

'Coastal squeeze' – an historical perspective

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Abstract

The use of salt marsh for agricultural use has probably been going on for thousands of years. This paper will look at the situation in southeast England, particularly the Wash. Here enclosure for extended grazing and over the last several hundred years, for arable cultivation, may have taken place since Roman Times. An enclosure of Freiston Shore salt marsh (1979) and a proposed further enclosure at Gedney Drove End at about the same time raised concerns about the cumulative effect of these developments on nature conservation interests. These concerns prompted the nature conservation agencies to oppose the Gedney Drove End enclosure.

Though the conservation argument did not persuade the Government that no further enclosure should take place, economic circumstances changed such that the pressure for the creation of new agricultural land diminished. This marked the end of 'reclamation' in the Wash. Since then, in the UK at least, there have been no further enclosures of salt marsh for agriculture.

What were the arguments that lead to this change? Up to this point the perceived wisdom, in the Wash at least, was that as enclosure took place new inter-tidal land was created to seaward – with no net loss of inter-tidal land. Today we accept that this is not the case and a policy of managed re-alignment has increasingly been adopted in England, at sites ranging from the Porlock shingle ridge in north Devon to the salt marshes of Freiston in the Wash.

It is argued that recognition of 'coastal squeeze' probably began in the Wash some 20 years ago. It would appear that we are now witnessing a reversal of this trend. How far will it take us? Will we see a return of the large expanses of tidal swamp around the Wash and elsewhere along the southern North Sea coast? Is this an inevitable consequence of global warming?

This paper provides an historical perspective of the issues and arguments that have led us to recognize 'coastal squeeze' and the importance of dynamic coasts, including the European Commission's 'EURosion Project', which reported in 2004 (Salman et al. 2004).

Keywords: Cardiff Bay; Essex coast; Salt marsh; Sea level rise; Seal Sands; Severn; Wash.

Abbreviation: NCC = Nature Conservancy Council.

Introduction

Enclosure of tidal land, especially in estuaries, has for centuries been a way of creating 'new' land for industry, housing and agriculture. Some of the more significant examples in England are summarized in Table 1 below. Fig. 1 shows the approximate location of the sites mentioned in the text.

The nature conservation movement, recognizing the potential harmful effect of further, often cumulative developments on the wildlife value of the affected areas, has battled against them for two decades and more. During the latter part of the 20th Century there were several types of proposals. These are listed below with an indication of the main nature conservation issues:

Energy generation – The Severn Estuary (Anon. 1933) re-assessed Vaughan-Lee et al. (1945) and again in 1976-1977 (Palmer 1977; Bondi 1981); change in estuary status, loss of extreme tidal range;

Water storage (freshwater) – The Wash (Anon. 1970) and Morecambe Bay (Anon. 1972). Loss of habitats and winter feeding areas for birds;

Airport construction – Maplin Sands (Department of Trade 1974). Loss of habitat and winter feeding areas for waterfowl;

Port and harbour development – Tees Estuary, jobs versus birds (Seal Sands), Cleveland Structure Plan, Examination in Public 1975. Loss of habitat for winter feeding birds and seals;

Enclosure for agriculture – Extension of the historical 'reclamations' up to and including Freiston Shore on the Wash (1979). Cumulative loss of foreshore habitats (salt marsh and mud flats) and reduced feeding areas for wintering waterfowl;

Economic regeneration – Cardiff Bay amenity barrage proposal, (Cardiff Bay Barrage Bill and Select Committees of the House of Commons and the House of Lords in 1990/1). Loss of estuary, displacement of wintering waders.

Many of these were represented by major developments affecting large parts of the sites. In addition there

Table 1. Historical enclosure of tidal land in England. The examples are indicative only, similar examples can be found from around Europe.

Geographical Area	Land claim (ha)	Purpose	Reference
The Wash (Lincolnshire/Norfolk)	29 000 < 17 th Cent. 3000 in 20 th Cent.	Agriculture	Dalby (1957)
Essex and North Kent	4340 < 18 th Cent.	Agriculture	Macey (1974)
Morecambe Bay (Cumbria/Lancashire)	1300 13 th - 14 th Cent.	Agriculture	Gray (1972)
Southampton Water (Hampshire)	1170 mainly 20 th Cent.	Docks & industry	Tubbs (1981)
Tees Estuary (Teesside)	3300 1852 onwards	Docks & industry	Davidson & Evans (1986)

were also many other smaller proposals. The proliferation of threats to coastal wetlands prompted the Nature Conservancy Council to undertake a review of the status of estuaries in Great Britain (Davidson et al. 1991). This review confirmed that the rate of loss and the adverse implications of future developments, including the implications of global warming were considerable. The foreword to the report sets the basis for future conservation of this ecosystem as needing “a better understanding of the needs of estuarine wildlife and the pressures facing it now and in the future.”

It goes on to say “We have treated estuaries in the past as wastelands. Let us treat them as treasures in the future.” This sets the tone for approaches to estuarine conservation, though in the absence of reciprocal recognition of the plight of our estuaries by developers the conservation lobby continued to be required to oppose many of the developments, including those highlighted above.



Fig. 1. Outline map of England and Wales showing the location of places mentioned in the text together with the county boundaries.

The case against enclosure and development

Throughout the 1970s and 1980s the conservation case against further enclosure and development on the estuaries of the UK developed. This rested on four principle arguments:

1. The inherent value of the areas affected;
2. Direct loss of habitats and their associated plants and animals in relation to features of national and international importance;
3. The indirect impact on the feeding areas of wintering bird and their ability to sustain numbers at national and internationally recognized levels;
4. The implications for the wider conservation of migratory species using a network of sites, including those in the UK.

Two cases in the UK illustrate the way in which the conservation argument developed:

1. Seal Sands

These arguments were rehearsed during the Cleveland Structure Plan examination in public in relation to the development of Seal Sands in 1975. Despite the already considerable loss of tidal land in the estuary through industrial development and use, the Nature Conservancy Council argued it still retained features of nature conservation importance worthy of national recognition. Its international importance and wider role in the conservation of the wintering waterfowl visiting the site was highlighted. It was further suggested that removing this element in the network of sites upon which the wintering bird populations relied, could have potentially harmful effects. This would be especially significant when other elements of the network were threatened. Loss of breeding sites (causing reduced breeding success) or destruction of migratory stop-over areas and winter feeding habitats could cause death of individuals and have a cumulative effect on the population as a whole.

Arguments to the contrary were presented and the significance of removing one element in a network of sites was disputed. The economic argument together with uncertainty about the precise role of Seal Sands in the wider species conservation failed to convince the inspector of the case against the enclosure of Seal Sands. The area was allocated for port development in the Structure Plan. – In the event only part of the site was developed due to changes in economic requirements and today the remaining habitats form part of a National Nature Reserve.

2. Cardiff Bay

The four key arguments continued to form the basis of opposition to development proposals affecting UK estuaries up to and including opposition to the Cardiff Bay Barrage Bill in the early 1990s. Here comprehensive evidence was presented to Select Committee hearings of the House of Commons and House of Lords, by the Nature Conservancy Council and others opposed the building of the amenity barrage across Cardiff Bay both about the significance of the direct loss of habitat and the implications for the wider conservation of birds using the Severn Estuary and beyond. Notwithstanding this opposition, Cardiff Bay was lost with the construction of the barrage in the late 1990s following the enactment of the Cardiff Bay Barrage Act in 1993 (Fig. 2).

Most of the early cases referred to above were presented as simple choices: socio-economic progress versus nature conservation (often expressed as jobs versus birds). Most of the cases were lost, at least those found to be technically feasible and affordable; the conservation arguments were always considered as secondary. However, despite the continued threats to coastal habitats generally and estuaries in particular throughout the 1990s, the Cardiff Bay case marked something of a change in attitude to the needs of wildlife. Although the political drive towards the creation of an amenity lake as part of the regeneration strategy for Cardiff was unstoppable, concessions were made. In particular it was agreed that development and maintenance of a wetlands reserve involving the creation of saline pools,

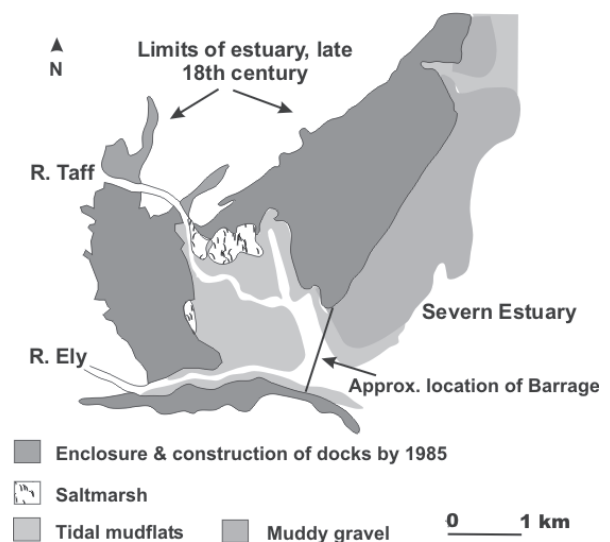


Fig. 2. Progressive loss of Cardiff Bay. The final act of destruction took place with the building of a tidal exclusion barrage across the mouth of the estuary as shown.

reedbeds, and managed grassland on the Gwent Levels should be made to 'compensate' for the loss of the tidal land in Cardiff Bay, some 15 km or so to the west. Eventually this proposal was accepted by the European Commission who wrote confirming this in February 1996 to the Royal Society for the Protection of Birds who had lodged a formal complaint in relation to the barrage under the Wild Birds Directive. It stated its acceptance of the UK Government's view that the construction of the barrage could be justified for reasons of overriding socio-economic interest. The letter continued: "*The UK authorities have also given guarantees concerning the measures to be taken to satisfy the criteria of Article 6(4) of Council Directive 92/43/EEC. The wetland compensation and conservation measures to be taken by the UK authorities include substantial measures to create new wetland habitat and put in place additional management plans for 31 estuaries in the UK.*"

Other developments such as the proposed expansion of the port at Southampton appear to continue the attrition of coastal wildlife areas, especially in estuaries. In their turn the conservation organizations have continued the 'battle' including, in the latter case, opposition at a Public Inquiry. Significantly the further port development at Southampton has recently been refused because of the impact on wildlife. A slightly different scenario has unfolded in southeast England.

Southeast England

It has been known for some time that southeast England is sinking and that this combined with global sea level rise meant that there was an overall rise in sea level along the coast. Less clear, certainly in the early 1980s, were the implications for coastal habitats. However, over the next two decades our understanding began to change.

The Wash

The history of enclosure in the Wash seemed to suggest that the creation of new land from the sea provided never ending opportunities for landowners to add to their estate, at little cost. All that was needed was intent, money and machinery and by erecting an earth embankment enclosing mature salt marsh 'ripe for reclamation' new land could be created. In just a few years this could be cultivated with arable crops (or even daffodils)! The benefit to the landowners was obvious as they were able to acquire new land at relatively low cost and subsequent maintenance of the sea wall became the responsibility of the National Rivers Authority (En-

vironment Agency).

In general land above Mean High Water in England becomes the property of the adjacent landowner once enclosed.

Although the Nature Conservancy Council (NCC) became increasingly concerned about the cumulative impact of the enclosure of salt marsh on the Wash it decided not to oppose a proposed new 'Jubilee Bank' at Wainfleet/Friskney) in 1976. The concern was balanced by the view that was then held, namely "...after reclamation, accretion outside the sea wall would restore the loss of salt marsh." (Labern 1987). However, in 1979 a proposal to enclose 80 ha of salt marsh at Gedney Drove End was refused by the Local Authority and subsequently went to appeal. At the Public Inquiry in 1980 the NCC and others opposed the scheme. The arguments went something like this:

In the Wash, as elsewhere in the southern North Sea embankment of salt marsh not only destroys the habitat in the short term but also reduces its overall diversity by continually removing the more mature and botanically diverse sections of marsh. New marsh continued to develop outside the sea bank but it was argued that this did not fully compensate for the losses.

At the same time although the evidence was not conclusive, it was suggested that low water mark was not advancing progressively seawards. Thus as the salt marsh regenerated outside the sea-wall, there appeared to be a consequent loss of sand and mud flats in the Wash. Since these provided important winter feeding areas for large numbers of wildfowl and waders there appeared to be a potential for significant loss of value in these populations. On the basis of this evidence further piecemeal enclosure was resisted by conservation bodies at a public inquiry into salt marsh enclosure at Gedney Drove End in 1981. A local inquiry into a moratorium on enclosure proposed by the Lincolnshire County Council in their coastal subject plan in 1983 was supported. No further enclosures have taken place since 1979.

A conference held at Horncastle 1987

There were uncertainties about the contention that the intertidal areas of the Wash were being progressively diminished by salt marsh enclosure. Recognising this, the NCC and EBSA (Estuarine and Brackish-water Sciences Association) jointly held a conference to bring together as much of the available information as possible to improve our understanding of the ecological processes (and other factors) affecting the conservation of the site (Doody & Barnet 1987).

The results of a study of the effects of the enclosures

between 1971 and 1985 were presented. These showed a loss of 865 ha of marsh but with accretion rates of over 20 mm per annum new marsh totalling 781 ha developed over the same period (Hill & Randerson 1987; Hill 1988). Detailed reports were also presented on the sediment budget for the site (Dugdale et al. 1987; Evans & Collins 1987) and the potential impacts of sea level rise (Shennan 1987).

Taken together these results helped to confirm several important consequences of salt marsh enclosure for agricultural use in the Wash, namely:

1. Losses usually involve the more mature high level plant communities and their associated invertebrates and breeding birds. Whilst new marsh develops to seaward this takes many years to fully replace the biological diversity lost through enclosure;
2. Low water mark remains more or less static and does not move seaward in response to enclosure. This situation was likely to be aggravated by relative sea level rise;
3. Reduction of the intertidal area as new marsh, in some cases with an accelerated accretion rate, extends beyond the new sea wall. Continuing salt marsh enclosure inevitably results in a major reduction in the area of sand and mud flats available, particularly to feeding wintering ducks and geese.

These impacts led to the conclusion that “..each incursion into the intertidal zone represents a loss of interest and these losses are cumulative.” It was also suggested that “..any further *squeezing* of the intertidal zone” must upset the balance of processes “essential to the well-being of the system.” (Doody 1987).

Salt marshes in Essex

Extensive losses of salt marsh due to enclosure and subsequent use for agriculture (including coastal grazing marsh) were already known to be in the order of 4340 ha, according to studies undertaken to assess the implication of building a third London airport at Maplin Sands (Boorman & Ranwell 1977). Visual evidence suggested that the remaining marshes were suffering further degradation through erosion. This prompted the Joint Nature Conservation Committee (JNCC) to undertake a review of change in salt marshes along the Essex coast – The JNCC was set up following the split of the NCC into agencies for England, Scotland and Wales to help provide a UK nature conservation perspective in support of the agencies. In order to establish the extent of the losses detailed surveys were undertaken (Burd 1992). An example of the detailed results is shown in Fig. 3. This shows that the losses occurred along the seaward margins of the salt marsh in the creeks and exposed shores. The results of the Essex salt marsh erosion study are summarized in Table 2.

A similar study of the erosion of salt marshes in Suffolk between 1971, 1986 and 1998 revealed further losses (Anon. 2000); see Table 3.

This evidence of habitat loss was also supported by a Sea Defence Management study prepared for the National Rivers Authority in 1991 by Halcrow consulting engineers, which concluded that 70% of the coastline from Humberside to the Thames was retreating. Thus by the middle of the 1990s it was generally accepted that, at least in southeast England, where sea level was rising relative to the land, there was a general loss of tidal land.



Fig. 3. Loss of salt marsh at Northey Island in the Blackwater Estuary, Essex. The darker areas give an indication of salt marsh loss; scale – 1-km squares are shown.

Table 2. Loss of salt marsh in the estuaries of Essex and Kent 1973-1988 (Burd 1992).

Estuary	Original area (ha)	Total area lost (ha)	Loss (ha) to reclamation	Loss (ha) to erosion	% original area eroded
Orwell	99.5	39.9	7.5	32.5	32.6
Stour	265.2	129.5	13.3	116.2	55.0
Hamford Water	876.1	170.6	1.2	169.5	19.3
Colne	791.5	97.7	5.2	92.5	11.7
Blackwater	880.2	200.2	-	200.2	22.7
Dengie	573.8	56.7	-	56.7	9.9
Crouch	567.1	156.1	22.1	125.0	26.5
Thames (Essex)	365.9	105.6	22.3	83.3	22.8
Thames (Kent)	77.8	17.5	3.2	15.3	18.5
Medway	853.8	198.3	18.2	180.1	21.3
Swale	377.0	61.6	3.5	58.2	15.5

The combination of direct habitat loss and better understanding of the way coastal systems respond to enclosure helped generate a change in perception of the sustainability of some coastal defences and the real impact of habitat loss on features of nature conservation value.

Changing perceptions

Developments such as the loss of Seal Sands followed a pattern in the 1970s and 1980s where conservation interests were largely considered secondary to the economic arguments. The Cardiff Bay case suggests that although the strong conservation case could not overturn the political pressure for an 'amenity lake', compensation for its loss became an important part of follow up action. This approach has become much more significant in recent years and mitigation or compensation for losses of wildlife habitat is much more prevalent, especially in sites forming part of the European Natura 2000 series.

Similar arguments to those advanced in the UK were also made by conservationists in Germany. Here enclosure of tidal marshes had continued up to the 1990s. From the 1960s onwards the primary objective of embankment had been for sea defences. However, recogni-

tion that these have had a detrimental impact, especially on the biologically rich areas of the German Wadden Sea, saw a decline in these projects. A number of factors came together to persuade the authorities that continuing enclosure was not in the best interest on the environment or for sea defence. These were:

- objections from environmentalists;
- a reduced need for greater agricultural production;
- new more environmentally sound legislation;
- recognition that sea level rise was an important issue (Goeldner 1999).

Meanwhile back in southeast England a potentially more serious threat was beginning to be recognized – 'coastal squeeze' – and acted upon!

'Coastal squeeze'

The situation in the Wash undoubtedly led to the recognition that it was no longer feasible to enclose tidal land without permanent loss of intertidal habitat. This fact together with the results of the studies on the loss of salt marsh on the Essex coast further south (Burd 1992) suggested that simply maintaining the current line of defence along much of the coast would eventually lead to the loss of substantial areas of salt marsh. In some areas this had already resulted in the virtual loss of the whole intertidal zone (Fig. 4).

Table 3. Loss of salt marsh (erosion and enclosure) Suffolk estuaries 1971-1998.

Site	Total salt marsh area (ha)			Net change (ha & %)
	Years	1971	1986	1998
River Blyth		68	66	63
River Ald/Ore		265	267	257
River Butley		96	89	87
River Deben		312	266	241
				5 ha (7%) loss
				8 ha (3%) loss
				9 ha (10%) loss
				71 ha (23%) loss



Fig. 4. Rising seas create a narrowing shoreline in areas where sea walls protect agricultural land or property – ‘Coastal squeeze’ on the Blackwater Estuary, Essex.

Conclusions

In the early 1990s notions that we should (or could) give up land to the sea were an anathema to many, especially in the field of engineering.

A review of the relationship between sea defence and nature conservation was presented to the River Engineering Section of the Institution of Water and Environmental Management (IWEM) on 1 February 1991. The author was asked to submit a paper to the IWEM Journal. This paper argued that we may have “..devoted too much effort to the ‘battle with the sea’.” and that adopting a more flexible approach to coastal defence “might provide opportunities for positive nature conservation action and more cost effective sea defences.” It was rejected. The editorial panel in assessing the paper “agreed that (it) puts forward a fresh and interesting idea but did not convince them that we could safely leave coastal protection to natural processes, except in a few fallible situations.”. In fact the author suggested a policy involving developing a strategy where resources were allocated to “areas where the needs of sea defence and coast protection were paramount, provides opportunities for ‘soft’ engineering and increases the size of the zone in which the natural sea defences can operate.”. The paper was published as a ‘Viewpoint’ article in the *Aquatic Conservation Journal* (Doody 1992).

The understanding derived from this author’s experience and expressed in the paper referred to above

relates back directly to the situation in the Wash. In its turn this led to the work undertaken on the salt marshes along the Essex coast commissioned by the JNCC (Burd 1992). In this context it is also instructive to read part of the final report of the Royal Commission on Coastal Erosion 1911:

“The rate of erosion varies with the geological formation of the coast, but is most marked along the east and south coasts of England. On the other hand there have been considerable gains, particularly in the mouth of the Humber and the Wash. Natural protection is afforded to the coast by the foreshore and beach material produced by erosion and it is essential that such material should not be removed. In some places erosion has been aggravated by the erection of defences of the wrong type. The Central Authority, aided by scientific experts, should make systematic observations of coastal changes. In late years the gains had generally outweighed losses, but this took no account of the value of the property, especially as many accretions were below high-water level. There had been some serious losses calling for effective measures of prevention. The cost of protecting purely agricultural land will usually exceed the value of the land and such works should be undertaken only when they preserve a considerable area of low-lying land.

Some of the messages contained in this report are no less relevant today.

The European Union coastal erosion project (EUErosion; see <http://www.euroasion.org/>.) provides a

comprehensive review of the current situation in Europe. Analysis of 60 case studies showed that coastal defence has relied on hard engineering structures up to the end of the 1990s. However, their 'life-expectancy' was found to be very variable, from three to ten years, and has in many cases shifted erosion problems to other adjacent locations. The review also showed that traditional engineering techniques have increasingly been replaced by 'softer' options. These include techniques such as artificial beach nourishment and sedimentary by-passing. Four policy recommendations are included in the final draft report:

1. Increase coastal resilience by restoring the sediment balance and providing space for coastal processes;
2. Internalize coastal erosion cost and risk in planning and investment decisions;
3. Make responses to coastal erosion accountable
4. Strengthen the knowledge base of coastal erosion management and planning.

In the context of this paper the first of these is probably the most significant. It clearly links the role of sedimentary systems with sea defence capability and the need to allow space for the necessary coastal processes to operate. It remains to be seen whether the trend towards



Fig. 5. A 'field scale' re-alignment along the Freiston Shore on the Wash. See <http://www.thebostonwashbanks.com/> for further information.

abandonment of land to the sea becomes acceptable as a more effective means of sea defence especially in areas of rising sea level. The evidence from elsewhere in Europe suggests that there is an increasing realization that if current trends continue many areas will be lost or increasingly rendered uninhabitable. It is probably better to plan for this by strategic retreat rather than continue the battle with the sea.

Fig. 5 shows an example of a restoration scheme, at Freiston in the Wash. The total area of saltmarsh and mud flat that will be 'reclaimed' from the sea through 're-alignment' is 78 ha. It is perhaps appropriate that this area, which was the last enclosure of saltmarsh on the Wash should be one of the first 'managed re-alignment' along this shoreline.

In the relatively short space of 20 years we have moved from a position where maintaining the existing line of defence was a first priority to one where it is only one of a number of options. Today not only has the enclosure of tidal land for agriculture ceased in areas like the Wash, but also habitat restoration and re-creation for conservation and sea defence purposes has

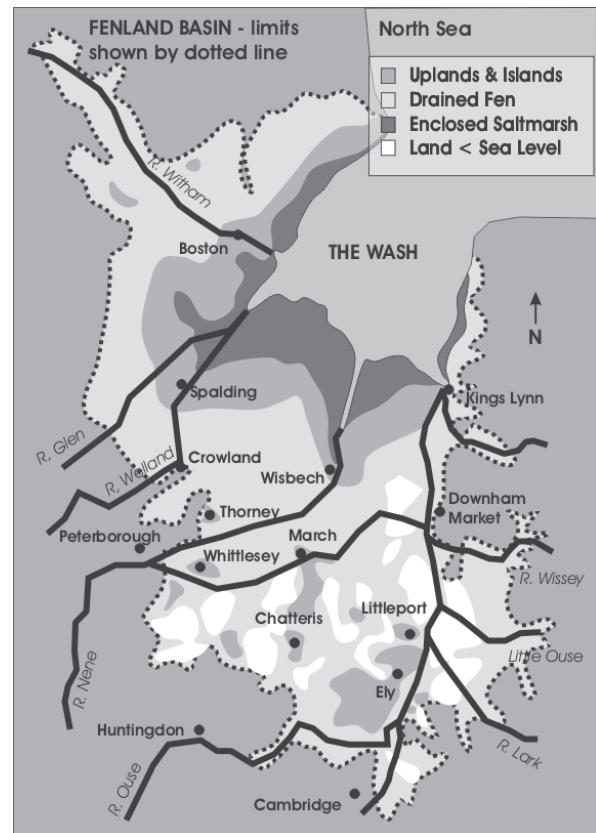


Fig. 6. The Fenland Basin showing areas of drained fen and enclosed salt marsh surrounding the Wash. The location of the Freiston shore re-alignment is shown by a star. Note the areas now lying below mean sea level.

become much more acceptable. It is significant that the above re-alignment was allied to a scheme for improving the defences along some 8 km of the shoreline either side of the scheme. Strengthening and re-aligning the sea defences in this way has provided a sustainable 1 in 200 year standard of defence helping to protect an area of 80 000 hectares of low lying fenland including Boston, scattered villages and prime agricultural land from flooding. Much of this land and property is 3 metres or more below surge tide levels.

This example is on a relatively small scale when compared with the original area of fen and tidal land to which it belongs (Fig. 6).

Comparison between the two maps shows this to be a relatively small contribution to the re-creation of the former tidal land in the Fenland Basin. Perhaps over the next 20 years we will see further 're-alignments' and eventually in 50 to 100 years time large areas of the Fenland Basin will be re-integrated with the sea.

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