and interested parties during the study. In the UK, steering groups may have members from the Environment Agency, English Nature, Local Authorities, a sailing group, Country Land and Business Association, commercial ports and local conservation groups.

Table 5: Typical issues raised during consultation exercises

<table>
<thead>
<tr>
<th>Requirements to Avoid impacts on:</th>
<th>Designated nature conservation sites and protected rare or BAP species/habitats;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Land uses and local businesses including fishing and agricultural land holdings (economic importance of agriculture, land acquisition and compensation);</td>
</tr>
<tr>
<td></td>
<td>Commercial fisheries;</td>
</tr>
<tr>
<td></td>
<td>Recreational activities in strategy area, particularly water-related leisure and the future needs of wildfowlers, public rights of way (their maintenance and necessary replacement/diversion), and cycle networks;</td>
</tr>
<tr>
<td></td>
<td>The distinctive landscape character and countryside management; and,</td>
</tr>
<tr>
<td></td>
<td>Archaeological features and cultural heritage.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Requirements to Ensure the:</th>
<th>Provision of adequate flood defences to protect lives, property, jobs and road networks;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maintenance of integrity of infrastructure for lifeboat and sailing operations in estuaries, and freedom of navigation and accessibility to ports;</td>
</tr>
<tr>
<td></td>
<td>Proper consultation with individual landowners;</td>
</tr>
<tr>
<td></td>
<td>Sewage treatment works, water quality and discharges; and</td>
</tr>
<tr>
<td></td>
<td>Consideration of localised erosion and cliff instability.</td>
</tr>
</tbody>
</table>

Table 5: Typical issues raised during consultation exercises
DISCUSSION

There are a number of advantages of a strategic approach to flood risk management in estuaries as adopted in the UK, since:

1. it allows for the assessment and management of risks for proposed specific options.
2. it promotes a balanced and auditable decision making process which will be used to deliver the proposed flood risk management options for estuaries. Such a strategic approach provides essential information for effective public consultation and other non-flood defence activities, such as local planning.
3. it gives regard to impacts on the environment and provides a measure of the compliance with environmental legislation such as the Habitats and Birds Directives.
4. it considers problems and solutions over the longer term and allows the implementation of works or management actions in a staged fashion. This allows:
   - The impacts of innovative schemes (e.g. managed realignment) to be monitored to build confidence in the subsequent scheme design;
   - policies on land purchase and compensatory habitat creation can be tested and developed in the light of early experiences; and,
   - it allows changes to be made to existing land management practice to minimise the potential impact of later managed realignment schemes and circumstances where it is necessary to cease Environment Agency maintenance.
5. it considers problems and solutions over a wide geographical area, which promotes management practices that avoid disruption to estuary processes and which are sustainable in the long-term (including adapting to climate change and sea level rise).
6. it allows the various types of uneconomic defences to be identified, including those defences that are necessary to protect internationally designated environmental features (Category 2), and those which are necessary since the withdrawal of maintenance would lead to uncertain and unacceptable flood risks (Category 3).

Inevitably, the adoption of flood risk management strategies that challenge the status quo, raises a number of issues with local stakeholders. Experience in the implementation of the Roach and Crouch Flood Management Strategy (Thomas and Turney, 2004) has highlighted a number of such issues including:

- the Environment Agency ceasing future maintenance of uneconomic sea walls;
- realigning flood defences that protect agricultural land and landowner compensation;
- Local Authorities have not yet agreed to adopt the Environment Agency’s flood risk management strategies as supplementary planning guidance; and,
- differing ‘visions’ for the coast.

One of the most easily appreciated issues relates to landowner compensation. The UK government guidance does not explicitly offer compensation to local landowners whose land may lie behind defences that will no longer be maintained by the government agencies. This is of obvious concern to the landowners, since the flooding of land would be likely to require a change of land usage and may ultimately result in the land being unsuitable for commercial use. However, options may exist to sell the land to either:

- the Environment Agency, who may wish to undertake managed realignment as part of the flood management strategy; or,
- a commercial developer (such as a port authority), who may require land to compensate for land lost elsewhere in the estuary (e.g. in connection with a port development).

Strategic flood risk management plans need to inform local landowners of the potential areas of land that may be of interest for purchase at an early stage. Such information helps limit uncertainty amongst the landowning community. Additionally, information of alternative land use strategies also helps in allowing landowners to assess their future business options. The Environment Agency is actively communicating with landowners regarding their future land options in the Roach and Crouch estuary area through the publication of a guidance booklet and face to face meetings.
Within Europe, and especially within the UK, the Habitats Directive has assumed a key role in influencing flood risk management policy. The requirement to maintain a range of internationally designated intertidal habitats in favourable condition is providing a key driver for managed realignment. Not surprisingly this has led to some local stakeholders accusing the government agencies of taking habitats more seriously than people and property. However, flood risk management and biodiversity are not mutually exclusive, since managed realignment schemes can deliver reductions in flood maintenance costs and flood water levels as well as creating new intertidal habitats.

Even if landowners are willing to fund their own flood defence maintenance, then it is necessary for them to obtain various consents before the works can go ahead. To date, experience in the UK suggests that landowners can view this as a potential obstruction to them maintaining or improving their own defences, which could potentially be considered as an infringement of their basic human rights under other European Union legislation. The key issues identified by landowners include the costs for developing supporting studies for their own works, the numerous consents that are required and the time taken to secure these consents, which could take more than a year. However, the Roach and Crouch Flood Risk Management Strategy is still at an early stage of implementation, and no such instances have yet arisen. In order to offset such problems the Environment Agency will continue with normal levels of maintenance or operation for the two year notice period and will assist landowners with alternative land management options, such as stewardship schemes for intertidal habitat.

Elsewhere in Europe, various approaches have been adopted to the delivery of sustainable flood risk management policies. These are being reviewed at present under FRaME project (Flood Risk and Management in Estuaries), which brings together a consortium of organisations from the UK, the Netherlands and Belgium (www.frameproject.org). This project aims to promote sustainable flood risk management policies in Northern European estuaries. The project is supporting 5 demonstration sites across northern Europe which are undertaking innovative approaches to the delivery of sustainable flood risk management. The experiences gained from these schemes, plus reviews of other sites are being used to create a web based Best Practice Manual (BPM). The manual will help promote the uptake of sustainable flood risk management strategies, especially those involving innovative solutions, such as managed realignment, both in terms of realigning the defended line and in accepting risks and revising land use. A key element of this approach is the concept of Flood Control Areas; areas which flood periodically to relieve flooding pressures elsewhere in the estuary system. The Best Practice Manual will be designed to provide information to range of stakeholders, including schemes promoters and local landowners, and will therefore assist in the dissemination of information to those affected by flood risk management strategies throughout Europe.

5 CONCLUSIONS

Against a background of sea level rise, it is necessary to accept that many European estuaries will change in the future. In many areas, it will not be possible to hold the shore in one position for ever and it is necessary to make space for coasts to change. Such approaches, whilst difficult for local stakeholders, are likely to be the most realistic and cost-effective over the long term. This may require difficult consultation activities in some coastal areas, where there may be adverse consequences whatever the decision. However, it is necessary to start planning for these changes as early as possible, to enable local communities to prepare for change.

Furthermore, it is necessary to recognise that there are a number of planning or land-use approaches that are needed in addition to traditional preventative engineering schemes. Future flood risk management approaches need to consider measures such as the:

- provision of flood control areas;
- adoption of new land uses;
- adaptation of buildings and infrastructure to be more flood resistant;
- regulated tidal exchange or flood storage areas to reduce the detrimental impacts of storm surges;
- prevention of unsuitable development in high risk areas; and,
- investment in appropriate warning systems.

In some areas it may be necessary to develop temporary solutions that allow people and assets to be moved out of areas at risk. Creating space for coastal change allows estuaries to function in a natural fashion and helps maintain environments,
such as salt marshes, dunes and beaches, allowing them to act as natural flood defences and recreation resources for future generations.

In the UK, Flood Risk Management Strategy Plans provide a strategic estuary wide approach to the delivery of flood defence. These plans are long term (up to 100 years) and identify flood risk management options that are:

- hydrodynamically, technically, economically and socially sustainable in the light of climate change;
- compliant with all statutory obligations arising from national and international nature conservation designations and legislation;
- provide opportunities for environmental enhancement; and,
- prevent the ad hoc development of local schemes, which have been responsible for larger scale estuary-wide impacts in the past.

By developing a holistic estuary-wide appraisal, the potential exists to combine the withdrawal of defence provision and creation of wetlands with the provision of improved flood defences in appropriate locations. Such an approach will allow the estuaries to be managed in a sustainable way thereby reducing the stresses on flood defences. Due to the timescales involved, the benefits of this approach may not be realised for many years. However, this approach should ultimately result in a reduction in both maintenance and capital costs, due to reduced hydrodynamic stresses on constrained points of an estuary, and more appropriately designed future flood risk management works in key areas.

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