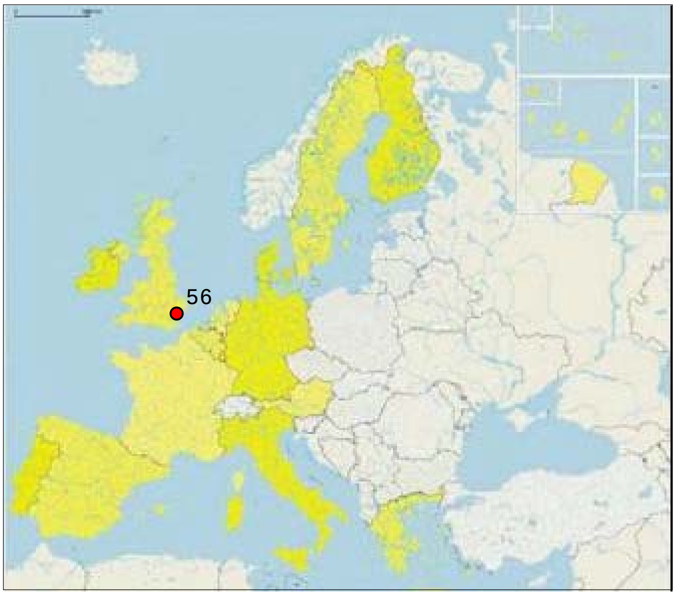
ESSEX ESTUARIES
(UNITED KINGDOM)



Contact:

Alex MIDLEN
Maria FERREIRA

Colchester Borough Council
EUCC

PO Box 885, Town Hall
Colchester ,CO1 1ZE (UK)

PO Box 11232
2301 EE Leiden (THE NETHERLANDS)

Tel: +44 1206 282 480
+31 71 512 29 00
Fax: +44 1206 282 711
+31 71 512 40 69

e-mail:
Alex.midlen@colchester.gov.uk
maria@coastalguide.org

1. GENERAL DESCRIPTION OF THE AREA

Essex is situated at the south western coast of England. The Essex Coast and Estuaries covers the coastal area from Hamford Water in the north to Benfleet in the south, including Southend Marshes, the Colne and Blackwater Estuaries, River Crouch Marshes and Old Hall Marshes, Dengie, and Foulness, all of which are designated as Sites of Special Scientific Interest (SSSI) and some as National Nature Reserves (NNR) under UK statutory conservation legislation.

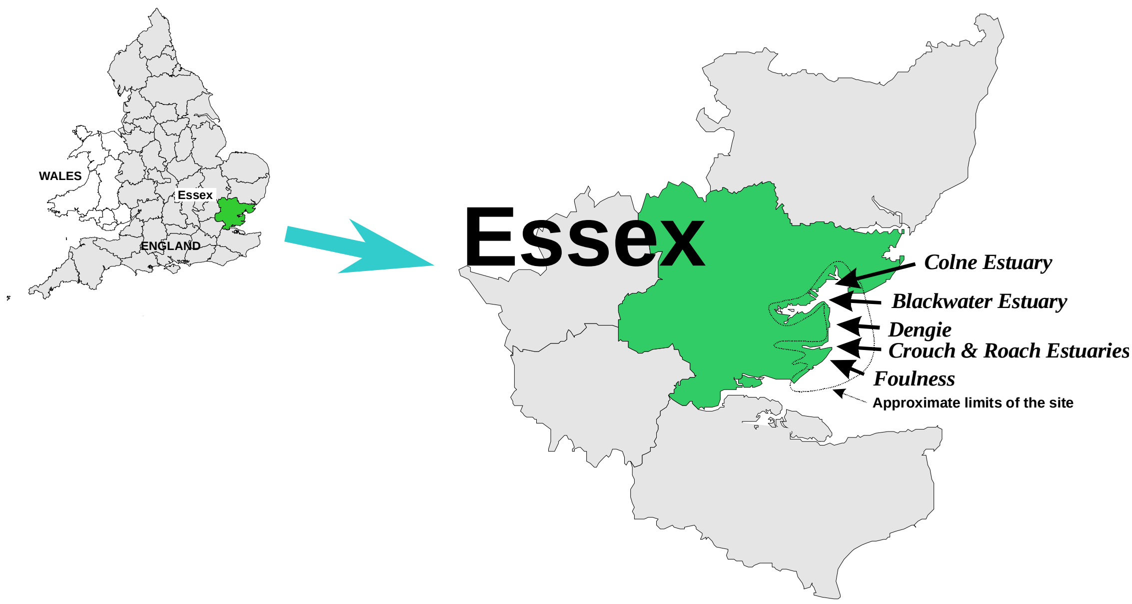


Fig. 1: Location map of the pilot zone (Source: Essex Estuaries Inititative).

1.1. Physical process level

1.1.1 Classification

- General: Estuaries
- CORINE: Muddy coast
- Coastal Guide: Estuary

The Essex Coast is an estuarine coast with extensive areas of fringing saltmarshes (Figure 2), mudflats and offshore sand banks. The area also includes grazing marsh and small areas of shingle shore. It represents a major complex of soft sedimentary habitats in the predominantly flat alluvial landscape.

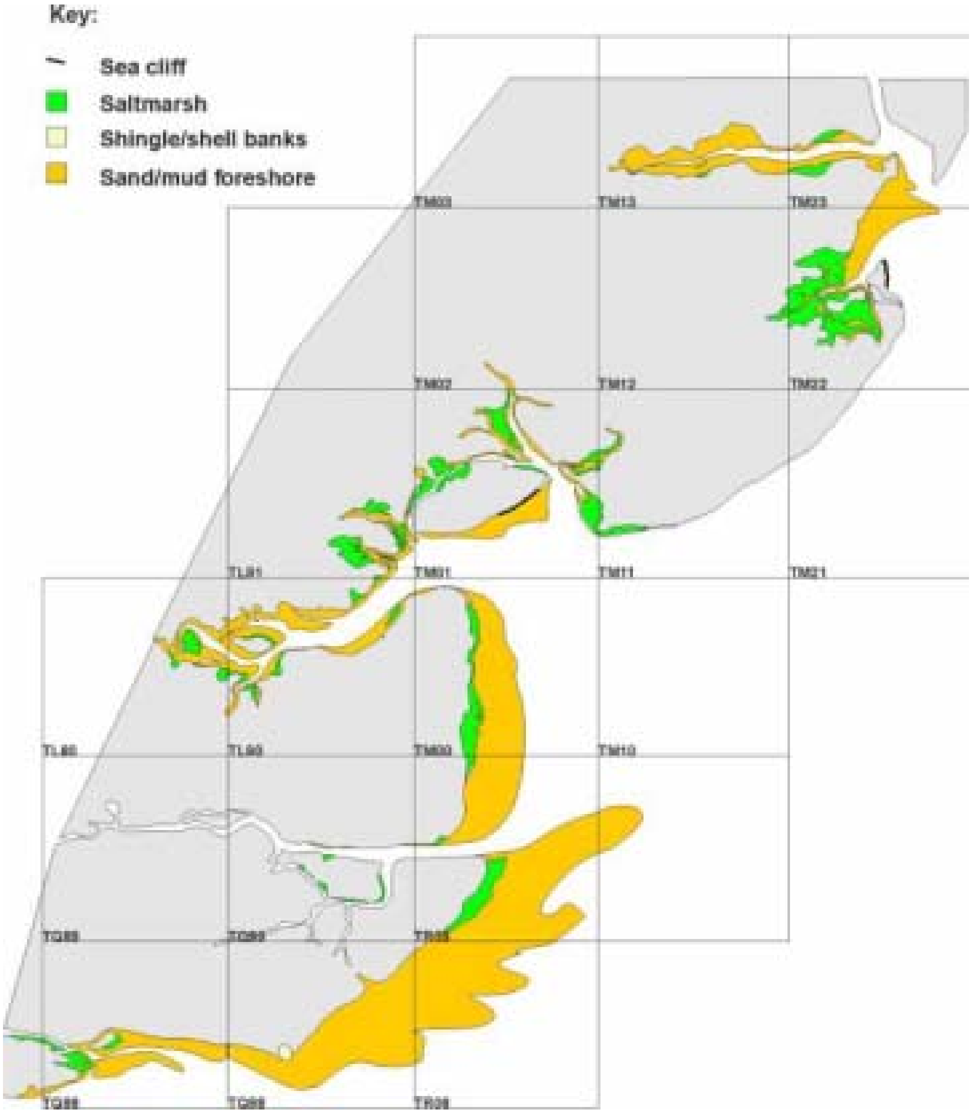


Fig. 2: Indicative map showing the approximate location and area of the principle coastal habitats on the Essex Coast, drawn from 1:50,000 Ordnance Survey maps.

1.1.2 Geology

Essex is composed of soft sedimentary rocks of the Tertiary Period. Most of the coast of Essex is underlain by London Clay deriving from deposits laid down some 55 million years ago. Over much of the rest of the area the solid geology is obscured by other Pleistocene deposits, laid down during glacial period. Offshore the sea bed is also covered deposits of sand, sand and mud or smaller pockets of gravel. These were mostly deposited during the Quaternary period.

The coast sediment is abundant, with a relatively small grain size. In the estuaries silt mud (<0.2mm) predominates whilst the offshore banks contain larger grained sandy material.

The shingle bank are composed of small shell fragments and whilst they are larger than the sand grains (between 0.2 and 2.0mm) they lie at the lower end of the scale for shingle deposits (2.0 and 200mm).

1.1.3 Morphology of the coast

The coastal areas of Essex are low-lying with large areas of land in agricultural use. Much of this area is protected from inundation from the sea by earth, sea walls and concrete embankments. To seaward of the seawall there are large areas of salt marsh which flood on high tides and provide a form of protection from wave attack. Saltmarshes and mud and sand flats are the dominant inter tidal habitats. The maximum depth is 40 m which is not reach until well offshore. Within the estuaries there may be deeper channels. For bathymetry see Figure 3 below.

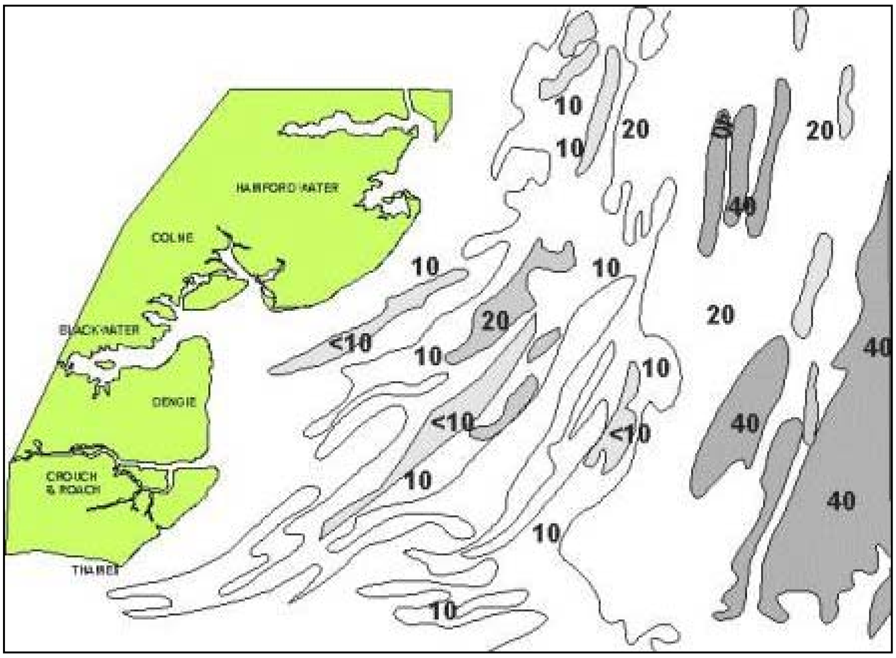


Fig. 3: Bathymetry redrawn from information in the Coastal Directories Series Volume 7 covering the Essex coast (Barne et al. 1998).

1.1.4 Physical processes

The coast of Essex is relatively sheltered from strong winds. Local topography has a marked effect on wind conditions and the Essex estuaries can be severely affected by easterly storms. Offshore, variation in the height of waves are influenced by the complex seabed morphology and local currents. Mostly wave heights of 0.5m are only experienced at some distance from the coast.

In this area the sea level is rising relative to the land. This is due to the combined effects of isostatic adjustment and eustatic change. The rise is estimated between +1.7mm/yr in the Stour Estuary and +1.4mm/yr in the Crouch Estuary.

The tidal stream flows south on the flood and north on the ebb. The maximum tidal current is 1.75m/s along the coast of Dover. This reduces to approximately 1.00m/s in the vicinity of the Essex estuaries. While the tidal range varies from between 3.6m in the north to 5.0m in the south.

1.1.5 Erosion

Type

Typically suspended sediment loads recorded in the Colne Estuary range from 70mg/l on spring tides to 25mg/l on neap tides. The difficulties of providing comparable data are shown by the figures derived from a study in a nearby channel where values as high as 6,000 mg/l have been recorded, It is suggested that high freshwater flows associated with exceptional rainfall may have been responsible for the increased availability of sediment evident from these values.

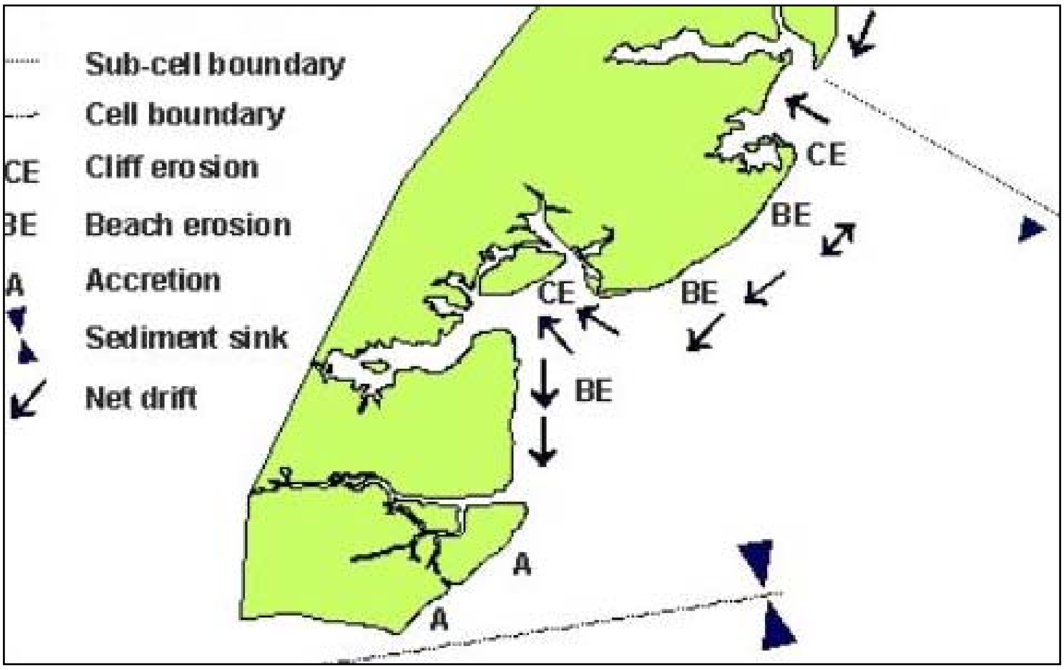


Fig. 4: The sediment transport in relation to cells and sub-cells on the Essex coast. Redrawn from information in the Coastal Directories Series Volume 7 covering the Essex coast (Barne et al. 1998).

To the north of the Essex coast littoral drift is southwards. The general situation of sediment movement is shown in Figure 4 above. This figure is based on an appraisal of the relationship between sediment sinks and drift divides. The former are places where sediment transport pathways meet and sediment tends to build up, as in the shelter of estuaries. The latter are areas where there is an abrupt change in the orientation of the coast with material moving away from the point.

Erosion cause

The main factor that can be related to erosion is the loss of salt marshes through “coastal squeeze”.

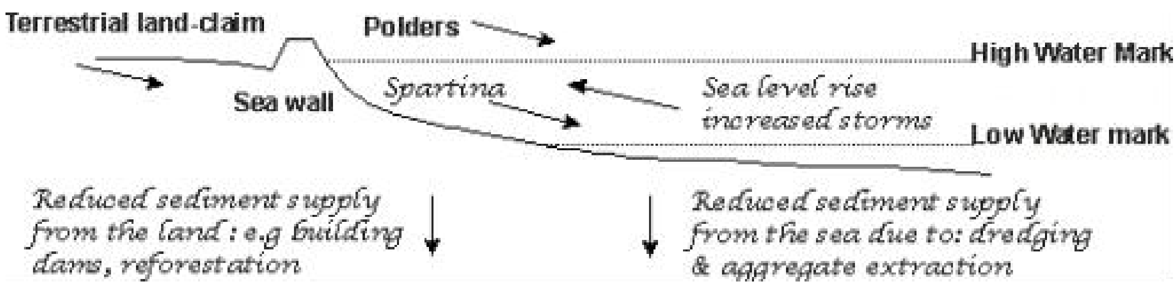


Fig. 5: A generalised picture of the way in which coastal habitats are affected by the 'coastal squeeze'.

From North to South there appears to be a general decline in beach levels. In the North this is attributed to the poor supply of material from the north with the approaches to Harwich Harbour forcing the material seawards. The loss of saltmarshes in south east England has been subject of a considerable amount of research. Losses due to enclosure and subsequent use for agriculture amounted to some 4,340ha see Table 1 below).

Table 1: Loss of saltmarsh in the Essex estuaries in ha, derived from Burd (1992) and Coastal Geomorphological Partnership (2000).

	Original area 1973	**Total area 1988**	**Total area 1998**	**Net loss 1973-1998**	**Net loss 1973-1998**
Stour	264.2	148.2	107.4	**156.8**	**59.3%**
Hamford Water	876.1	765.4	621.1	**255.0**	**29.1%**
Colne	791.5	744.4	694.9	**96.6**	**12.2%**
Blackwater	880.2	738.5	683.6	**196.6**	**22.3%**
Dengie	473.8	436.5	409.7	**64.1**	**13.5%**
Crouch	467.1	347.4	307.8	**159.3**	**34.1%**
Thames (Essex)	?	197.0	181.0	No 1973 data	

1.2 Socio-economic aspects

1.2.1 Population rate

The population density in Essex County is approximately 427 inhabitants per km^2. The population of the rural hinterland adjacent to the coast (pilot site) is 87,300 based on the 1998 mid-year population estimate (Office of National Statistics), excluding the settlements of Clacton-on-Sea, Colchester and Southend-on-Sea. The area covers approximately 710km^2 and therefore hosts an average of 123 people/km^2.

1.2.2 Major functions of the coastal zone

- **Agriculture and forestry:** Essex hosts well over the nationwide average "best and most versatile agricultural land". This allows for large amounts of arable crops to be grown and due to the flat nature of the land. Forestry is considered an economic factor; most of the land consists of damp and dry pastures, farmland and westlands.

- **Fisheries and aquaculture:** fisheries is one of the key economic activities on the coast. The Essex offshore fishing fleet is aimed at demersal, pelagic and shellfish species. West Mersea on the River lackwater hosts the largest inshore fishing fleet of almost the entire English south and east coast.

- **Tourism and recreation:** the Essex coast is a traditional tourist area based on caravan holiday parks, campsites and golf courses. In 2000 the total number of visitors was over 1,8 million.

- **Ships and ports:** the Essex estuaries are amongst the premier leisure boating areas in northern Europe, with about 11,000 boats moored in the area. In April 1990 were recorded 11 marinas, 54 areas of moorings and 3 additional unspecified boat facilities in Essex (Sidaway). At Brightlingsea there is also a small commercial and leisure port and in Colchester there is another general cargo harbour.

- **Industry, transport & energy:** most of Essex is well connected by road to the rest of the country, especially to the Greater London area. The railways in Essex connect Northern Essex (Clacton) to London and also run between Southern Essex (Southend) and London. Harwich International Port serves ferry connections to various destinations on the European continent. Stansted Airport in the north-west of the county is the third international airport of London. There are small and light industrial enterprises scattered around the Essex coast, like light engineering works and a boat-building/repair yard at Brightlingsea and some light engineering on the Blackwater Estuary. At Canvey Island some oil refineries are located.

- **Nature conservation:** almost the entire Essex coast is designated as a protected area under national or international laws.

1.2.3 Land use

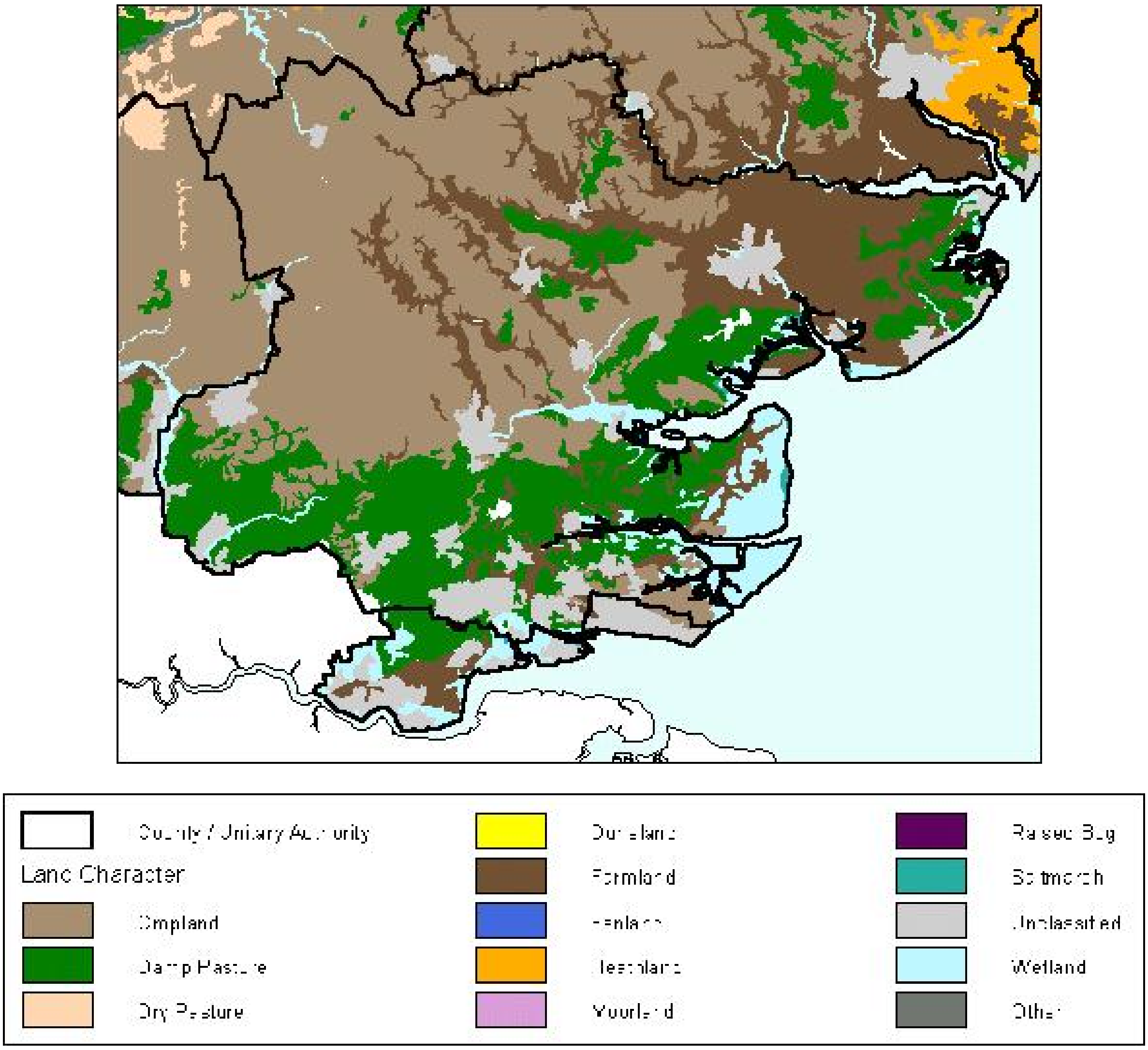


Fig. 6: Soil and Land characterisation of Essex County (England Rural Development Programme; East of England, 2002).

1.2.4 Assessment of capital at risk

Over 1,8 million residences and 180,000 commercial properties are at risk, potentially 5 million people, and 1,4 million hectares of agricultural land including 61% of the total of grade 1 land in England and Wales (see Figure 7). The total value of the assets at risk is estimated to be over 350 billion €.

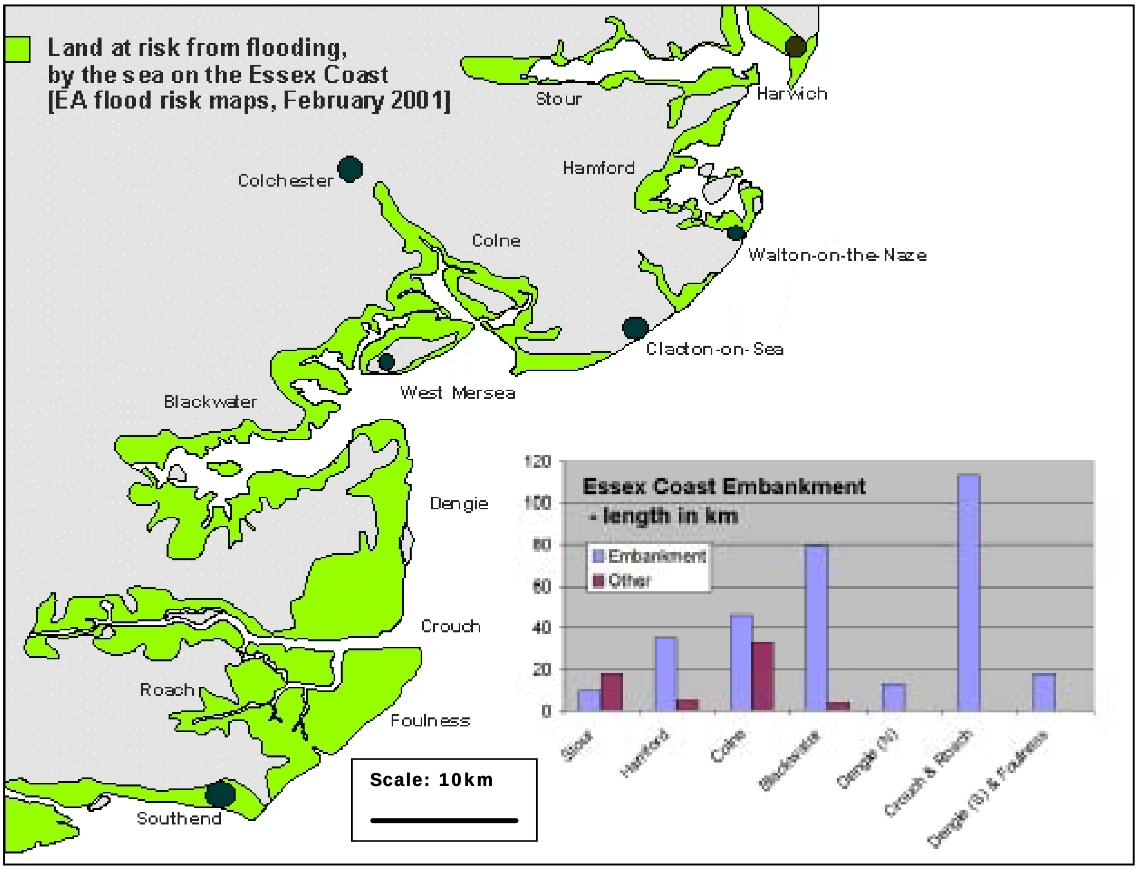


Fig. 7: Area of land on the Essex coast threatened from flooding by the sea in relation to the length of sea walls and embankments. The location of the rivers and the main towns are also shown.

2. PROBLEM DESCRIPTIONS

2.1 Eroding sites

The only quantitative figures for cliff erosion on the Essex coast are for Walton-on-the-Naze, Essex where the clay erodes at a rate which has been estimated at 0.52m/yr. The erosion on the north east corner of Mersea Island continues with little attempt to constrain it. Though no erosion figures have been obtained a reasonably substantial length of cliff is involved.

Birling Gap

This is an example of cliff erosion. The erosion measured is 89m, for the period from 1873 to 1997, with an annual retreat rate of 71cm.

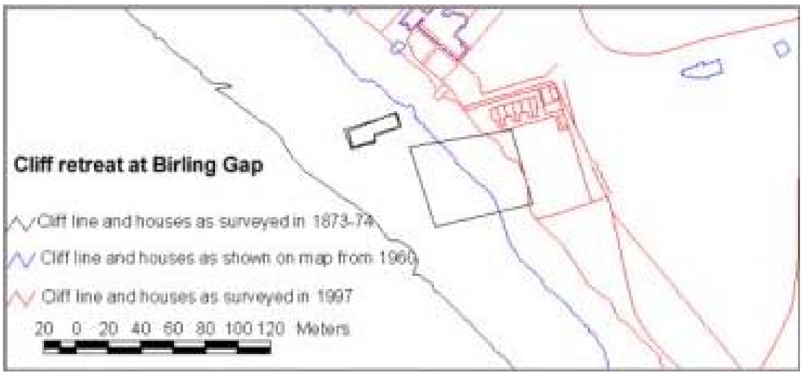
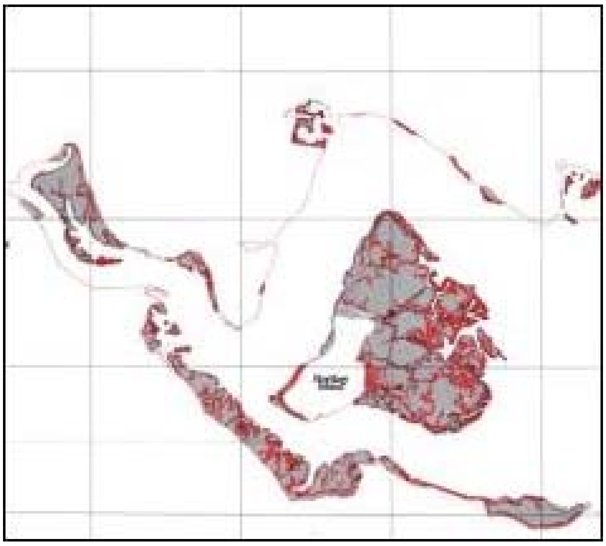


Fig. 8: Evolution of cliff retreat at Birling Gap.

The situation is different for the saltmarshes of the coast. There is a substantial trend towards erosion in all the estuaries on the Essex coast.

Northey Island



In 1840, the tithe map shows that most of the island to have been used as pastures or arable land. After a major storm in 1897, large (approximately 2/3 of the island) became flooded following breaches to the sea wall, which were not repaired. By 1901 these areas were reported to have reverted to saltmarsh. The saltmarshes that became re-established showed substantial erosion between 1973 and 1988. The major part of the saltmarsh is derived from failed defences.

Fig. 9: Eroding saltmarsh Northey Island in the Blackwater Estuary. The major part of the saltmarsh is derived from failed defences.

Orplands

The original saltmarsh was enclosed in 1880 and subsequently used for agriculture. The site includes two retreat areas, tidal mudflats and an area of saltmarsh to seaward. Breaching took place in April 1995 and involved demolishing the seawall to allow normal tidal exchange to take place. Breaching took place over a period of 4 days during neap tides. A series of nine meandering vertically sided 'creeks' one metre deep were excavated within the site to facilitate tidal flow over the area.

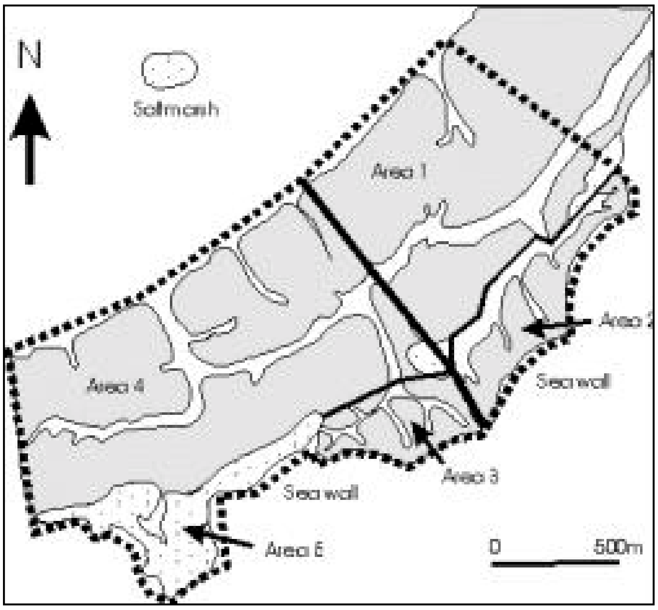


Fig. 10: Tidal mud (Areas 1 & 4) and control saltmarsh (Area 5) adjacent to the realignment sites (Areas 2 & 3).

2.2 Impacts

It is clear from the analysis of the situation in Essex that a rising sea level imposes severe restrictions on the capacity of the ‘Hold the line’ option to be sustainable in the medium to long-term.

Recent flooding events in the UK (and in the rest of Europe) suggest that whatever is spent on capital and maintenance of coastal protection features, extreme events will always overcome the defences.

3. SOLUTIONS/MEASURES

3.1 Policy options

Five policy options are identified for Essex coastal protection:

- Policy 1: Hold the line by maintaining or changing the standard of protection. This policy should cover those situations where works or operations are undertaken in front of the existing defences, to improve or maintain the standard of protection provided by the existing defence line. This policy has been adopted at *Sales Point, Marsh House, Deal Hall and Hamford Water.*

- Policy 2: Move seaward by constructing new defences seaward of the original defences.

- Policy 3: Managed realignment by identifying a new line of defence and constructing new defences landward of the original defences. Some experimental sites of this option were *Blackwater Estuary, Orplands, Tollesbury and Abbost Hall.*

- Policy 4: Limited intervention by working with natural processes to reduce risks while allowing natural coastal change. This policy was adopted at *Cudmore Grove.*

- Policy 5: Do nothing where it is no investment in coastal defence assets or operations.

3.2 Strategy

3.2.1 Approach related to the problem

Approach related to the problem are both soft and hard measures, depending on the type of option adopted. A combination of barges filled with sand/mud and brushwood groins were placed at Deal Hall. At Hamford Water, instead, is important beach recharge.

3.2.2 Issues concerning threat to life and property

The Environment Agency has a flood warning system which uses a special telephone number, which can be dialled to provide guidance on where warnings are in operation.

Access via the Internet provides a similar service (http://www.environment-agency.gov.uk/subjects/flood/floodwarning/). This is backed up by the provision of maps available on the Internet.

3.3 Technical measures

3.3.1 Historic measures

During the 1980s several attempts to restore saltmarshes and mud flats were made using offshore breakwaters and polders. Sales Point, Marsh House and Deal Hall are three locations along the Dengie Peninsula, Essex, where these measures are adopted.

3.3.2 Type

The technical measures are summarized following the main policy options adopted in Essex Estuaries; at each site the approach was different. Location of the sites can be seen in Figure 11 below.

Fig. 11: Location of examples of coastal defence activities in the Essex coast.

3.3.3 Technical details

Hold the line

Table 2: Historic measures in Essex.

Sales Point	11 Thames barges	1986
	Barges with connecting brushwood	1989
	Groins	
Marsh House	16 Thames lighters	1984
	2 Groins	1986
Deal Hall	400m^2 polder using brushwood	1980
	Groins	1981/1989
	Tidal flat were gripped	

In Sales Point, the Thames barges (filled with sand) were placed 200m offshore, spaced 20m apart, to create a wave break 'protecting' 600m of eroding saltmarsh were installed in 1986.

In Marsh House, the 16 Thames lighters were placed 500m offshore, spaced 20m apart, in 1984. Two groynes (clad with geotextile material rather than the traditional brushwood) were constructed in 1986 at either end of the wavebreak. *Spartina* was also planted in 'gripped' areas towards the landward side of the polder.

In Deal Hall, two 400m square polders were constructed in 1980 using brushwood groynes. The enclosed tidal mudflats were gripped[1] in 1981 and again in 1989. A third polder was constructed 1987/8 but not gripped. This was the only site where gripping was undertaken within the groyne fields.

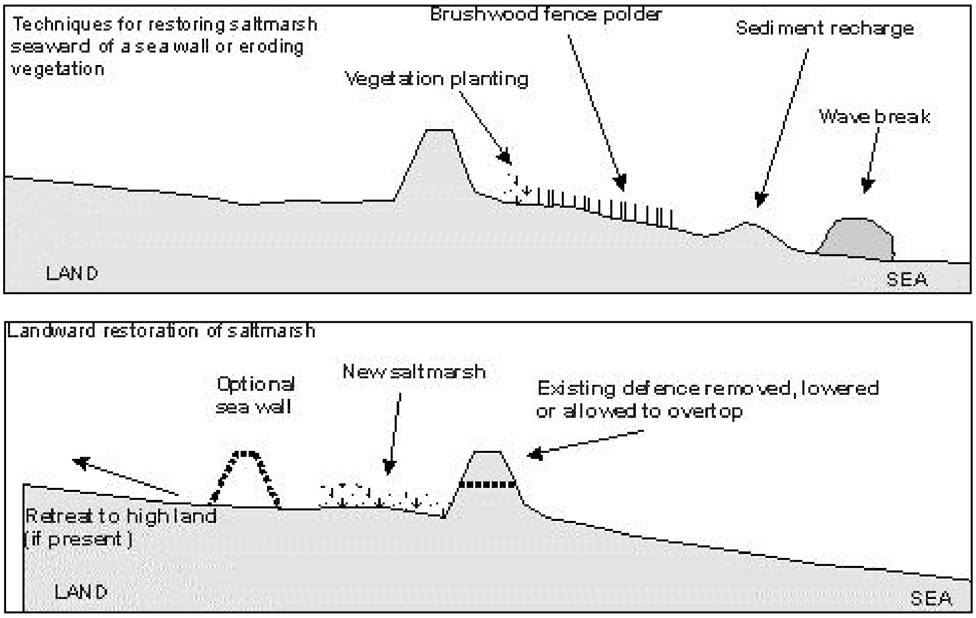


Fig. 12: Some of the design features associated with a move away from maintaining hard sea defences and allowing the sea to invade the land.

The loss of habitat, changing perceptions of the implications of sea level rise and cost on maintaining hard defences have all contributed to the move away from ‘protect at all costs’ to a policy of ‘realignment’ which accepts that some land will be lost to the sea. This combined with the use of ‘softer’ engineering options such as beach recharge represent a much more flexible approach to coastal protection.

In recent years a number of sites along the Essex coast have become the recipients of recharge material. Much of this is derived from the dredging to the Harwich Harbour. These involved placement of sediment on the foreshore at Foulton Hall and Stone Point (see Figure 13) and Horsey Island.

For the first two the material was similar in texture to that already existing on the site. It was placed at approximately low water over a period of about 5 weeks as a bank of sediment. At Horsey Island coarser material was used and because of the restricted water

[1] Gripped - a process where mud flats are excavated in parallel lines and the sediment placed to one side. This creates areas higher than the surrounding flats, which helps to speed up the colonisation by plants.

depth it was placed on Spring tides at high water by spray from a dredger. Gaps were filled between the sunken barges placed to reduce wave attack and left to be dispersed by tidal action.

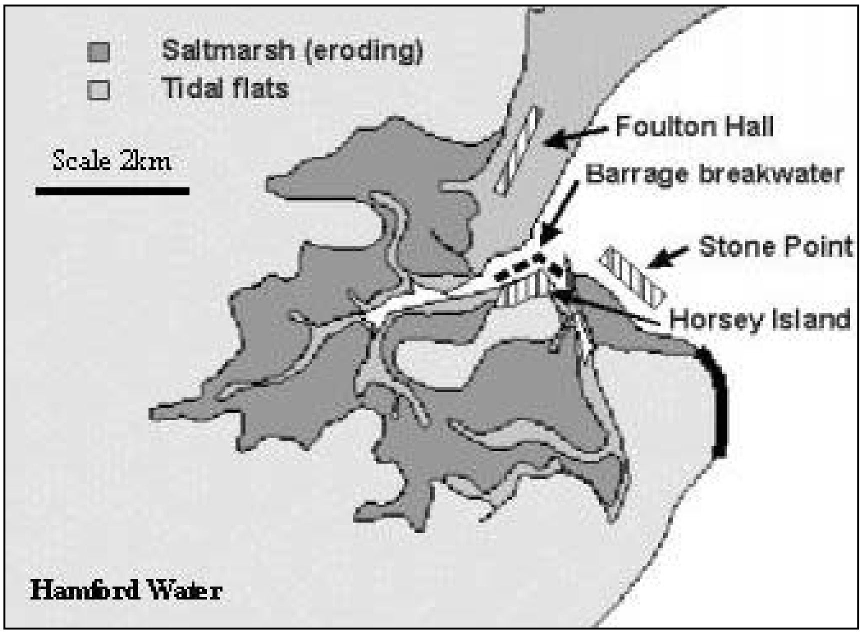


Fig. 13: Beach recharge sites in Hamford Water.

Managed realignment

Orplands is a 38ha coastal managed realignment site. The realignment site has been divided into two distinct parts, Site A and Site B, which are next to each other along the coast, but separated, by a counterwall (see Figure 10). The two sites had different pre-inundation characteristics:

- Site A (**Area 2**) was rough grassland before it was reopened to tidal flooding, it had not been ploughed and the line of the original major creeks can still be seen as shallow, linear depressions.
- Site B (**Area 3**) was used for cereal production. Clay pipe land drains had been installed approximately 1m below the land surface to lower the water table in the field.

3.3.4 Costs

A summary of some of the costs for different elements of the coastal defence strategy are summarised below. These are taken from the State of the Coast Report for England and Wales prepared by the Environment Agency and published in 1999 (Table 3).

Table 3: Costs for different elements of the coastal defence strategy in England and Wales

Item	Capital cost	Maintenance cost
Thames Barrier	£600 million (completed 1982)	£4 million per annum and protects the equivalent of one million houses
Thames tidal defences	£400 million (associated with Thames Barrage)	
Sea defence 1990-1996	£95 million total	£41 million total
Coastal protection 1990-1996	£253 million total	£100 million total (estimated)

4. EFFECTS AND LESSONS LEARNT

4.1 Effects related to erosion

There is no evidence to suggest that the policy of realignment has had any significant effect on the morphology of the adjacent coast. Studies of the Tollesbury site certainly indicate this is so. There is some concern that increasing the tidal volume of an estuary through managed realignment has the potential to increase wave energy and tidal currents.

4.2 Effects related to socio-economic aspects

It is too early to tell whether the long term realignment of the coast will achieve the aim of securing a more sustainable and cost effective approach to coastal defence. It is already clear, however, that the re-creation of mudflat and saltmarsh is possible and that considerable benefits are derived for nature conservation. The case for and the benefits derived from adopting a more flexible approach to coastal management are becoming much more widely accepted as the policy is promoted within the wider coastal community and to the public.

4.3 Effects in neighbouring regions

There is no evidence of any “knock-on” effects on adjacent regions. This is not surprising in the case of the Essex coast as it is more or less a morphologically closed system. It also does not contribute significant amounts of new material to the coastal system through coastal erosion.

4.4 Relation with ICZM

The *Essex Estuaries Initiative (EEI)* **-** partly funded through Interreg IIC - is a strategic approach to coastal management, which aims to coordinate and support the Essex Estuaires European Marine Site. This is a statutory designation, which involves a wide range of authorities from local authorities to fisheries regulators, from nature conservation agencies to harbour authorities. The main purpose is to ensure the nature resources of the coast, both on sea and land, in order to continuing support business, wildlife, and the sustainable development of coastal populations and nature areas.

The development of appropriate management will facilitate the attainment of the twin goals of conservation of the cSAC whilst at the same time maintaining and enhancing the socio-economic development of the area. The Initiative is greatly relevant to WP3 as it defines the same site boundaries (Essex Estuaries European Marine Site) and initiates coastal and estuary management with specific reference to sustainability and supported decision-making.

It aims to implement the Habitats Directive regarding the proposed Essex Estuaries European Marine Site by developing a management plan in partnership with relevant authorities, users and interest groups.[2]

[2] Essex Estuaries Initiative http://www.essexestuaries.org.uk

4.5 Conclusions

Effectiveness

It is clear from the analysis of the situation in Essex that a rising sea level imposes severe restrictions on the capacity of the 'Hold the line' option to be sustainable in the medium to long-term. Recent flooding events in the UK suggest that whatever is spent on capital and maintenance of coastal protection features extreme events will always overcome the defences. Hence it seems likely that the policy of managed realignment will provide some respite from current trends in coastal erosion and it may need to be extended both along the coast and inland.

Possible undesirable effects

Pollution is a potential problem where material is dredged from river channels especially in estuaries with heavy industry. There is not evidence as yet in the case of the Essex sites where beach recharge with dredged material has taken place that pollution problems have occurred.

Gaps in information

In general has been stated that an important amount of information is available. It has been found that in some cases, too much information exists and no time is available to have a good knowledge of this.

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