

BATTLING THE TIDE

FLOOD DEFENCES IN THE ANGLIAN REGION



NRA

*National Rivers Authority
Anglian Region*

INTRODUCTION

The battle to prevent the sea from invading the flat, low-lying land around the Wash and east coast estuaries began nearly 2,000 years ago when the Romans built simple earth embankments to protect the fens they had drained.

Since then, the history of the East Anglian coastline has been punctuated - even within living memory - with the terror and loss of life caused by flooding from the sea.

Today, the Anglian Region of the National Rivers Authority spends £50m a year on maintaining, renewing



and replacing 1,000 miles of defences along the coastline between the Humber and the Thames.

Since a quarter of the region is below maximum recorded sea level, thousands of lives, and billions of pounds invested in property, land and the infrastructure, are at stake.

Over the next ten years NRA Anglian Region intends to invest £340m in new flood defences.

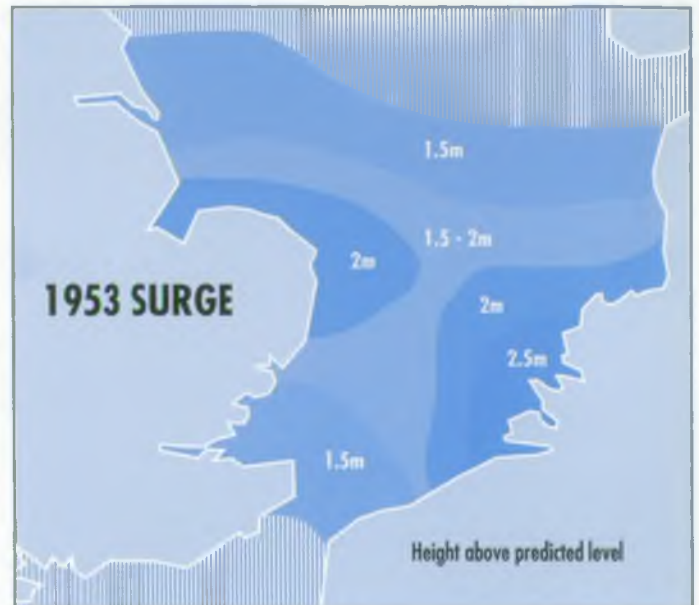
These will have to be capable of withstanding not only the potentially severe surge tides of the North Sea, but also the rise in sea level and the increase in storminess which scientists predict will result from global warming.

The danger of North Sea Surge

The phenomenon of North Sea surge occurs many times a year. Lasting for only a few hours, it is caused by low atmospheric pressure and high winds from the north which whip up a wall of water and drive it southwards.

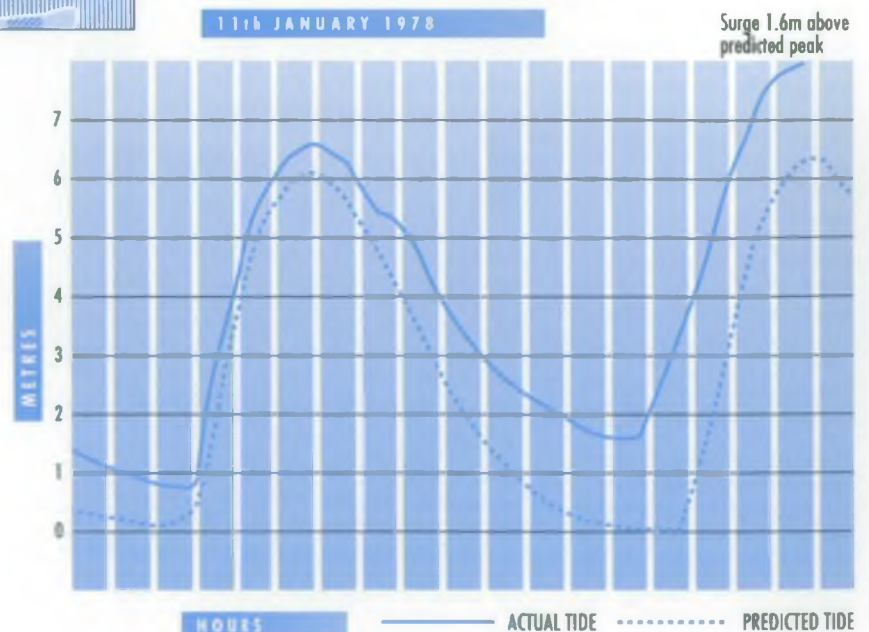
Four or five times a year the surge adds about one metre to the tide level but because it happens outside high water and bad weather there is no flooding risk.

But on January 31st 1953 the surge reached nearly 2.5 metres and coincided with an exceptionally high spring tide and freak storm conditions at sea.



Above: Surge patterns in the North Sea at the peak of the 1953 surge. A surge can become even higher as it funnels into estuaries and rivers.

Below: North Sea surges make tide levels unpredictable, as this graph, comparing predicted with actual tide levels, illustrates from the 1978 surge at Kings Lynn.





Sea walls were breached and sand dunes flattened. The surge funnelled down tidal rivers, bursting banks and flooding 150,000 acres of farmland from Lincolnshire down to Kent.

In the devastation that resulted, 300 people were drowned and thousands of farm animals perished.

In 1978 another severe surge funnelled up the Ouse and poured over the flood defences at Kings Lynn, where 15 people had died in the 1953 flood. No-one died in this second disaster, but there was extensive flooding as far inland as Wisbech, and the cost of the damage was estimated at £5.5m at Kings Lynn.

This second surge led to major improvements to the flood defences in and around Kings Lynn, which were completed in 1991.

Protecting the region against surge tides

High and spring tides can be predicted, but, as history has shown, surges in the North Sea cannot.

In planning sea and tidal defences for the region, therefore, the NRA has to assume that, at some point in the future, there will be a repeat of the severe tidal and weather conditions which caused flooding in 1953 and 1978.

Work to improve the Anglian Region's protection against unusually high surge tides is well underway.

Beach height will be raised all along the 25kms of Lincolnshire coast between Mablethorpe and Skegness. This will prolong the life of rock and concrete sea defences built or rebuilt after the 1953 sea surge, which cost 41 lives along this coastal strip alone.





The flood defences of towns along estuaries vulnerable to surge are also being reviewed and improved.

At Burnham on the River Crouch in Essex, for example, the sea wall and earth embankments either side of the town have been raised by 300mm to give the local community protection against a surge level which might only occur once every 250 years.

On Suffolk's River Deben the NRA has raised the Woodbridge and Melton flood defences by 800mm - again to protect against a 1 in 250 year surge tide. Great care was taken to ensure that the new brick wall and timber clad sheet piling would blend in with the existing attractive waterfront.



Investment in surge exclusion barriers

The new £12m surge barrier across the River Colne estuary at Wivenhoe will prevent surge tides from causing flooding inland. The Colne Barrier is designed to resist tides likely to occur only once in a 1000 years, and, like the Thames barrier, it will only close when freak winds in the North Sea are likely to channel very high surges inland.

Surge barriers are particularly useful forms of sea defence because their height can be increased as time goes on, and they avoid the building of lengths of embankment. The environmental impacts of barriers are often less intrusive.

Storm tide warning service

A remarkable feature of the 1953 flood was that the surge water burst upon many of its victims unexpectedly, and for many hours the rest of Britain was unaware of the tragedy that was unfolding along the East coast from the Humber estuary in the north to Canvey Island in the south.

The East Coast Storm Tide Warning Service has been developed to provide advance warning of tidal surge conditions which could result in flooding of low lying areas. The Meteorological Office at Bracknell, Berkshire, once it has forecast weather patterns known to cause a surge tide, is responsible for issuing warnings to the NRA and the coastal police forces.

The tide is monitored at key locations and, depending upon the severity of the situation, the NRA issues Yellow (flooding possible), Amber (flooding likely) or Red



(serious flooding likely) warnings to the police, who may then decide to issue a public warning and sound the sirens installed in vulnerable coastal areas.

Global warming and rise in sea level

Records show that in the last 100 years the sea level around the East Anglian coastline has risen by an average of 150mm.

Environmental scientists warn that sea levels will rise much faster as global warming melts the polar ice caps and causes oceans to expand.

According to generally accepted scientific opinion, the North Sea could rise by 700 mm during the next century.

Although definite proof of global warming and its effects on sea level may not emerge for another 10 or 20 years, the NRA is taking the precaution of adding an additional 350 mm to the height of new sea defence schemes, to take account of the predicted rise in sea level over the next 50 years.



Working with nature

The NRA has adopted a strategy for flood defence in the Anglian Region which is based on the principle of understanding and working with nature rather than against it.

A continuous coastal study costing £250,000 a year has been established to monitor changes in the region's coastline and estuaries and analyse the effects of tides, currents, weather and wave action.

The monitoring programme - which includes aerial surveys - is designed to detect, and discover the causes of changes such as beach steepening, the formation of off-shore banks, and the movement of sediment and shingle around the coastline.

These detailed records, which are stored in the NRA's computerised Shoreline Management System, will make it possible to predict the effects of specific weather and tidal conditions so that sea defences can be planned accordingly.

As time passes, patterns of change are expected to emerge from the monitoring process, and these will give an early indication of the effect of global warming on sea levels.

The database also provides the NRA with the information it needs to abandon the piecemeal approach of the past, and develop long-term strategic solutions to the region's flood defence problem.

The NRA's engineers are already using the database to evaluate the effectiveness and value for money of 'soft' engineering solutions such as beach profiling and off-shore breakwaters, which are more sympathetic to the environment than the concrete and steel structures so heavily relied upon in the past.

The region's open landscape, its numerous Sites of Special Scientific Interest, bird reserves, Heritage Coast and historic towns make the coastline particularly worthy of special attention to the environmental effects of sea defence schemes.





Conservation organisations such as English Nature, the Countryside Commission, and the Royal Society for the Protection of Birds are therefore closely involved in the public consultation process which precedes the implementation of any new sea or tidal defence project. All projects are assessed environmentally and in many cases a detailed environmental statement prepared.

A 'softer' approach to sea defence

Wherever possible, the NRA is softening the look of sea and tidal defences by designing cost-effective and environmentally acceptable alternatives to the concrete sea walls which have become all too commonplace in east coast seaside towns.

Beach recharge

The NRA's success in recharging the 7kms of beach between Hunstanton and Snettisham on the north Norfolk coast has shown that returning beaches to their original appearance is a cost-effective way of protecting the shoreline. In this project, which cost £5m, vast quantities of shingle and sand were transported from the Humber to the Wash to replace beach material which had been washed away by tidal currents.



The raised height of the beach will protect and prolong the life of the 'hard' (concrete) defences and the natural shingle ridge along the Hunstanton and Heacham sea front. Left alone the beach would become severely depleted again within about 60 years, but even when maintenance costs are taken into account, the beach recharge technique involves a fraction of the cost of less visually pleasing concrete sea walls.

Rock groynes

£11m has been spent on improving sea defences at Clacton on the Essex coast. The project, completed in 1988, involved rebuilding the sea wall at Jaywick and rebuilding the natural beach. Three large rock-armoured breakwaters, costing £1.5m each, were built to absorb wave power and thus protect the imported beach material from erosion. The scheme protects more than 2,000 houses, holiday chalets and caravans from the surge tide flooding which might otherwise occur once in 1,000 years.

Off-shore reefs

On the East Norfolk coast between Happisburgh and Winterton, the NRA has found a long-term solution to the drift of sand and shingle southwards and out onto the



North Sea shingle banks. Lost beach material is being replaced, and, in order to retain it on the foreshore, 16 off-shore reefs will be built. These will help to change the wave patterns which would otherwise eventually reduce the beach to mud flats leaving the sea walls and sand dunes at the mercy of the waves. If this was allowed to happen the defences would be undermined and the sea would flood into the Norfolk Broads.

Rock armour protection

At Aldeburgh on the Suffolk coast the NRA arrived at the most cost-effective design for the town's new sea defences by developing a computer-based beach model which was used to demonstrate the likely performance of various options. Once the best solution became apparent, a physical model of the proposed design was built and successfully tested.



The outcome is a partially rebuilt sea wall, strengthened by rock armour and protected by a sloping shingle bank. The project, which involved replacing beach material lost to tidal erosion, cost £5m.

Tidal defences inland

The NRA is constantly reviewing flood defences along the banks of the tidal rivers in the Anglian region

Repairs and improvements have to counteract a general rise in water levels, deterioration and settlement of the banks, and problems caused by poor access.

The NRA is investigating the cost and viability of several options for the Broadland area, where, in some places, flooding is an annual event. These include raising the flood banks, using washlands to hold water at times of flood, and building barriers across the Bure and the Yare.

Along the tidal Ouse Washes the NRA is raising the entire length of the Middle Level Barrier Bank north of Earith, and strengthening the parallel South Level Barrier Bank. The £25m project is designed to prevent a repeat of the



floods of 1947 when water from melting snow burst the flood banks in the Fens, and 37,000 acres went under water.

The armoury of defence

There is no single solution to the constant battle against the sea. There is no single method of defence. The armoury of methods available to the NRA includes:

TECHNIQUE	COST
Earth embankments - to build - to heighten	£2,000 - £3,000/metre £1,000/metre
Rvetments - subject to wave attack - in exposed areas where steel sheet piling has to be used	£800/metre £2,000/metre
Rebuilding beaches - 'soft' engineering	£800 - £2,000/metre
Rock groynes - imported rocks are between five and eight tonnes each	£1.5m per groyne
Concrete sea wall - with promenade and wave wall - stepwork repair	£7,000/metre £1,000 - £2,000/metre
Rock toe work - to reduce wave energy	£1,000/metre
Dune protection - stabilising using brushwood	£30 - £40/metre

The National Rivers Authority

Guardians of the Water Environment

The National Rivers Authority is responsible for a wide range of regulatory and statutory duties connected with the water environment.

Created in 1989 under the Water Act it comprises a national policy body coordinating the activities of 10 regional groups each one mirroring an area served by a former regional water authority.

The main functions of the NRA are:

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| Water resources | — The planning of resources to meet the water needs of the country; licensing companies, organisations and individuals to abstract water and monitoring the licences. |
| Environmental quality and Pollution Control | — maintaining and improving water quality in rivers, estuaries and coastal seas; granting consents for discharges to the water environment; monitoring water quality; pollution control. |
| Flood defence | — the general supervision of flood defences; the carrying out of works on main rivers and sea defences. |
| Fisheries | — the maintenance, improvement and development of fisheries in inland waters including licensing, re-stocking and enforcement functions. |
| Conservation | — furthering the conservation of the water environment and protecting its amenity. |
| Navigation and Recreation | — navigation responsibilities in three regions — Anglian, Southern and Thames and the provision and maintenance of recreational facilities on rivers and waters under its control. |

ENVIRONMENT AGENCY



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