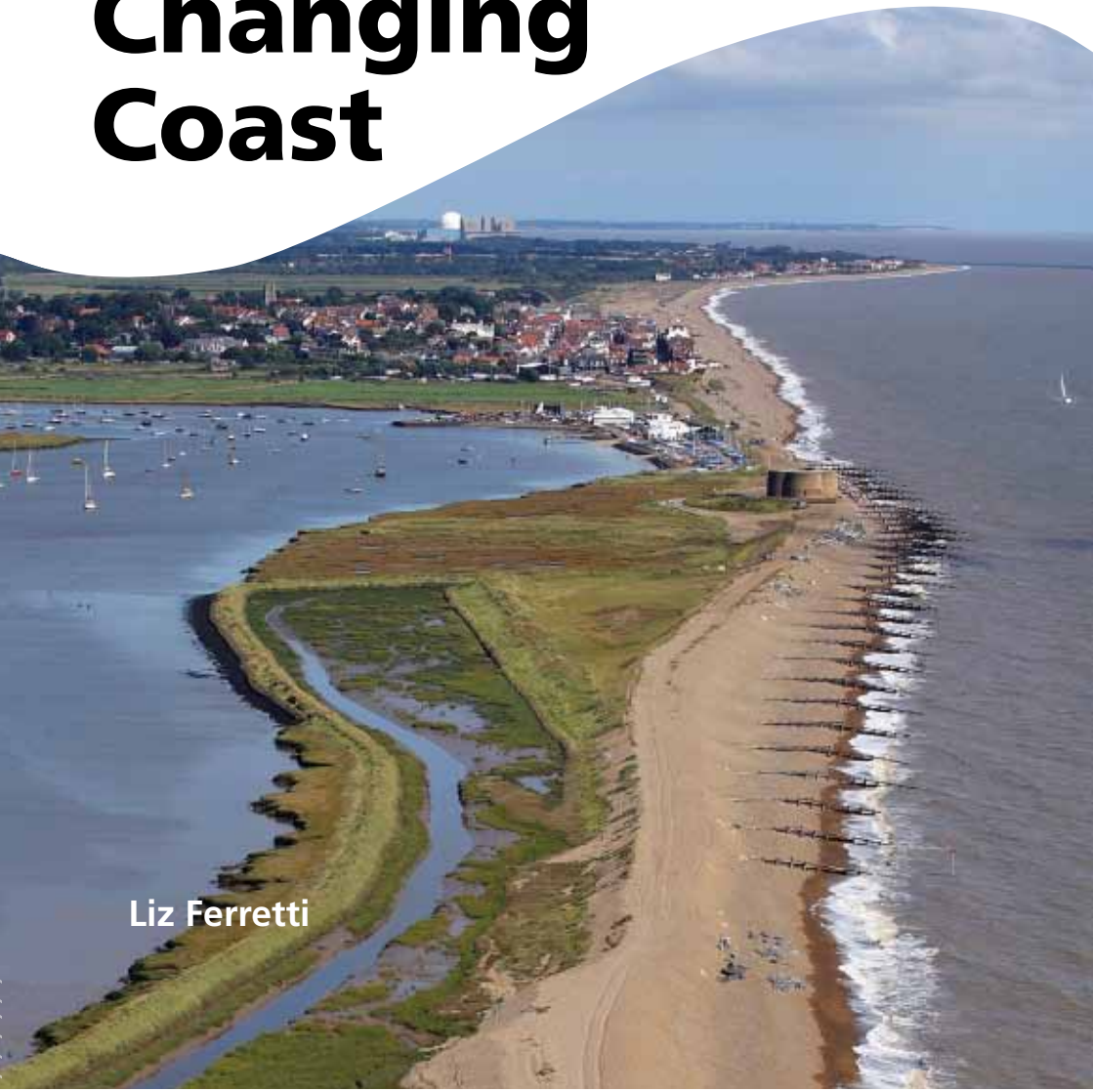
Suffolk's Changing Coast



Liz Ferretti

Touching the Tide

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Suffolk Coast & Heaths

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Disclaimer: It is important to note that while I have been careful with my research, opinions expressed in this booklet are those of the author and do not necessarily represent those of the Suffolk Coast & Heaths AONB or of the people mentioned in this booklet.

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Touching the Tide

Touching the Tide (TtT) is a Heritage Lottery Fund Landscape Partnership Scheme for the Suffolk coast, covering the area between Covehithe and Felixstowe. It aims to conserve and celebrate the heritage of the coast and to increase understanding of coastal change.

Full details of the Partnership, and of all TtT's work, are on the website at www.touchingthetide.org.uk. The Scheme is hosted by the Suffolk Coast & Heaths Area of Outstanding Natural Beauty (AONB) and Suffolk County Council.

Front cover photo:
Northern end of Orford Ness showing Slaughden, Aldeburgh and with Sizewell nuclear power station in the distance. © Mike Page

1. Orford Ness from Shingle Street. © Chris Allen

2. Covehithe. © Glyn Collins

3. Felixstowe seafront. © Peter Stokes

4. Rolo at Aldeburgh. © Melanie Smith

5. Felixstowe seafront. © Peter Stokes

6. View across the Alde. © Michael Bird

INTRODUCTION

The Suffolk Coast can seem timeless with its soft, yellow cliffs and banks of shingle washed by the silty North Sea. The county's estuaries are the habitat of oystercatchers, avocet and curlew. Here, boats sail narrow channels through mudflats and saltmarsh (known as saltings in Essex and Suffolk), and walkers are silhouetted against the sky on river walls.

It's an attractive picture, but that sense of timelessness is an illusion. In fact, Suffolk has a dynamic coast, with change measured over centuries, years and even on a daily basis. The rate and implications of these changes may not be immediately obvious as you trudge through the shingle on a weekend walk, but we are at a point where change has the potential to affect Suffolk's coast and estuaries significantly.

There are two main issues. The first is rising sea levels, currently around 4 mm per year in this part of England. Around 1.5 mm of this is due to isostatic rebound (explained on page 24) ongoing since the end of the last ice age, with the rest caused by melting ice sheets and glaciers, and thermal expansion – the results of changes to the planet caused by human activity. The second issue is a trend for more frequent and more intense storms – also linked to changes in weather patterns resulting from climate change.

New ways of managing sea-level rise and increasing storminess are being put into practice along soft coasts all around Europe. There's growing emphasis on trying a combination of approaches and working with natural processes, challenging the assumption that the only way to protect the coast is to keep the sea out.

Shingle Street. © Justin Minns

Boats on the Alde. © Justin Minns

I am a writer with a strong interest in Suffolk's changing coast, where I have lived for over two decades. This brief introduction has been commissioned from me by Touching the Tide – a three-year Landscape Partnership Scheme funded by the Heritage Lottery Fund. Touching the Tide aims to encourage people to explore the Suffolk coast and as a result to understand it better; this booklet is part of that aim. During my research, I have spoken to people from many disciplines and perspectives, all linked by a common interest in coastal Suffolk. Through their stories and expertise I hope you will gain a better understanding of the interaction between the land and the sea, and the thousands of years of human history here.

Water Rail, which lives in freshwater wetlands.
Photo Jon Evans, courtesy RSPB

BENACRE

I began my research just south of Kessingland in north Suffolk, on the Benacre Estate, which owns 6 km of Suffolk's 80 km coast. My trip there was a stark introduction to the realities of coastal change.

Edward Vere Nicoll runs the Benacre Estate with members of his family and a staff of over 45. It is clear he cares deeply about this area and that managing a section of eroding coastline is challenging and frustrating.

We drove along a farm track past low-lying grazing marsh, towards Benacre Pumping Station on the Kessingland Levels. It had been a dry autumn and the fields were still dotted with grazing cattle. After the gate, the track became a concrete road which rose sharply to the top of an area of sand dunes called The Denes. On the left was the still water of the Hundred River, fringed with reeds, ending in a metal conduit and the Benacre Pumping Station. The Hundred River runs at or below sea level and would not drain naturally – this pumping station prevents 500 acres of grazing from flooding, and helps protect houses in south Kessingland and a holiday caravan site.

When we visited in autumn 2015, there was almost no beach in front of the station. There were grey-green blocks of granite instead, protecting the narrow strip of dunes that still remain between the pumping station and the sea. The images below also help us to imagine what changes this section of coast has been through still further back in time.

Benacre Sluice pumping station, rock armour visible on the seaward side. © Mike Page

The pumping station was built in the 1950s and, on this rapidly eroding coast, always had a limited lifespan. However, during the last half of 2010 rates of erosion increased. That put the pumping station under threat sooner than anticipated and created a health and safety problem which needed to be resolved. In 2011, the Environment Agency (the EA) reused granite blocks, originally brought in during the 1990s, to create a new defence in front of the pumping station. The aim was to keep the sluice working "for years to come"[1]. However, less than two years later, during the night of 5 and 6 of December 2013, a tidal surge hit the east coast of England.

"This estate loses several acres of land to erosion every year, but storms and surges are becoming our biggest concern," Edward Vere Nicoll told me as we walked to an area of slumped cliff where the granite blocks end.

"We've seen storms and tidal surges remove in one night an area of beach that everyone thought would last months or even years," he explained. And this is what happened that night in December 2013.

Following the 2013 tidal surge, the EA added more granite blocks in early 2014. This hard defence has halted erosion of the dunes in front of the pumping station, but does not completely absorb the energy of the sea, which is forced to wash north and south. As a result, erosion increased either end of the 'rock armour', particularly to the south. In 2015, the rock armour was extended again, to stabilise the dunes until a decision can be made about the long-term future of the Kessingland Levels.

Benacre looking north to Kessingland and Lowestoft in 2003. © Mike Page

[1] http://waterbriefing.org/home/water-issues/item/3896-environment-agency-to carry-out-£395k-urgent-work-on-benacre-flume

Benacre Broad in 2015 – the shingle bar at the mouth periodically breaches and then re-forms. The Broad is a silted-up ancient river valley which is becoming smaller as the bar rolls back with the retreating coastline. In 150 years or so it will probably be gone. © Mike Page

Decisions on coast and estuary management, like those at Benacre, are complex. Conflicting needs and requirements, as well as funding issues, can make them very difficult. In England and Wales, the EA are generally responsible for coasts where sea flooding is the main risk; maritime local authorities have powers over erodable coasts. The EA commissions reports by coastal engineers, provides expert advice, carries out flood defence work and has the overview of how coasts and estuaries are managed. Decisions also involve a wide range of government and non-government organisations, as well as landowners, and have to be made in accordance with a range of legislation.

The Shoreline Management Plan

Lying behind decisions on coastal management in England and Wales is the Shoreline Management Plan , known as the SMP. This document describes the coast, looks at risks to coastal areas over the short, medium and long term, and sets out the 'intent of management'.

These are divided into three main options: 'hold the line', 'managed realignment' (discussed in more detail through this booklet) and 'no active intervention'. Where a coast changes as frequently as it does in Suffolk, this document needs periodic updating.

Following the December 2013 surge, the EA commissioned a report on the state of the defences and coast at Benacre[2]. This report sets out options and estimated costs, which include moving the sluice inland by varying amounts, and/or building new sea walls inland to protect buildings and the A12.

Although by the time you read this a decision may well have been made at Benacre Pumping Station, the problems there are not unique. They provide a good example of the kind of issues that face many locations on this coast in the short or longer term. As I left, Edward Vere Nicoll expressed concern about the future of the pumping station and the land behind it. There appears to be no easy solution and negotiations are bound to be tough for everyone involved.

WWII pillbox on the beach at East Lane, Bawdsey. © Suffolk Archaeology

Covehithe church. © SC&H

[2] *Benacre Pumping Station High Level Options Appraisal*, published November 2015, prepared for the Environment Agency by engineering consultants, CH2M Hill

I later learned that the Hundred River up to the 'Latymere Dam' inland of the A12 was once tidal, used by Vikings and presumably the Saxons before them, to anchor their boats. Judging by what has happened on other parts of this coast, it is likely that the mouth of the Hundred River was gradually blocked with shingle and the river silted up. At some point in the Middle Ages, the river was enclosed from the sea ('reclaimed') to create the grazing land we see today.

Erosion and Archaeology

The evocative Covehithe church is part of the Benacre Estate. If current rates of erosion continue, then within the next fifty years the cliffs may be getting close to it. From an archaeological point of view, Suffolk's eroding cliffs act as interesting time capsules. As they 'move' inland, they are revealing military buildings and equipment from both world wars. Pill boxes in particular are good markers of erosion as they fall down the cliffs more or less intact and then appear to move out into the sea – though of course it's the land that's being washed away, the pill boxes remain roughly where they were built. At Covehithe, medieval well shafts with domestic artefacts in them were revealed through erosion and then destroyed with the next high tide, as the erosion front 'moved through' an entire medieval settlement. Some of the artefacts were recovered in time and are at Lowestoft Museum at Oulton Broad.

DUNWICH

Recent excavations at Dunwich have found evidence of human occupation going back thousands of years, but the coast has eroded rapidly here so charting the fate of this place accurately is difficult. What we do know is that the current beach is well over a mile further inland than it was when the Romans were here, when a natural inlet provided shelter for their boats. You can, however, get some sense of the volume of land that the sea has washed away if you stand on the beach at Dunwich and look north along the bay to Southwold. Once you find Southwold's white lighthouse, you will need to imagine a point even further east, out into the sea. That is about where the coast was two thousand years ago.

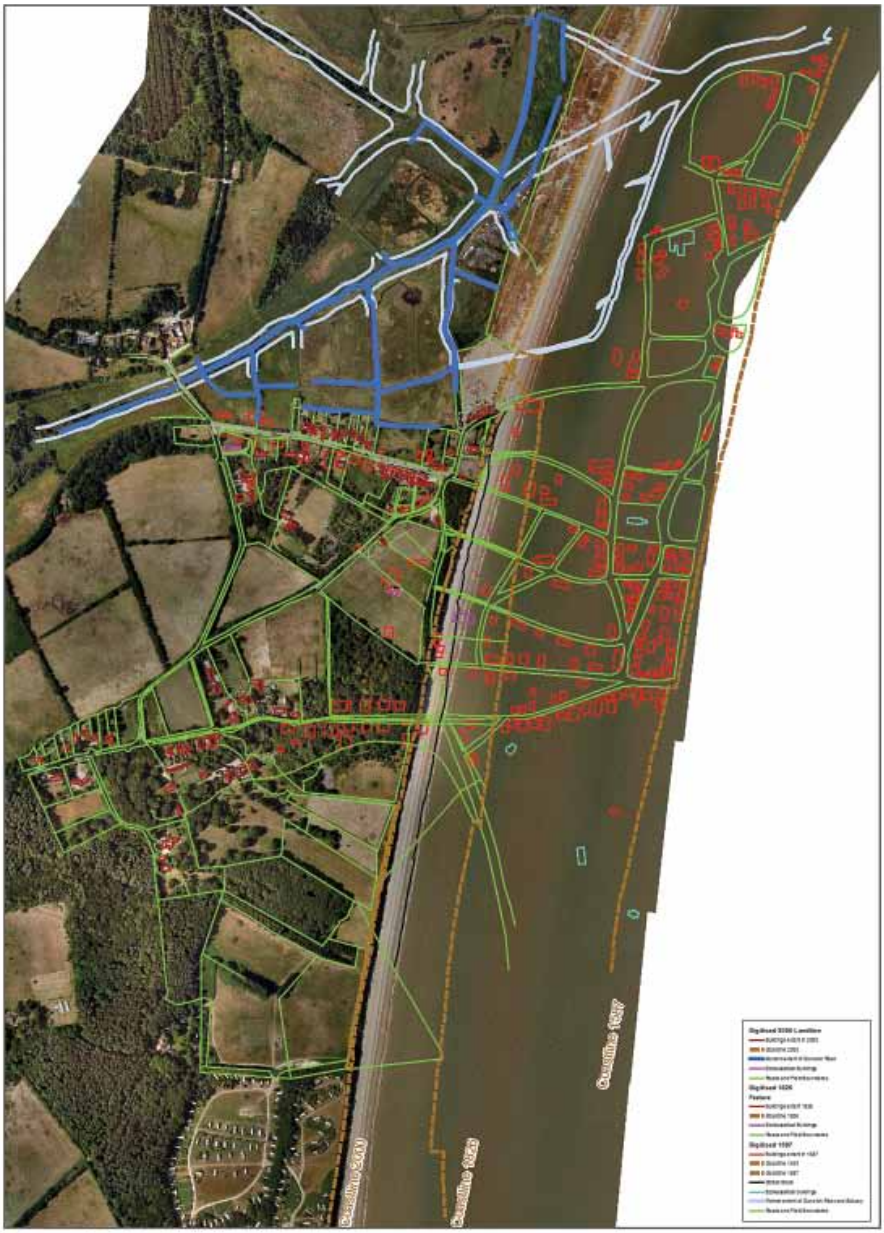
Erosion has always been a feature of Dunwich; the Domesday book mentions the loss of half of the town's farmland. In spite of this, medieval Dunwich grew and prospered. It was made a free burgh by King John in 1199 (for which privilege the town paid over a hundred pounds and more than two thousand smoked 'red' herring), it had six churches, three monasteries and at its peak 4000 inhabitants, making it an important medieval city[3]. For centuries a large shingle spit, similar to today's Orford Ness to the south, had 'grown' south from Southwold towards Dunwich. This spit, called King's Holme, created a safe harbour and it was this harbour that made Dunwich rich.

The people of Dunwich had always been aware of erosion. They used brushwood bundles to protect the base of their cliffs and later built a sea wall to protect the lower part of the town from flooding, but at the start of the thirteenth century, the town's fortunes began to change. The shingle spit kept 'growing' southwards, making the entrance to the harbour increasingly narrow and shallow, and then, in the late 1280s and early 1300s, a series of surges and storms devastated the North Sea coasts of England and Holland.

On the night of 1 January 1286, a powerful storm surge began (similar to that of 1953). At least a third of Dunwich was washed away in that three-day surge, and many dozens of people were likely drowned. During the storm, the spit shifted south, sealing off the harbour mouth, and the sea broke through the northern end of the spit, giving Southwold the harbour that Dunwich had now lost and sealing the town's economic fate.

Right: 1587 map of Dunwich overlaid on 2006 aerial photography, showing the lost streets and estuary.

[3]*Men of Dunwich: the Story of a vanished town,* by Rowland Parker, is a lively account of medieval Dunwich.



Dunwich 2000 Landline, Digitised 1826,
Digitised 1587 overlaid ontop of 2006 Aerial Photography

Above: Contemporary picture of the Burchardi flood (also known as the second Grote Mandrenke – the second "Great Drowning of Men") was a storm tide that struck the North Sea coast of North Frisia and Dithmarschen on the night between 11 and 12 October 1634. (*Die erschreckliche Wasser-Fluth* = "the terrible water flood").
Source Wikimedia Commons

Dunwich All Saints 1913.
Image courtesy of Dunwich Museum

For a while after that storm the men of Dunwich tried to keep a channel open to their harbour, but it must soon have appeared hopeless. The Great Storm of 1286 was followed by two more storms at the start and end of 1287 (for example, the St Lucia's Flood in December is recorded as causing the deaths of fifty to eighty thousand people in Holland). We get the first evidence of empty properties in Dunwich around this time. There were more storms through the early 1300s, then the Black Death arrived in 1349, killing an estimated half of Suffolk's people.

Tidal Surges

The tides along the Suffolk coast flood southwards from Scottish waters, where the North Sea is over 200 miles wide. They flow towards the Straits of Dover, where the sea narrows to about 20 miles, and then ebb back northwards to the North Atlantic and the Arctic Ocean. This normal course of events is primarily due to the moon's gravitational pull and is predictable

Tidal surges are not unusual. They happen when atmospheric pressure forces water from an area of high pressure towards an area of low pressure; water levels can increase by up to three or four metres as a result.

Tidal surges rarely cause problems if they coincide with mid or low tide. They do become a problem, however, when they coincide with the top of the tide. The situation is worsened when a surge further coincides with a strong or storm-force northerly wind, as it did during January 1286, but on the other hand is lessened if there is a strong westerly wind, for example.

It is worth noting that the tidal surge of December 2013 did not coincide with high tide, and there was no accompanying storm – the flooding and damage it caused would have been much worse if it had.

Dingle Marshes, between Dunwich and Walberswick, after the December 2013 tidal surge.

THORPENESS

It doesn't take long to work out that there's something unique about the coastal village of Thorpeness. There are rows of mock Tudor and quaint, black clapboard houses, a country club and a five-storey House in the Clouds built to disguise a huge water tower, visible for miles. At the centre of it all is a shallow boating lake, the design of which was inspired by J.M. Barrie's *Peter Pan*.

Dating from the 1910s and 20s, Thorpeness is believed to be the world's first purpose-built holiday village, the brainchild of Scottish barrister Glencairn Stuart Ogilvie, a friend of Barrie's, who had made his money building railways around the world.

The ness (from old Norse nes or nose) of Thorpeness is just to the north of the village. Thanks to a layer of coralline crag (a sandy limestone full of fossil shells) which protrudes as a series of ridges north and east under the sea bed, this ness is a relative hard point on this eroding coastline.

Coastal erosion at Thorpeness appears to go in 30-year cycles. It is thought that the location of mobile offshore sandbanks opposite Sizewell and Dunwich have a significant influence on how and where the erosion occurs. We also know that strong and prolonged easterly or north-easterly winds have a significant impact.

If you look on the beach today you will see wire cages (or gabions) filled with flints to protect the most northerly houses of the village of Thorpeness. Between 2010 and 2013 there was significant erosion and two phases of geotextile (fabric bags) have been installed to help protect the gabions, at reasonable cost – partly financed by local residents, as well as by local and national tax payers. However, this is not a permanent solution and discussions are taking place about how to manage this section of coastline in the future.

One of the biggest challenges to planning for and predicting erosion on the coast is to understand how sand banks change shape under the sea. A new technique is being applied at Thorpeness by the National Oceanography Centre and Bournemouth University, which can interpret the shape of the sea bed from the pattern of the waves. Early results of this research indicate that the seabed here is highly dynamic. Further study should help researchers to understand better how the changing underwater landscape affects the shore.

Thorpeness coast defences, 2013. © SC&H

Thorpeness from the sea, "House in the Clouds" can be seen top right. © Mike Page

SLAUGHDEN

To the south of Aldeburgh on the shingle spit called Orford Ness – the narrow strip of land that divides the sea from the Alde & Ore estuary behind it – was another of Suffolk's lost villages. Since at least 1500, the village of Slaughden had an inn, a small farm and houses. There was a thriving ship building industry, fishing, and tithes were collected from ships moored at a quay in the river. Sir Francis Drake's ship The Pelican (later renamed The Golden Hind), which circumnavigated the world, was built here in 1576. Over the centuries, the land that Slaughden was built on was eroded. The last residents moved away after a severe storm in the late 1920s left shingle almost up to the second floor of their home. The remaining boat builder's yard was destroyed in the floods of 1953.

There have been minor breaches by the sea of the shingle ridge at Slaughden before, but there is a concern that a major breach – separating Orford Ness from Aldeburgh – would cause significant knock-on effects to the estuary. In order to help protect this vulnerable point, over the past few decades, the EA has carried out 'beach recycling' during September and October. Shingle from Sudbourne beach (around 4 km to the south of the Martello Tower), which is moved there naturally by coastal processes, is collected by EA contractors and re-deposited on the beach near the Tower.

In spring 2016, the EA also imported rock from Brittany to protect the sea-wall piling to the north of the Martello Tower when shingle levels (which can vary considerably over a season) are particularly low.

Beach replenishment will continue for now, but it is not clear how long this solution will be cost effective and/or environmentally acceptable. A number of other possible solutions have been proposed. One of the most recent ideas is for a beach recharge on a huge scale first devised in Holland – the Sand Engine, or as it might be at Slaughden, a Shingle Engine (see box).

Sand Engine

In the south of Holland, 21 million cubic metres of sand have been added to a coast facing the same challenges of sea-level rise and storms as Suffolk. This has created a new, hook-shaped beach. Over a period of decades, the sand on this beach will be moved along the Dutch coast by natural coastal processes. The material that 'washes' north and south from this artificial beach effectively protects the existing coast[4]. This type of coastal defence is known as a Sand Engine (Zandmotor in Dutch).

There is interest in the UK in this type of project, but it is a very new idea. It will need to be thoroughly tested and modelled before it is clear whether a sand, or rather shingle, engine is an affordable and effective option for the Suffolk coast. It's worth noting that there are significant differences between the Dutch and Suffolk coasts. An innovative project that works in Holland might not work here.

Zandmotor construction, April 2011. © Photo Jurriaan Brobbel, courtesy Rijkswaterstaat

Zandmotor looking south, March 2013. © Photo Jurriaan Brobbel, courtesy Rijkswaterstaat

[4]There are two short films on YouTube which explain how the Dutch 'Sand Motor' works. Go to YouTube and search for *Sand Motor in the Netherlands,* and *The Sand Motor Virtual Tour*. You can find out more about sand engines at (p. 34 and following): http://www.greensuffolk.org/assets/Greenest-County/Water--Coast/Suffolk-Coast-Forum/Full-Workshop-Presentationfor-distribution.pdf

ORFORD AND ORFORD NESS

Orford Ness is an internationally important area of vegetated shingle – a globally rare habitat. This fragile place is home to specialised plants such as yellow horned poppy, sea pea and sea kale which are adapted to the virtually soil-less, salty, hot and dry conditions.

Standing on the seaward edge of Orford Ness today is what will almost certainly be the last lighthouse on this part of the coast. Built in 1792, it is the tallest and strongest of nine other lights built over several centuries on the eastern bulge of Orford Ness – the largest area of vegetated shingle in the Northern Hemisphere.

The fate of the current lighthouse, like those of its predecessors, has been sealed by erosion. Orfordness lighthouse was decommissioned by Trinity House in 2013. The red-and-white tower, still an important daytime landmark for fishermen and sailors, now stands a few metres from the sea edge, and it is not certain how long it will remain standing. Its function has now been taken over by GPS, navigational buoys and a more powerful beam from Southwold lighthouse.

When Henry II chose Orford as the site for his castle in 1165, the tip of Orford Ness likely sat no further than the southern end of Havergate Island. Judging by later maps and records, Orford provided a haven for the ships and boats that plied the east coast over several hundred years. As at Dunwich, however, the spit that created a safe anchorage kept on 'growing' in a southerly direction as the sea moved shingle along the coast. Through the interaction of sea and sediment, the Ness also 'moved' landward making the Ore narrower and shallower, eventually leaving an estuary entrance passable only by small boats, made trickier still by shifting shingle banks. The mouth of the estuary is now around five miles south of Orford.

Orfordness lighthouse in 2011. © Tony Pick

Orford Castle.
© English Heritage

The key map to Norden's survey, 1601. By permission of Suffolk Record Office

Longshore Drift

Waves approaching a beach at an angle push the shingle or sand on that beach up and along. When the wave washes back into the sea however it does so at right angles to the beach, taking the shortest path. The overall effect is that each wave pushes sediment along the shore.

In the past, longshore drift has tended to push sediment southwards on the Suffolk coast, but more recently drift patterns have changed. The direction is now much more variable and in any one place the movement can change from season to season, which is another reason why planning for coastal change can be so complicated. At Shingle Street, for instance, the beach has been growing rapidly as new shingle has accumulated from both north and south through the action of the waves and sea currents.

Shingle is picked up and carried by the rising tide and, with added influence from the wind and sea currents, is dumped on beaches at the top of the tide. This shingle only comes from eroding cliffs and is not pushed up from the seabed. This means that along the Suffolk coast, one person's eroding cliff is another person's beach.

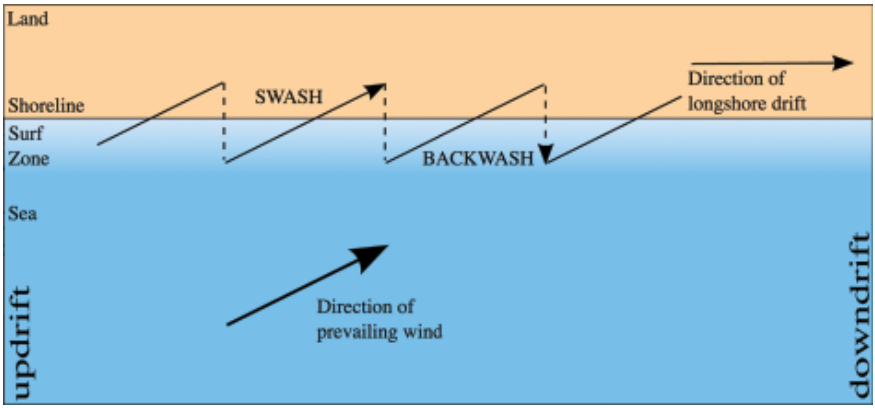


Diagram of longshore drift. Source Yefi on Wikipedia

THE BIRTH OF THE SUFFOLK COAST

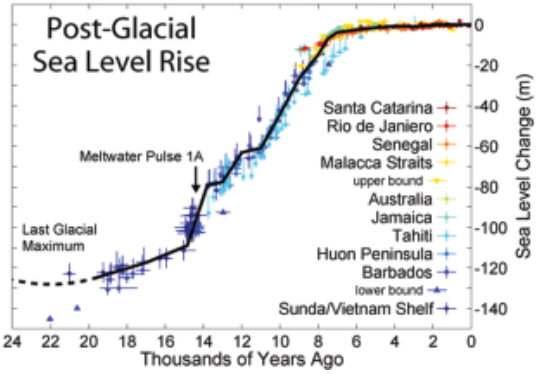
In summer, the North Sea shore is a good place to be. The gentle waves and sun on the water are very different from the choppy, grey–brown of winter. On such a summer day it's easy to forget the dramatic history of this sea, which opposite the Suffolk shore rarely gets deeper than 50 metres. In fact, you're looking at one of the younger stretches of water on our planet.

The Earth's most recent 'ice age', ended less than 12,000 years ago. As the ice melted, global sea levels rose by around 120 metres. A lot of land disappeared under this water, including the wide plain which linked England to what are now Denmark, Holland, Belgium and France.

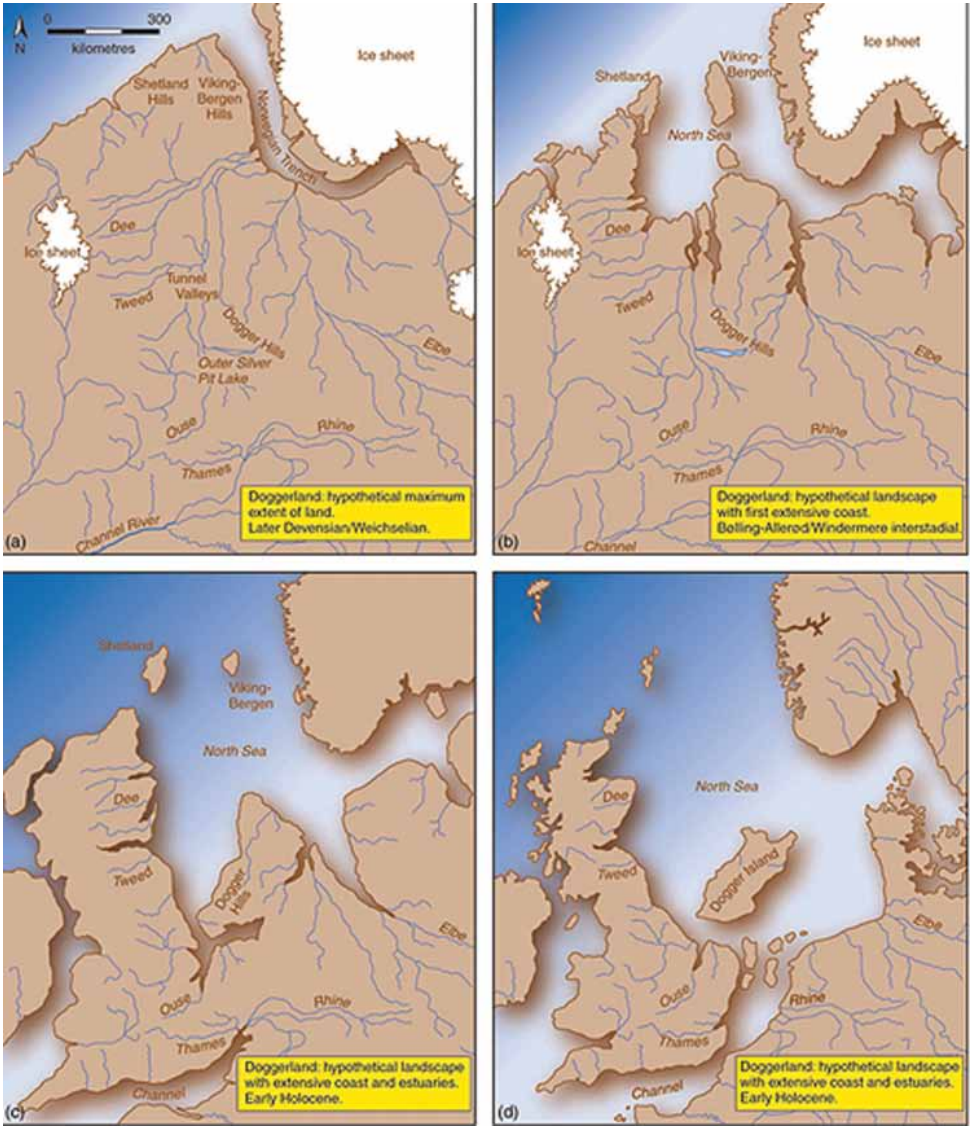
This plain, which archaeologists have named Doggerland, was once home to herds of bison, wild horses and mammoth. Their fossilised bones are dredged up in the nets of trawlers and along with them, occasionally, delicate flint tools. Later, the area became the forested heartland of Mesolithic Europe where our ancestors lived along rivers and in wetlands, harvesting fish and game.

At times following the end of the ice age, the sea rose rapidly and Doggerland became smaller. Around 8000 years ago sea levels rose by 6.5 m in less than 140 years as great ice dams in the far north of the planet burst and meltwater flowed into the ocean. Doggerland was also sinking as the Earth's crust responded to the loss of the weight of ice as it retreated north. Doggerland became an increasingly swampy area of willow and alder, reeds and eels, until there were only a few islands left.

Any life on what remained of Doggerland was almost certainly finished off by a tsunami. This tsunami was triggered by a 3500 cubic kilometre underwater landslide off Norway, known as the Storegga Slide. After that, what had been the biggest and perhaps last of the Doggerland islands became the shallows of Dogger Bank off the coast of Humberside. In modern times, the bank became one of the most productive fishing grounds in the North Sea – worked for centuries by the Dutch cod fishing boats known as *Doggers*.



This figure was prepared by Robert A. Rohde from published data, and is incorporated into the Global Warming Art Project.
Source Wikimedia Commons



Maps of possible outlines of Doggerland.
Image Drawn by Henry Buglass (after Professor Bryony Coles). Copyright North Sea Palaeolandscapes and Lost Frontiers Projects (University of Bradford)

Modern Sea-Level Rise

During the ice age, the ice on top of Scotland was hundreds of metres thick and heavy enough to affect the Earth's mantle. When the ice melted and all that weight went, the land that is now Scotland began to rise, and at the opposite end of the country, Doggerland and the south-east of England began to sink. This is known as isostatic readjustment, or rebound.

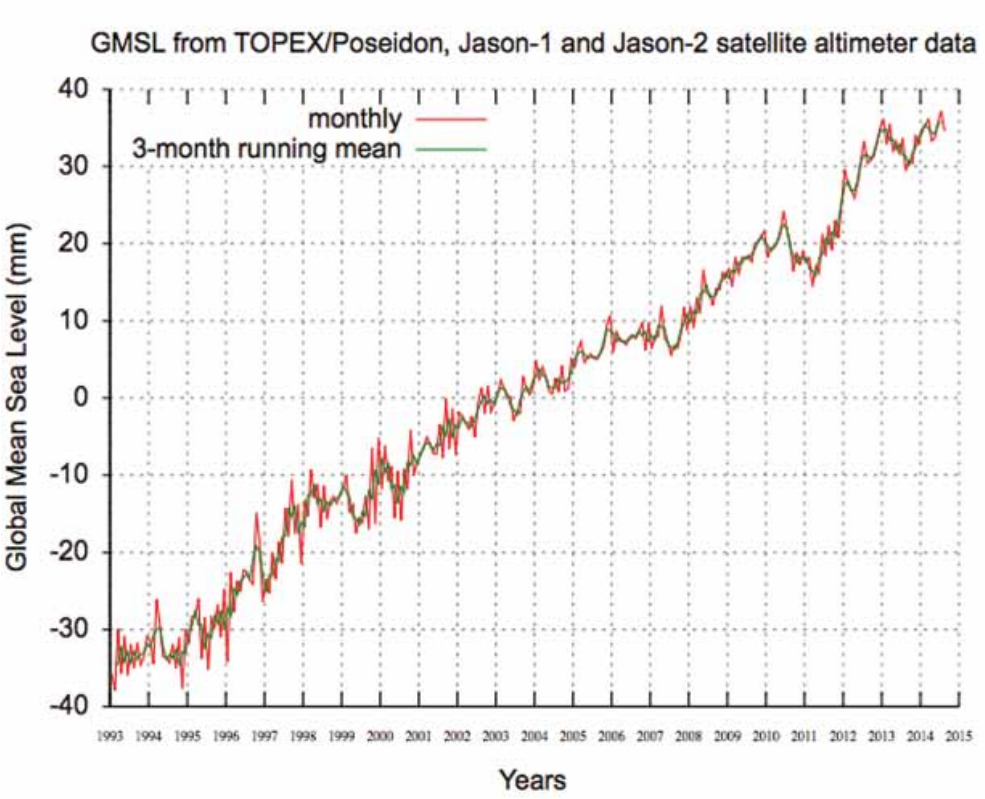
Isostatic readjustment accounts for around 1.5 mm per year of today's sea-level rise along the Suffolk Coast. In addition, ice is melting from the Greenland and Antarctic ice caps, and the ocean as a whole is undergoing thermal expansion as average ocean temperatures increase. In 2013, the IPCC (Intergovernmental Panel on Climate Change set up by the United Nations) predicted that global sea levels would rise between 93 cm and 1.94 m by 2100. Of course, as new evidence is gathered by scientists, using radar technology in satellites and tide gauges positioned around the world, these predictions may change. The most recent studies suggest predictions are more likely to increase than decrease.

Current projected sea-level rise in the East Of England[5], published by the British government, showing a cumulative rise of 1.21 metres over the next one hundred years.

1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cumulative rise 1990 to 2115 / metres (m)
4 mm (140 mm)	8.5 mm (255 mm)	12 mm (360 mm)	15 mm (450 mm)	1.21 m

Projected sea-level rise in mm per year. Cumulative sea-level rise for each time period in brackets. Based on a 1990 baseline.

[5]https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances Table 3



Global sea level since 1993. Data from Neil White of CSIRO, originally conducted via satellites TOPEX/Poseidon, Jason-1 and Jason 2.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is the federal government agency for scientific research in Australia. Source Wikimedia Commons

It can be difficult to appreciate the full effect of these changes on a coast – it helps therefore to think of the coastline as a point in time, not a fixed line on a map. As we have seen, the Suffolk coast is characterised by change and climate change is accelerating that trend.

HAZLEWOOD MARSHES

In 2013, a Touching the Tide archaeological dig at Barber's Point on Hazlewood Marshes near Aldeburgh uncovered 19 burials. The earliest and most memorable of these, dating from 550–600 AD, was that of a young pagan Saxon woman buried with a casket and a conch shell. She became known as Casket Girl.

The dig was closed by the end of that summer for the archaeologists to assess the finds. It was to be the last chance anyone would have to dig there. Until December 2013, Hazlewood Marshes, owned by Suffolk Wildlife Trust, was a freshwater grazing marsh[6].

During the surge of 2013, sea water came over the top of the river wall that runs between the marsh and the Alde & Ore estuary, and the wall was breached. In one night, Hazlewood went from freshwater marsh to intertidal habitat.

Barbers Point dig site at Hazlewood Marshes seen (bottom right) from the west in September 2013, just before the tidal surge.

[6]http://www.suffolkwildlifetrust.org/reserves/hazlewood-marshes

Looking east over Hazlewood in December 13, soon after the breach. Barbers Point is the small 'island' at the top of the picture.
© Mike Page

The last time I visited here in summer 2013, I'd walked across lumpy pasture towards a group of enthusiastic archaeologists and children scrubbing finds in the drizzle. When I returned in winter 2015, to be shown round by site manager Andrew Excell, I was unprepared for how different it looked.

The sun was low and the tide out as we arrived. Now, instead of small fields there was mud, but as we walked along a newly built-up track towards the Trust's bird hide, I began to

understand how interesting this place was. Less than two years after the surge, solitary samphire plants were growing on the mud. There was sea aster and sea purslane. Andrew Excell pointed out the artificial islands he had designed for redshank, avocet and lapwing, and wildfowl such as teal and widgeon. With careful management, this site was being transformed into a valuable wildlife reserve.

"It's a blank canvas, and that's what has captured people's imagination," Andrew Excell said. "The fifteen islands we've created should provide safe roosts and nesting sites. It's an exciting phase, we're waiting to see what will turn up."

Andrew drew my attention to the chattering song of a Cetti's Warbler, the high trill and exotic plumage of a Kingfisher flashing along a ditch. As the tide came in, there were redshank feeding along the tideline. On other days there had been hundreds of redshank and black-tailed godwits, 17 spoonbills, terns and black-headed gulls, an otter in one of the tidal ditches. In the distance, cormorants back from fishing were drying their wings in the sun. Behind them you could clearly see a number of deep breaches in the river wall, with the estuary beyond.

Andrew Excell is pleased with how his plans for this intertidal site are taking shape 18 months on. I asked him how he'd felt in the immediate aftermath of the storm surge.

Mixed shelduck including juveniles and gulls at Hazlewood, July 2015.

"My initial thoughts were very negative," he admitted, "we'd just spent time and money creating breeding areas for avocet and making other improvements. That was all lost overnight. But once the water level decreased and tides went back to normal, hundreds of birds moved in to pick out freshwater invertebrates that had been flushed out by the flood. They were having a feeding bonanza! I realised that even after the invertebrates had gone this could be a vision of the future, that this place could be utterly stunning."

The changes to this reserve have been dramatic, but it is important to remember that the freshwater Hazlewood Marshes were themselves man-made. Only a few hundred years ago the sea wall was built, the salt marsh drained and the land turned into cattle and sheep grazing. If we go back to the sixth century, when the girl with the casket lived here, Barber's Point was a low-lying island surrounded by saltmarsh.

"There had always been some uncertainty about how long we could keep Hazlewood as a freshwater site," Andrew Excell told me. "Before the winter of 2013, the Environment Agency reinforced the river wall and this should have protected the site for 25 to 30 years. However, there was no saltmarsh in front of the wall to absorb the wave energy, and the highest Spring tides already reached over half-way up it. The wall was weakened during the St Jude's storm of October 2013 and before that damage could be addressed, it was hit with the full force of the December 2013 surge."

After the wall breached and the site was flooded, the Environment Agency said it could no longer take responsibility for repair and maintenance of the wall. Suffolk Wildlife Trust had to consider what to do next. The wall was inaccessible and would cost several hundred thousand pounds to repair and maintain. In addition, there was deep uncertainty about how long any repairs to the wall might last.

In the end, with agreement from Natural England the Trust decided that the best solution for the long-term future of this wildlife reserve, and therefore the best use of its funds, was to manage it as an intertidal site. The wall would be left untouched and the tide would bring in the sediment needed to create saltmarsh.

"It wasn't easy to give up the freshwater marsh," Andrew Excell concluded, "and the decision necessitated some difficult conversations with affected adjacent landowners, but we've all found ways to adapt to the change. As a wildlife charity we're pleased that, together with Snape Marshes and Alde Mudflats, Hazlewood now provides saltmarsh habitat for wading birds which are in serious decline nationally."

Saltmarsh

Although less rare than vegetated shingle, saltmarsh is as important a habitat. Twice a day, the tide brings water, nutrients and sediment to specialist plants such as samphire, sea purslane, sea lavender, thrift and sorrel, which tolerate this salty environment. Saltmarsh is also important as a fish nursery and for invertebrates, which in turn support wading and other water fowl.

Saltmarsh is increasingly valued as a first line of defence for sea walls because it absorbs much of the energy of waves before they reach the wall itself. It is being seen as an important carbon store and is a favourite landscape for residents and visitors.

Saltmarsh establishment in former freshwater sward, July 2014. © SWT

Hazlewood Marshes after the tidal surge, view at low water to wall breach, 10 December 2013. Photo Andrew Excell, © SWT

Managed Realignment

Hazlewood is an example of *unmanaged* realignment within an estuary where new intertidal habitat for wading birds has been created following a breach in the river wall. Unmanaged realignment has had good results at Hazlewood but it can result in large areas of standing water behind breached defences if the land is very low lying. In these cases saltmarsh is unlikely to result. In order for saltmarsh to be created, tidal water needs to flow in and out slowly enough for sediment to be dropped at the top of the tide.

As of 2016, there are over 50 examples of *managed* realignment across the UK. In these projects new defences are built inland and existing defences are allowed to erode, or are breached, in a controlled way. This slows the flow of water enough for sediment to drop behind the breached defences, allowing the build-up of saltmarsh. Good examples of managed realignment are Wallasea Island, between the rivers Crouch and Roach in Essex, and Medmerry, south of Chichester on the Sussex coast, both of which are big enough projects to be significant at a European level[7].

On the open coast in Suffolk a partial realignment has been created at Easton Broad. This decision was taken because the shingle ridge that separates this freshwater broad from the sea has eroded. As a result, sea water has been coming over the top of the ridge more often.

Easton Broad is an important reedbed habitat for the endangered bittern which lives in reedbeds. Reeds require fresh or brackish water, if the shingle ridge failed, the entire freshwater marsh would become saline. To pre-empt that, a new wall is being built which protects the local road and freshwater marsh behind it. The land in front of the wall is not being actively managed, but saltmarsh will gradually build up between the ridge and the new wall as sediment is brought in by the tide.

In this way, part of the freshwater marsh has been protected and can now be managed over a longer time frame, measured in decades not years, and at a relatively low cost. However, Easton Broad did not affect property or agricultural land. This is not the case at Benacre (pages 6–9), where managed realignment is a serious option but would affect agricultural land, or at East Lane to the south (pages 38-41), where there is opposition to this approach.

Managed realignment in Medmerry, West Sussex. Photo courtesy ABPmer

[7]You can find more about both of these projects on the RSPB website under Medmerry, and Wallasea Island Wild Coast Project.

Building Resilience

Resilience is an increasingly important concept in coastal and flood defence. It accepts, and as a result works *with*, rather than against, natural processes.

Until recently, saltmarsh has been allowed to erode or has been drained to provide agricultural land. It should in fact be seen as a first line of defence because it absorbs much of the impact of waves in front of river walls. Pilot projects on suitable sites along Suffolk's estuaries, particularly the Alde & Ore, the Deben and the Orwell, are using natural materials, such as brushwood and coir, to restore and protect existing saltmarsh[8]. Once complete, these projects will create a natural defence that also provides valuable habitat and at a relatively low cost.

A further example of a resilience approach is a rethink on river walls, which are being redesigned to make them wider at the back, as at Waldringfield on the Deben. This does not stop water coming over the top in a surge, an event known as overtopping, but it does reduce the chances of flood water scouring out the rear face of the wall, leading to a breach. The new shape accepts the possibility of overtopping but if a wall doesn't breach it is easier to pump or drain flood water out after a surge.

Project leaders hope that strengthening river walls in this way will provide protection for twenty years or more. However, there are low-lying areas on all the estuaries that are becoming more vulnerable to sea-level rise and storm surges. Looking further ahead, it is likely that a greater variety of approaches will be needed. For example, 'sacrificial' flood compartments that can take the worst of a tidal surge to protect a settlement further up the river, such as Snape, Orford or Woodbridge, or more areas of realignment which allow the landscape to absorb flood water and provide new habitat to replace that lost by coastal squeeze. These all need careful modelling to take into account the complex way that tidal waters, called the tidal prism, behave in an estuary.

[8]You can find out more about a project on the River Deben (Falkenham Marshes) from the website of project designer Professor Simon Reed: http://www.simonread.info/falkenham-saltmarsh-tidal-management-scheme

Damage to rear of river wall following December 2013 surge. Photo Andrew Hawes

Trial river wall design at Orford, 2011. The wall height has been built up and the wall has been widened on the landward side to avoid breaching if overtopping occurs. Photo Amanda Bettinson

WILDLIFE ON THE SUFFOLK COAST

Suffolk is an internationally important home for migrating and breeding birds which often have their young here. However, many of the county's best-loved species, particularly birds that nest on the ground, have seen a significant decline in numbers. This is due to a combination of factors such as the way we use the land, for example by draining wetlands for agriculture, disturbance by us (and especially our dogs), predators such as foxes and gulls, loss of habitat due to sea-level rise and, perhaps ironically, moves to increase access for walkers and cyclists.

To find out more about the challenges facing Suffolk's wildlife, I went to the RSPB's reserve at Minsmere[9] to meet the Area Manager, Ben McFarland.

"Minsmere is one of the most biodiverse of all nature reserves in Britain because of the wide range of habitats we have here," Ben McFarland explained, "there's shingle, reedbed, saline lagoon, wet grass and wet woodland, dry woodland, heath and acid grassland. But these habitats need careful management. If you leave a reedbed, then alder and willow come in. Over many years leaf litter drops, the area dries out and eventually the land becomes woodland. Without our work, the specialist species that people come to see, such as the bittern or marsh harriers, wouldn't be here."

Minsmere has been the host for a number of years of the BBC *Springwatch* programme, but Ben McFarland is keen to point out that, while important, Minsmere does not work in isolation. "The Suffolk coast has a mosaic of reserves. If these are managed so that they complement each other, then you provide stepping stones for the wildlife and that makes the whole picture more robust. We work closely with Suffolk Wildlife Trust, for instance, looking at how we each manage our reserves. We also work alongside other key landowners who can help breeding waders by managing their land slightly differently."

Marsh Harrier.
Photo Jon Evans, courtesy RSPB

Bittern.
Photo Jon Evans, courtesy RSPB

Reedbed management volunteers.
Photo courtesy RSPB

[9]www.rspb.org.uk/minsmere

I ask whether sea-level rise is affecting the wildlife.

"It is certainly an issue," Ben McFarland answers, "but if we learn to adapt, then change is not always negative. During the storm surge of 2013, the shingle ridge at Dingle Marshes between Dunwich and Walberswick, which the RSPB manage in partnership with Suffolk Wildlife Trust, was overtopped. Since then, apart from some new walls to protect the back of properties at Dunwich, this site has been allowed to evolve naturally. The shingle ridge has rolled back and this has provided new nesting sites for little terns."

The Suffolk coast's wildlife and landscape is protected in national and international law. To some, it can seem as though this protection takes precedence over human needs. However, the reality is that the UK's native wildlife is in serious decline and therefore needs to be protected, for people, as well as for the sake of the wildlife itself.

On the Suffolk coast, the natural environment underpins the area's growing tourist economy, which contributes over £200m a year to local businesses. As we saw in December 2013, many coastal habitats also act as cost-effective flood defence for homes and businesses, but their value is far greater than that. I'll leave the last word to Ben McFarland.

"Access to wild spaces is hugely beneficial, not only for the local economy but also for public health and wellbeing. As such, places like Minsmere run by the RSPB or other sites run by Suffolk Wildlife Trust and the National Trust, have as much right to be considered for public investment to help them adapt to climate and coastal changes as our towns, villages and farmland."

Otter. Photo Ian Clarke, © RSPB

Photo Ian Barthorpe, courtesy RSPB

Coastal Squeeze

Coastal Squeeze is the term used to describe habitats on the coast that are 'squeezed' between man-made barriers, such as river walls, sea walls and farmland, and an eroding coast. In a natural system, areas of saltmarsh or shingle 'move' inland as sea levels rise, and the animals and plants that depend on them simply move with the habitat.

Realignment is one answer to the problems caused by coastal squeeze because it gives the coast room to evolve. Realignment can happen in an unmanaged way, as at Hazlewood Marshes, or as a management decision, as at Easton Broad. In each of these locations, walls have been built inland of historic defences to protect land and property behind them, while in front, natural processes take over and saltmarsh, for example, is allowed to develop.

EAST LANE

East Lane leaves the main road half way through the village of Bawdsey. It turns sharp bends round fields before ending at a car park beneath a sea wall that you need to climb to see the sea. The far side of this wall is made up of hundreds of imported rocks which stop the sea breaking through the wall and flooding the land behind.

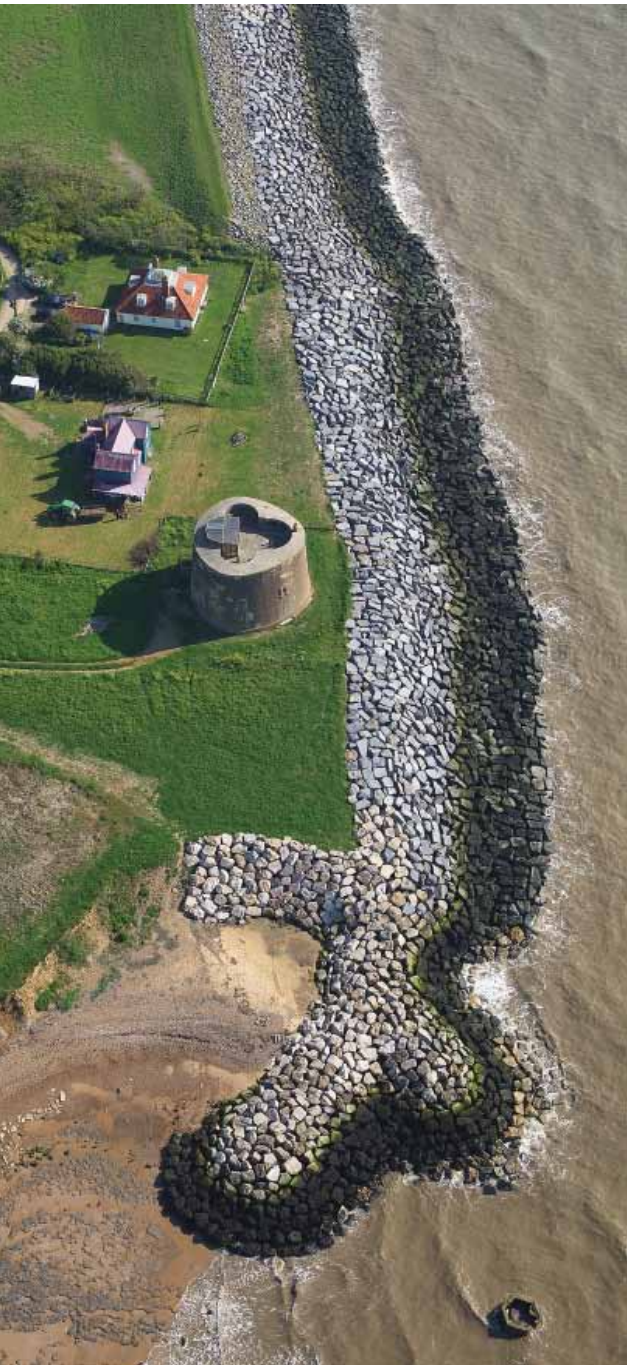
Today, the sea washes against this recent rock armour at East Lane but until a few decades ago there was a wide beach here. People I met while researching this piece talked of fishing and swimming off that beach or camping there at night, when they were young. After that time, the natural action of the sea washed the beach away and started to erode the original sea wall.

At this point it was decided to protect Martello Tower W and the two houses next to it, as well as the farmland behind. The first set of rock armour was put in place in 2006.

Martello Towers

Martello towers were built in the early nineteenth century along the coast from East Sussex to Suffolk as a defence against invasion by Napoleon. Each tower was given a letter of the alphabet to distinguish it; the East Lane Martello is Tower W. These towers have become an iconic part of the coastal landscape.

East Lane, December 2004.



By 2008 it was clear that further defences would be needed to the north of this artificial headland, created when the first set of rock armour was put in place in 2006. This coastal defence scheme cost approximately £3.06 million (inclusive of consultancy fees), paid for by the East Lane Trust (a group of local landowners), who raised £1.8m through enabling development (see box on following page) together with funding from Suffolk Coastal District Council and the EA's grant-in-aid national flood and erosion risk management funding programme.

As we have seen, while hard defences protect the area behind them, rates of erosion tend to increase at the points where they end. At East Lane wave energy has been concentrated on an older section of seawall to the north of the defences, which is no longer protected by a beach. Several emergency extensions to the rock armour have been needed as the focus of erosion moves north. To the south, erosion is also continuing in spite of a 'fishtail' of granite blocks that was designed to limit its impact. This underlines the difficulties of trying to stop the natural action of the sea, which is behaving as it has done since this coast was formed at the end of the last ice age.

East Lane, 2012. © Mike Page

Costs of recent coastal management projects along the Suffolk Coast.

Location	Year/s	Total cost m (millions)	Source of funding	Breakdown of cost and notes
Lowestoft	2015/16	£2.9m	EA (emergency funding) Waveney DC	South Beach emergency works EA £2.5m WDC £0.4m
Benacre pumping station	2011 2014/15	£0.24m £0.16m	EA EA (emergency funding)	Flume emergency works Surge recovery rock extensions
Southwold	2006	£8.5m	EA	New groynes and beach nourishment
Minsmere	2013	£1.9m	EA	Coney Hill cross bank and sluice refurbishment
Slaughden	2008–2014 2016	£0.4m £0.4m	EA EA	£100,000 per beach recycle 2008/2012/2013/2014 = £400,000 Rock from Brittany £400,000
East Lane Bawdsey	2006 2008 2009–2016	£2.4m £2.9m £2.85m	EA East Lane Trust, EA, SCDC EA (emergency funding)	 East Lane Trust £1.2m, EA £1m, SCDC £700,000 2009/10 £1.3m 2013/14 £0.2m 2014/15 £0.9m 2015/16 £100,000 + £350,000 (estimated = £100,000 construction + £250,000 rock stockpile supply) Total since 2006 = £8.15m
Felixstowe	2008 2011	£9m £10m	EA EA	South Felixstowe rock groyne and beach nourishment Central Felixstowe rock groyne and beach nourishment

The Environment Agency, Natural England and the local community at East Lane now need a longer-term solution. The EA commissioned coastal engineering consultants, Mott MacDonald, to look at the processes causing the erosion at East Lane and to set out possible solutions.

Mott MacDonald's *Coastal Processes Study* was published in September 2015[10]. It concluded that the approach to coastal defence between East Lane and Shingle Street needed rethinking, and that coastal realignment could be a sustainable way forward. The situation at East Lane presents genuine difficulties. Is it possible to find a sustainable solution that doesn't require increasing amounts of money? Is there a way forward that doesn't simply leave the next generation to pick up the tab? Will ever-increasing defences damage the very landscape they are trying to protect?

Enabling Development

Through the Environment Agency, the government has the *power* to protect lives and property from flooding, but it has never had a *duty* to do so – a fact that often surprises people. After the 1953 floods (which hit the east coast very badly) the government paid for the majority of flood defences, but these are now reaching the end of their design life.

In emergencies, funds still come from central government. However, most other public funding for flood defence work is now prioritised according to the value of the property, businesses, habitat and agricultural land to be protected (there's a weighting to ensure that poorer communities with cheaper houses don't lose out). The economic value is compared to the cost of the proposed defences, over their likely effective lifetime. This evaluation is known as cost–benefit analysis.

In the past, an area either qualified for flood defence funding or it didn't, but since 2011 there has been a move towards partnership funding, especially where the value of property and land are too low to qualify for full government funding. At East Lane, as at many rural locations, the combined value of property and land was not great enough to justify full government funding of proposed sea defences.

One of a range of solutions to filling at least part of this funding gap is 'enabling development'. In enabling development, landowners donate land adjacent to existing villages which is then sold to housing developers. The farmer receives the agricultural value of the land. The difference between that and what the developer pays can contribute to coastal and flood management to benefit the community. East Lane was the first time this approach was used in the UK.

The concept of enabling development is innovative and has set a precedent. It has had the positive result of establishing new partnerships between the authorities, local government, residents and landowners, and has allowed funds for defence work to come from a wider range of sources.

Enabling development is a useful funding tool, however it does not replace the process of deciding what type of management is right for each location.

[10]You can read this report and look at possible options here:
http://www.suffolkcoastandheaths.org/estuaries/bawdsey-coastal-partnership/

MANAGING THE COAST

The Suffolk coast, with other coastal communities around the world, is on the front line of climate change. The people who live and work here are beginning to find ways to adapt. In fact, Suffolk is developing a reputation nationally for innovative ways of working.

Estuary partnerships have been piloted in Suffolk and are being taken up across the country[11]. Community groups, such as SCAR[12], have also taken part in the discussions. The Suffolk Coastal Forum – a broad partnership of organisations with a role in managing the Suffolk coast, was set up in 2010. These partnerships allow expertise and experience to be shared, and different opinions to be discussed. Importantly, they also take into account the whole landscape and the variety of approaches that are used across the UK coast, as well as internationally.

Instead of seeing options such as realignment only as a loss, for example, projects in Suffolk and around the UK coast are providing a longer-term solution at an acceptable financial cost. They also create habitat for plants, birds and fish, as well as opportunities for recreation.

The visual impact of defences on the coast also has to be considered. The Suffolk coast is valued by residents and visitors for its relative wildness – hard defences alter the look of a place.

During my research I asked one of the people involved in coastal management in Suffolk what she would wish for the Suffolk coast. "I'd like to see a reconnection between people and nature, and a proper understanding of the way things work," she said, "if we had that good understanding, we would make the right decisions." Another told me that when making decisions about coast and flood defence we should think ourselves twenty-five or fifty years into the future and then ask – 'Have we made the best decision for those that come after us?' Most recently, a coastal engineer told me, "You can't make decisions based on denial".

For me, those three statements are the crux of the issues facing the Suffolk coast. If we want to manage the coast in the best, most cost-effective and sustainable way then we need to understand and accept how this coast works. We also need to understand and accept sea-level rise and the growing influence of storms and surges and, finally, we need to plan for the longer term, taking into consideration a variety of approaches.

[11]You can find out more about all the local estuary partnerships here: www.suffolkcoastandheaths.org/estuaries/
[12]www.suffolkcoastagainstretreat.co.uk

The Suffolk coast is a dynamic coast; there are areas where the land is growing as well as eroding. These two pictures of Shingle Street, taken 5 years apart, show an area where shifting currents have created a new ness or headland. In 2016 this was still expanding, but who knows what will happen in the coming decades? Pictures © Mike Page

List of websites for further information

touchingthetide.org.uk
suffolkcoastandheaths.org
suffolksmp2.org.uk/index.php
aldeburgh.oneplacestudy.org
dunwichmuseum.org.uk
orfordmuseum.org.uk
discoverlandguard.org.uk
dezandmotor.nl/en/research

Touching the Tide

heritage lottery fund

LOTTERY FUNDED

Suffolk Coast & Heaths

Area of Outstanding Natural Beauty