Broadland Futures Initiative

Coastal Processes Within the Plan Area

Contents

Photo on cover sheet is aerial shot of Winterton and Winterton beach in 2019 © Mike Page

1. Introduction

The Broadland Futures Initiative

The **Broadland Futures Initiative** (BFI) is a partnership whose main goal is to agree a plan for future flood risk management in the Broadland area that copes better with a changing climate and rising sea level. Our focus is on what will happen from the mid-2020s onwards, but we need to start planning now to secure support and make well-informed decisions.

> The three main processes occurring at any coast are erosion, transportation and deposition of natural material.

This document is one of a number of studies we are producing to help explain the background to flood risk management. It describes the evolution and processes of the coast between Cromer and Great Yarmouth, with a focus on the low-lying Eccles to Winterton frontage, and tells local communities about:

- The changes we see at the coast
- Why the coast changes
- Predicting the future under different scenarios

This document aims to inform you about the wide range of processes to be considered when dealing with the coast, and the complexity of coastal processes acting between Cromer and Great Yarmouth. This report also provides information to understand possible solutions, which will be considered later on during the project.

Introduction to the Plan Area and Coastal Processes

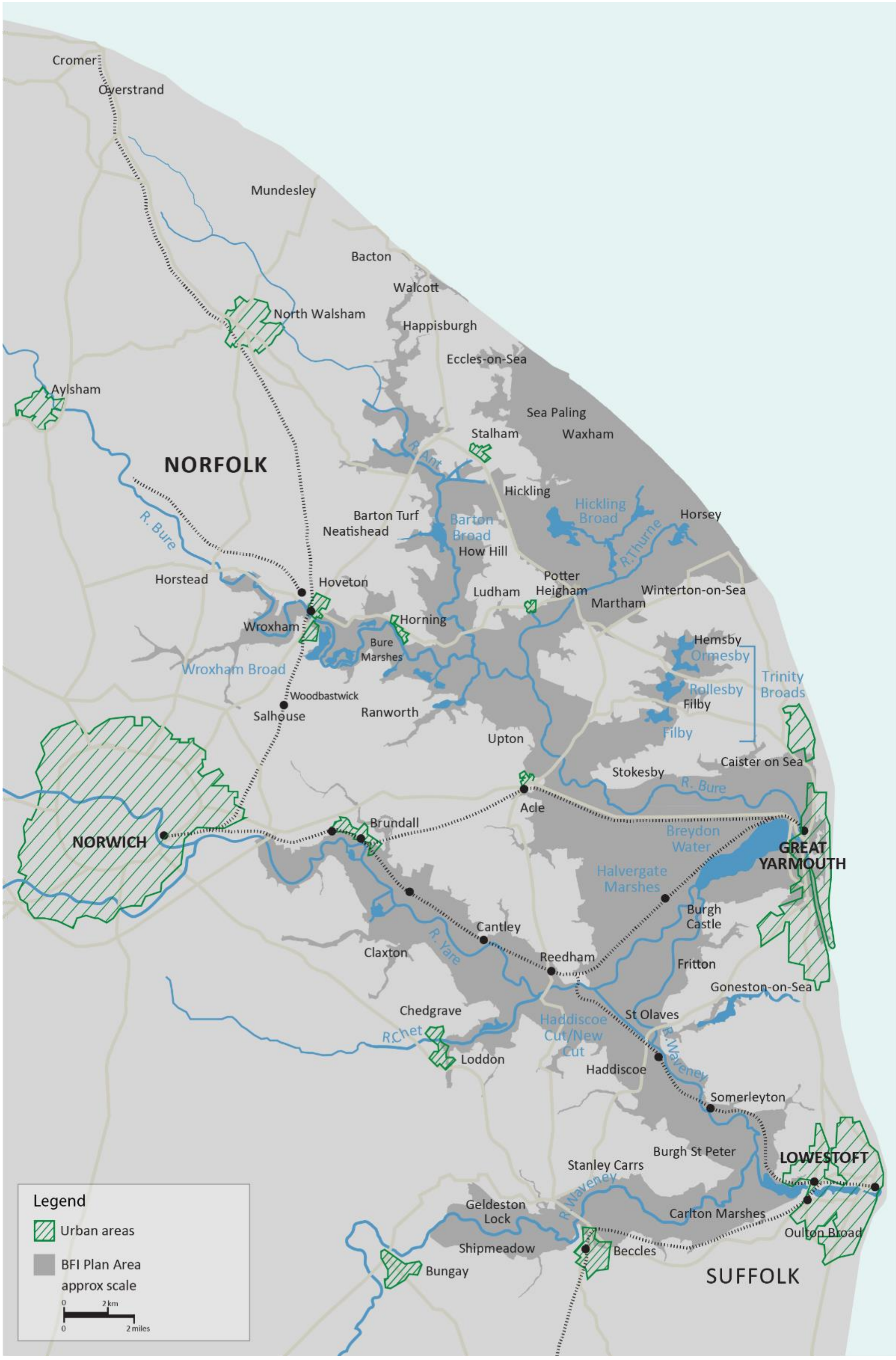
The BFI plan area includes the Broads Authority executive area and key stretches of the coast which could influence flooding in the Broads (see plan of the plan area on page 2). The plan area is predominantly in east Norfolk, but also crosses into north-east Suffolk.

The coastal frontage between Cromer and Great Yarmouth is a combination of soft glacial cliffs, sandy beaches and sand dunes on top of clay and peat. These beaches and sand dunes have important roles in contributing to a number of benefits, such as:

- Economic value, as beaches offer opportunities for tourism and recreation;
- Stability of structures, beaches dissipate wave energy, resulting in reduced impact to man-made structures, which are usually located at the upper part of the beach;
- Natural flood and erosion protection, as dunes and beaches are the first barriers to storm events; and
- Habitat for wildlife, which is rich and diverse along the coast. It includes places for marine life, breeding and feeding areas for rare little terns, natter jack toads and grey seals, along with a host of specialised coastal invertebrates. Some of the coastal area is designated for nature conservation to protect species and habitats.

Historically, **flooding and breaching of sand dunes has been recorded at the Eccles-Winterton frontage since the 13th Century at least**. 1938 saw the most extensive recorded coastal flood, affecting around 3,000 hectares following a breach in the dunes. In response a seawall of concrete-filled sand bags was built at Horsey and Eccles. The 1953 storms, which resulted in major flooding, loss of life and a significant erosion of the beach and dunes, led to the construction of a more substantial concrete seawall along most of the frontage.

The BFI is looking at assessing coastal processes in order to understand the natural and man-made changes observed at the coast. Understanding those processes will better support what decisions need to be made for the future management of the coast.



Plan of the plan area. The figure contains OS data © Crown copyright [and database right] 2020.

2. The Changes We See at the Coast

The coast is a dynamic environment, forming a transitional zone between ocean and land. Natural processes have shaped the cliffs, beaches, and other coastal features for thousands of years. Changes at the coast are, therefore, natural and inevitable.

Between Cromer and Great Yarmouth, changes at the coast have occurred and been ongoing since the last glaciation. These changes are driven by the tides and waves during normal weather conditions, storms, and sea level changes. The map below shows how the position of the coast has moved inland from the 1880s to the present day, a distance on average of 200 metres.

Cliffs between Cromer and Eccles are a mix of clays, silts, sands and gravels deposited during glacial and interglacial phases over the last two million years. These characteristics make the cliffs soft, which means they are more **susceptible to erosion**.

These are the three main changes we see along the coast, which are detailed in the next pages:

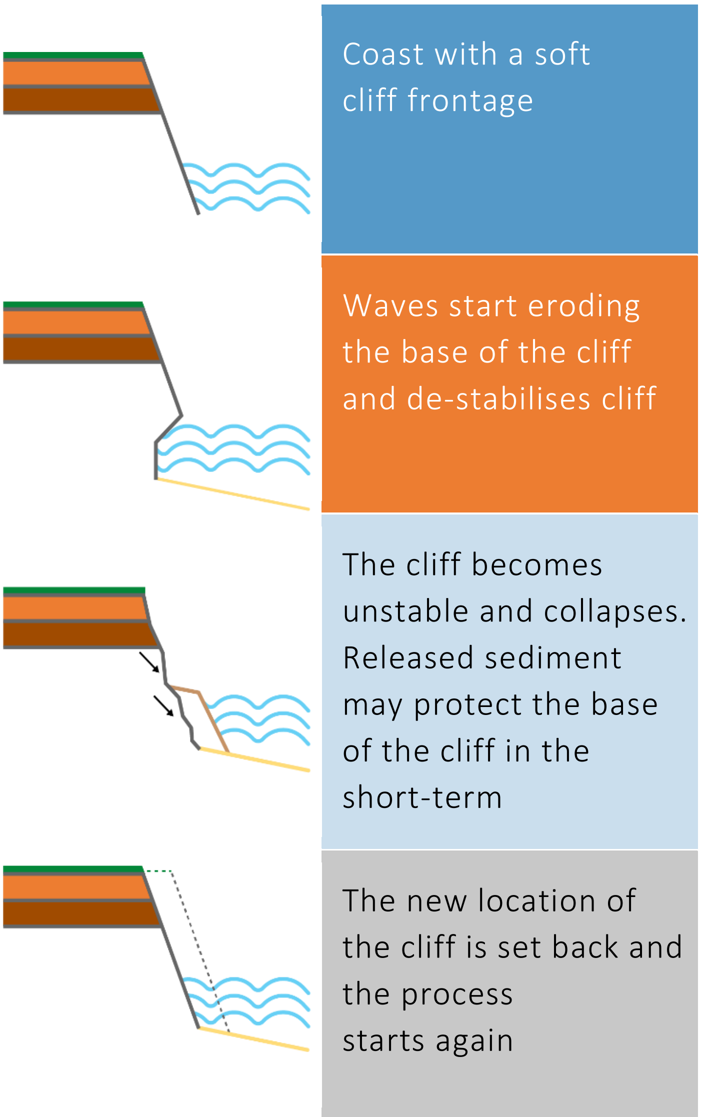
1. Cliff erosion
2. Changes in beach profile
3. Sediment deposition: primarily along the Broads frontage (Eccles to Winterton). Sediments are mainly sand with some shingle.

Historical (1880s) and recent (2016) position of the coast. The figure contains OS data © Crown copyright [and database right] 2020.

Cliff Erosion

Given the cliffs in this area are soft, the base of the cliff is easily eroded by waves. As the cliff becomes unstable, it collapses. The material is then deposited and transported along the beach by waves, and a new location of cliff face further back is established. Groundwater and landslides can also destabilise the cliffs. When groundwater levels are high, waves can reach higher beach levels, increasing erosion.

Between Cromer and Eccles, cliff erosion predominantly occurs during or after storms, when substantial parts of the cliffs can be lost. Erosion is a continual process, taking place even during periods of mild conditions. Along the East Anglian coast, erosion averages between 1 to 2 metres per year. However, some large storms can result in cliff losses of many metres in a single event.



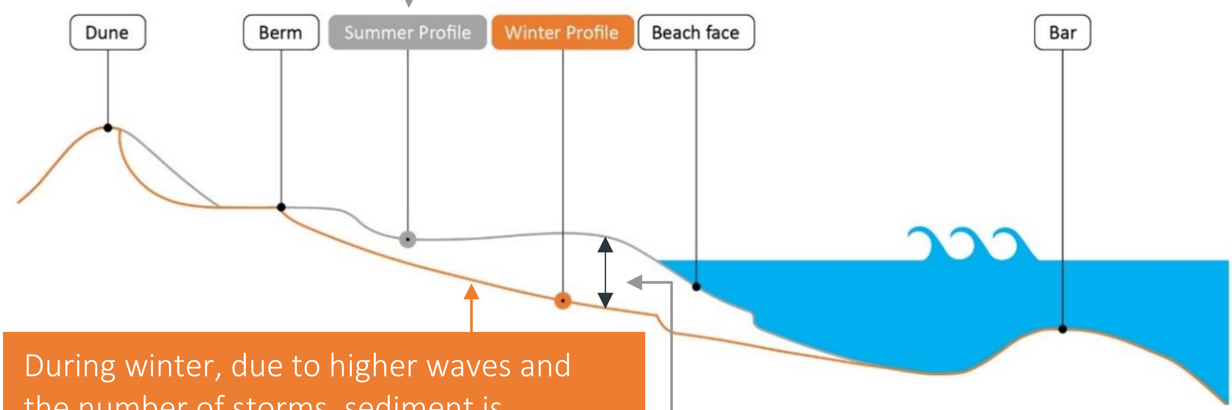
Although cliff erosion can be a significant concern locally, the process has wider coastal significance; the material eroded from the cliffs forms the natural beaches. The sediment is moved along the coast by waves and is distributed across beaches over a much wider area. This is vital to maintain those beaches which are the first line of protection to many communities. The erosion of cliffs south of Cromer, for example, is essential for the maintenance of the beaches all the way along to Great Yarmouth.

Cliffs eroding south of Happisburgh © Evelyn Symak www.geograph.org.uk

Changes in Beach Profile

In general terms, sandy beaches change seasonally, so the beach profile is different in summer and in winter.

In the summer, dunes and the beach face are high, with a greater volume of sediment.

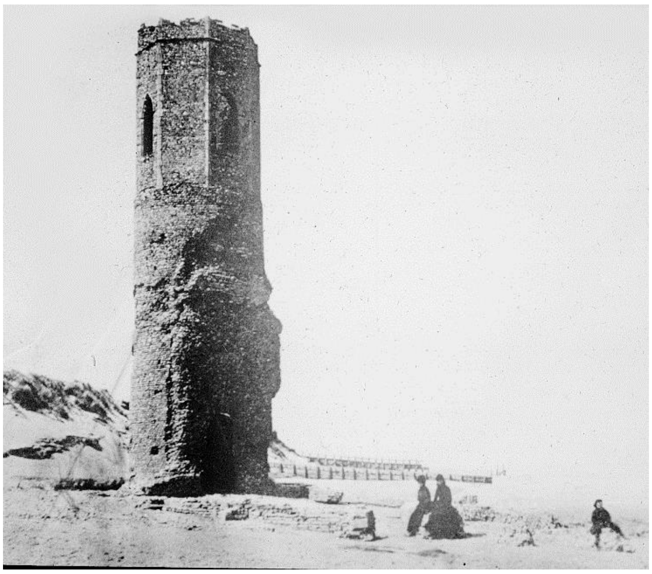


During winter, due to higher waves and the number of storms, sediment is removed from the dune and beach face and is deposited nearby, usually in a nearshore bar. The volume of sediment is not lost, but simply moved to a different location.

Difference in beach height between summer and winter

In the next summer, sediment is often brought back from the nearshore bar onto the beach by the action of normal waves and tides.

In addition to the natural changes to the beach, sand dunes tend to gradually move landwards along areas of the coast with no obstacles behind (such as developments) to block their movement. This is an ongoing process as sea levels have been rising since the last glaciation. This image shows the ruins of St.Mary's church Eccles on Sea The church was on the landward side of the sand dunes in 1823, but by 1895 when it completely collapsed it was situated on the beach. This natural process of landward movement cannot be readily halted by human interventions.



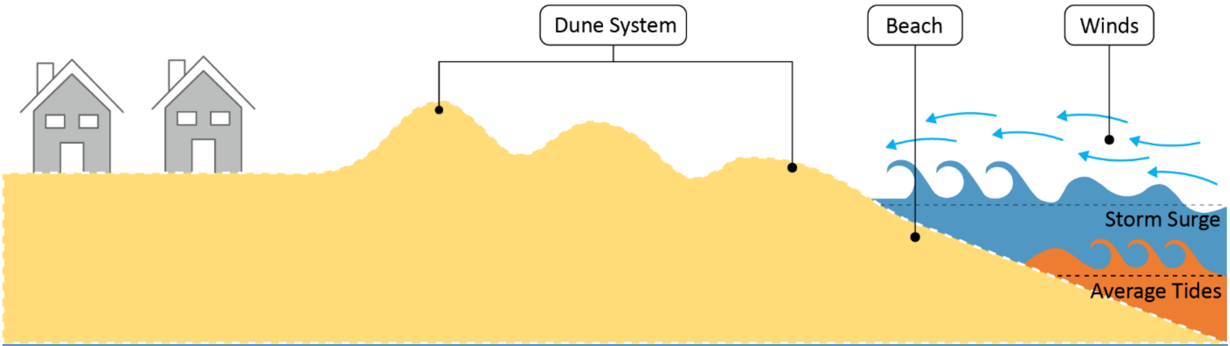
Eccles-on-Sea church ©Image courtesy of Norfolk County Council Library and Information Service.

Beach erosion and lowering occurs when the sediment moved offshore does not return to the beach during the next season. This is because it is lost offshore or moved along the coast without being replaced. In other words, more material is eroded from an area than is deposited on it. There are many locations on our coast that are eroding over time in this way.

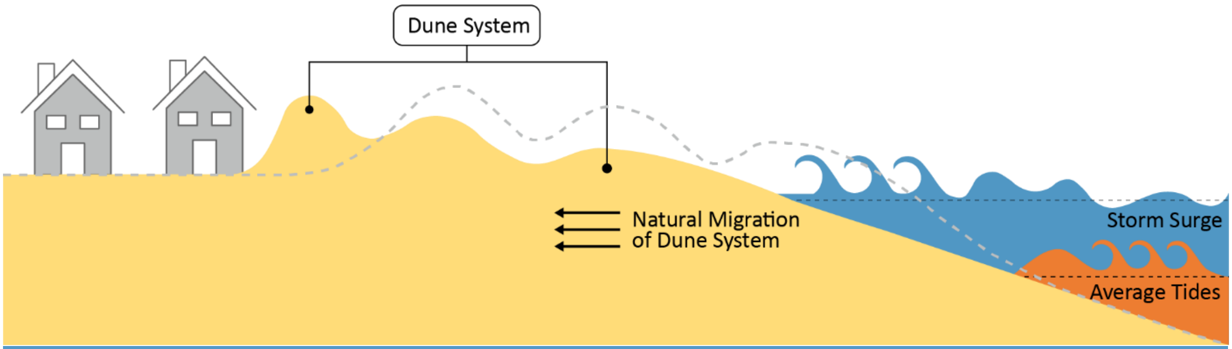
In addition, at some parts of this coast, the natural landward movement of the sand dunes has been restricted or 'squeezed' by development behind the dunes and the **seawalls** in front. If the walls and development were not there, the **dunes** would naturally move landward and maintain their form further inland, allowing the coast to realign naturally. However, the dunes do not have the space to move landwards, and higher waves and storms remove sand from the front of the dunes. Without the dunes, the coast becomes more susceptible to flooding and its protection becomes dependent on human intervention.

When beach erosion and lowering occurs, seawalls might become undermined and unstable. To avoid this happening at the coast between Eccles and Winterton, a number of **engineering measures** were carried out to seek to maintain the level of the beach. Engineering measures included the construction of offshore reefs (also known as breakwaters), groynes and beach recharge. This is explained further in Section 3.

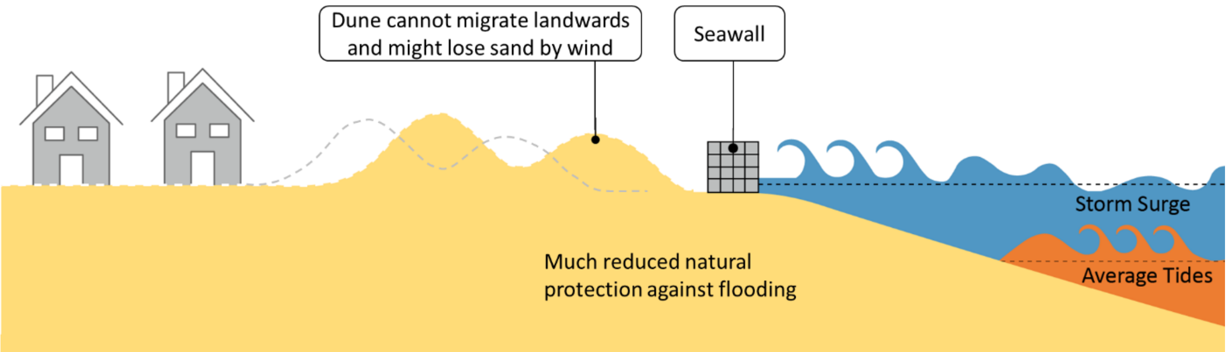
The village of Winterton lying behind the sand dunes in 1996. The dunes here act as a natural protection. Contrast this photograph from 1996 with the one on the front cover from 2019: over time, the dune width has reduced. © Mike Page.



When dunes and beaches have a healthy volume of sand, storms hitting the coast are blocked as the dunes and beach protect the land behind. Breaches through narrow dunes might occur, but if there is enough sand available in the system they are repaired naturally.



Over time, the dune system migrates further inland, maintaining the heights and widths of the dunes and beach. This occurs because there is enough space for them to move landwards.



With a seawall on the seaward side and properties on the landward side, the dunes are trapped in the middle and cannot migrate. Sand from the beach is removed by waves and sand from the dunes is removed by wind, which do not recover, and so erosion is more likely to occur.

Flood and gale damage following the 2013-2014 storms at Great Yarmouth. Although some overtopping has occurred due to the severity of the storm, the natural protection provided by the dunes has helped to keep the homes safe from the full force of the sea. © Mike Page.

Sediment Deposition

Deposition is the process that occurs when waves or tidal currents lose their energy, dropping the sand (sediment) at a certain location. If this happens often, the area will **accumulate sediments** and coastal scientists say that the area has 'accreted'. Deposition is usually in sheltered areas such as estuaries, quiet bays and beaches, as well as offshore.

Deposition of sediment can be temporary or permanent. When deposition is temporary, the sediment settles out for a while, then moves on and is replaced by new sediment arriving at the location. Temporary deposition happens on the beaches between Eccles and Winterton.

When the deposition is permanent, the sediment settles out and stays at the same place until geologically long-term conditions change.

Winterton beach looking north-west © Richard Law www.geograph.org.uk .

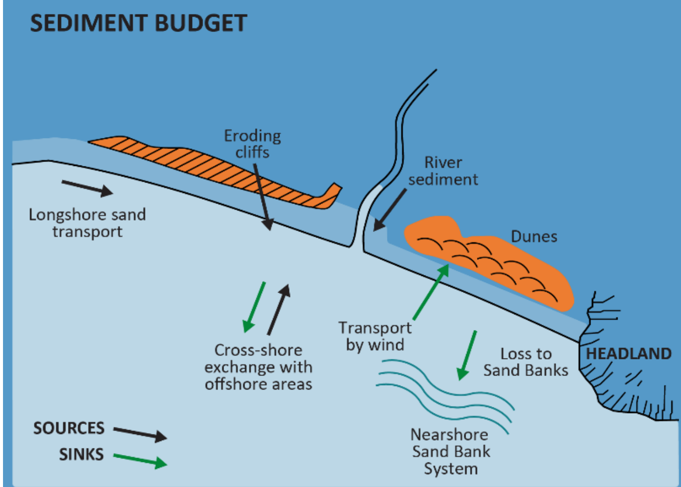
Sediment budget is a term used to quantify the amount of sediment present in a defined area, usually called a **cell**. A sediment cell is an area of the coast which has been defined as having sources, pathways and stores or sinks of sediment.

Within the Happisburgh to Winterton frontage, Winterton Ness acts as a store of sediment, where sand is deposited for a short period of time before moving on further south. However, this in itself is variable as Winterton Ness is a very complex feature of the Broads coast. For example, the images below show how much the Ness can move in size and position over a period of time, and we know from historic records this movement and growth/reduction is always changing.

Winterton Ness in 1999 (left) and 2019 (right), showing the accumulation of sand in this area over 20 years. ©GoogleEarth

Key processes at our coast

Sources: where the sediment comes from. In the BFI area, sources are the cliffs, beaches and dunes eroding by the force of waves.



Pathways: the ways in which the eroded material is transported, such as by tides and waves. It can occur along the coast (called longshore transport) or across the coast (called cross-shore transport).

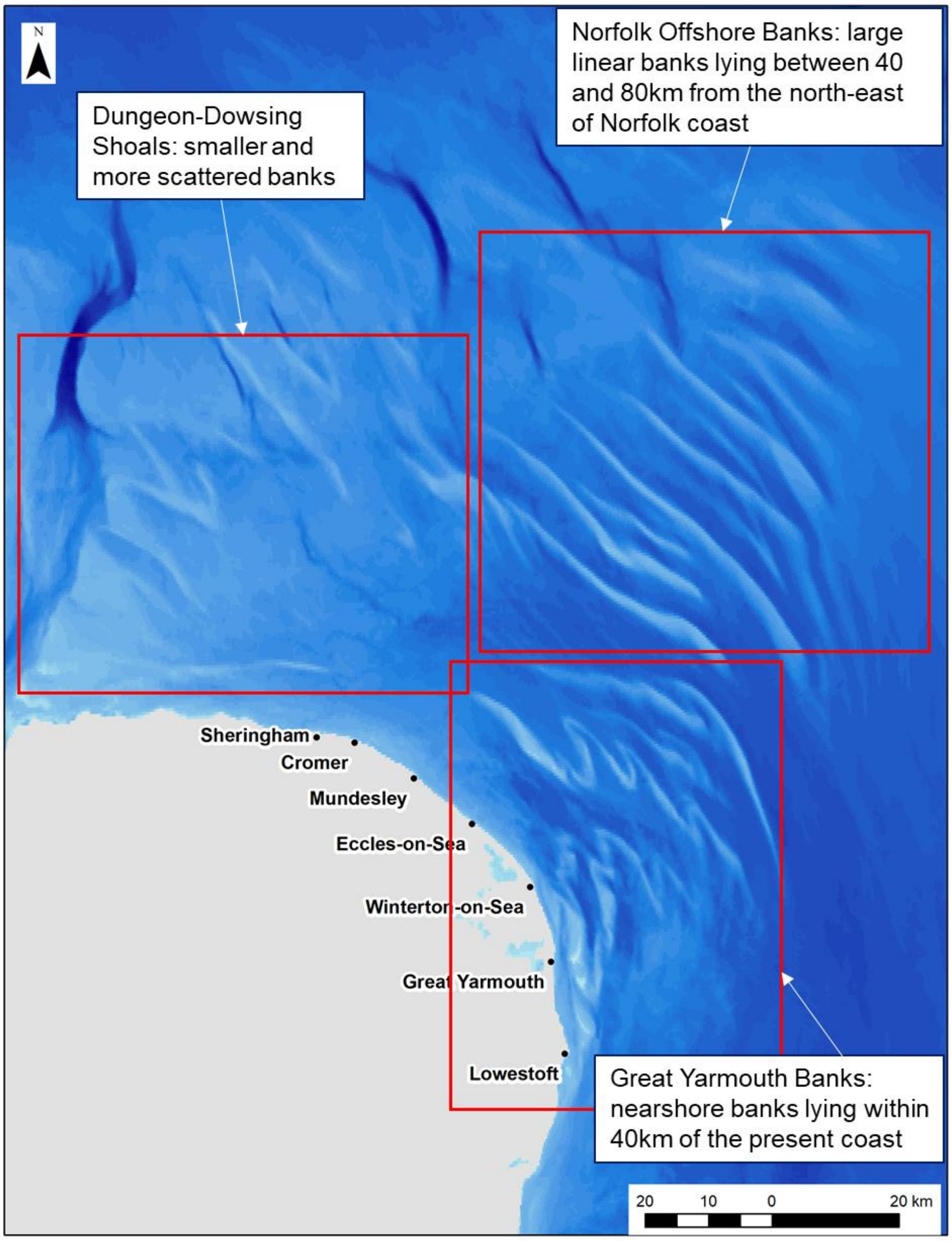
Stores and sinks: the locations where the transported sediment is deposited. This happens when waves and tides lose energy and cease to be able to transport the eroded material. This eroded material is then released. Stores are temporary locations of deposition, and sinks are permanent.

3. Why the Coast Changes

The changes seen along the coast between Eccles and Winterton are also happening along other stretches of the coast. Changes to the north, between Cromer and Eccles, influence what is happening further south, and changes between Eccles and Winterton influence what is happening to the south of Winterton and down to Lowestoft. This is what we call **a linked coastal process system**, and these changes can have three main causes:

1. Natural changes to the seabed offshore
2. Natural processes at the coast
3. Man-made changes at the coast

Natural Changes to the Seabed Offshore



Offshore bank location

The Norfolk coast includes extensive sandbanks lying up to 80 km offshore. The banks closest to the coast are called nearshore banks, such as those found to the south east of Winterton. However, the whole seabed varies in shape and depth, which alters under the influence of waves and currents. These variations influence the way in which waves and currents reach the coast and determine the direction and scale of movement of material along the coast.

Offshore dredging for construction purposes is a common practice, especially at locations of high accumulation of sand such as the marine sandbanks and ancient river beds now under the sea. It is important to note however that the volumes dredged from these areas are very small compared with the considerable volumes of sand which are accumulating on those same banks, despite the dredging. Erosion has been present to thousands of years and well-regulated modern dredging is unlikely to cause changes to erosion.

For many years there has been public concern over the effects of dredging and a perception that it is a cause of coastal erosion experienced along the Norfolk coast. Several studies have generally concluded no adverse effect, although some of those have not been universally accepted. However, more recent information lends itself to the conclusion that there is unlikely to be any direct link between those operations and erosion issues.

Dredger for offshore wind farms © Mike Hastings

A recent independent study calculated that the Great Yarmouth bank system has grown by almost 1 million m^3 per year for the last 40 years, i.e. even with the dredging taking place. That vastly exceeds the volume of sand that could come from erosion of the North Norfolk cliffs and beaches, with most of this sediment coming from the bank systems much further offshore to the north. The areas where offshore dredging is permitted actually lay in deeper water and outside of the Great Yarmouth nearshore bank system; so if the bank system is growing and not being affected, then it is highly unlikely that dredging has any effect on drawing material away from the beaches at the shore.

Natural Processes at the Coast

The coast has been changing for centuries, both naturally and due to human influence. This section explains the natural coastal processes between Eccles and Winterton and the wider area.

The erosion of the cliffs between Cromer and Eccles is the main source of sand for beaches to the south. Along this frontage, more sediment erodes away from the cliffs than arrives from the north. This means that **a high quantity of sand is moved by natural processes from the cliffed frontage in the north to the south to the Eccles to Winterton frontage and beyond**.

Sediment transport is a very complex processes along this frontage. **Waves** driven by winds and **tidal currents** are the main drivers of sediment transport to the south. During good weather, waves reach the coast at an angle, which helps to spread sediment along the coast. During storms, higher waves come straight onto the shore rather than at an angle, which increases erosion of cliffs between Cromer to Eccles and makes more sand available. See summary of coastal processes below.

The Eccles to Winterton frontage is both a pathway and a store of sand, which means that:

- part of the sand arriving at this frontage from the north will pass-by and continue its southwards transport; and
- part of the sand will be deposited for a short period of time, before being eroded again and transported southwards.

Sediments transported from the north along the coast are critical to the maintenance of beaches and natural protection between Winterton and Great Yarmouth.

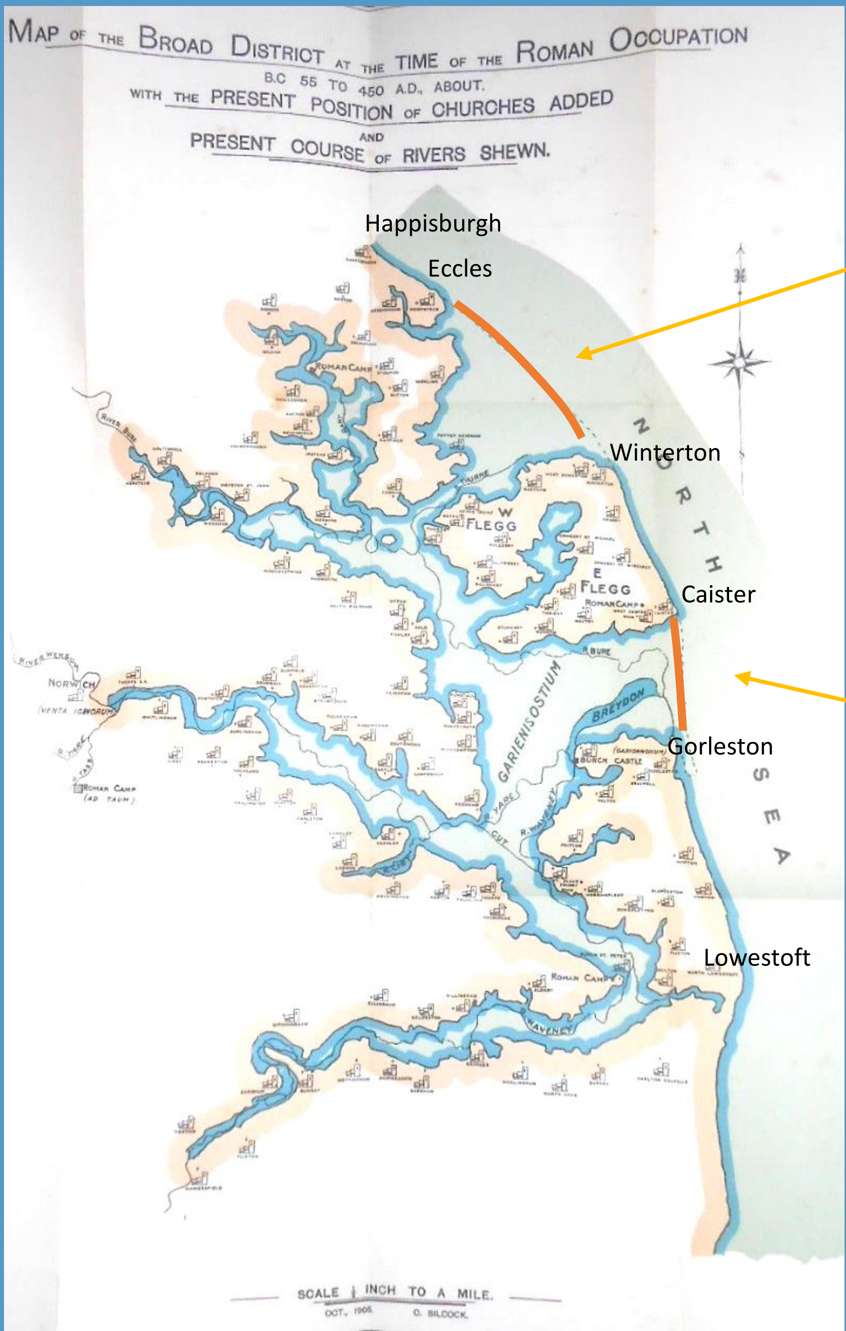
Both waves and storm surges (high tides during storms) are important to transport sediment further south. Some transport of sediment also occurs cross-shore, this means that there is an exchange of sediment between the beach and a nearshore bar located about 300 metres offshore along the Eccles to Winterton frontage.

Sediments arriving from the north at Winterton are slowed down by the ness (headland), which holds sand and gravel for a while. This area is considered a **temporary store of sediments**. Sediment continues to move along the coast to the south and feeds the beaches all the way to Great Yarmouth and beyond.

Waves and groynes along Winterton beach © Jonathan Hillaby

To understand the extent of flood risk in the Broads, it is useful to look back at the history of the area and its interaction with the coast. This map shows the configuration of the coast at the time of the Roman occupation, about 2,000 years ago. The names of current towns and villages have been added to show their approximate location.

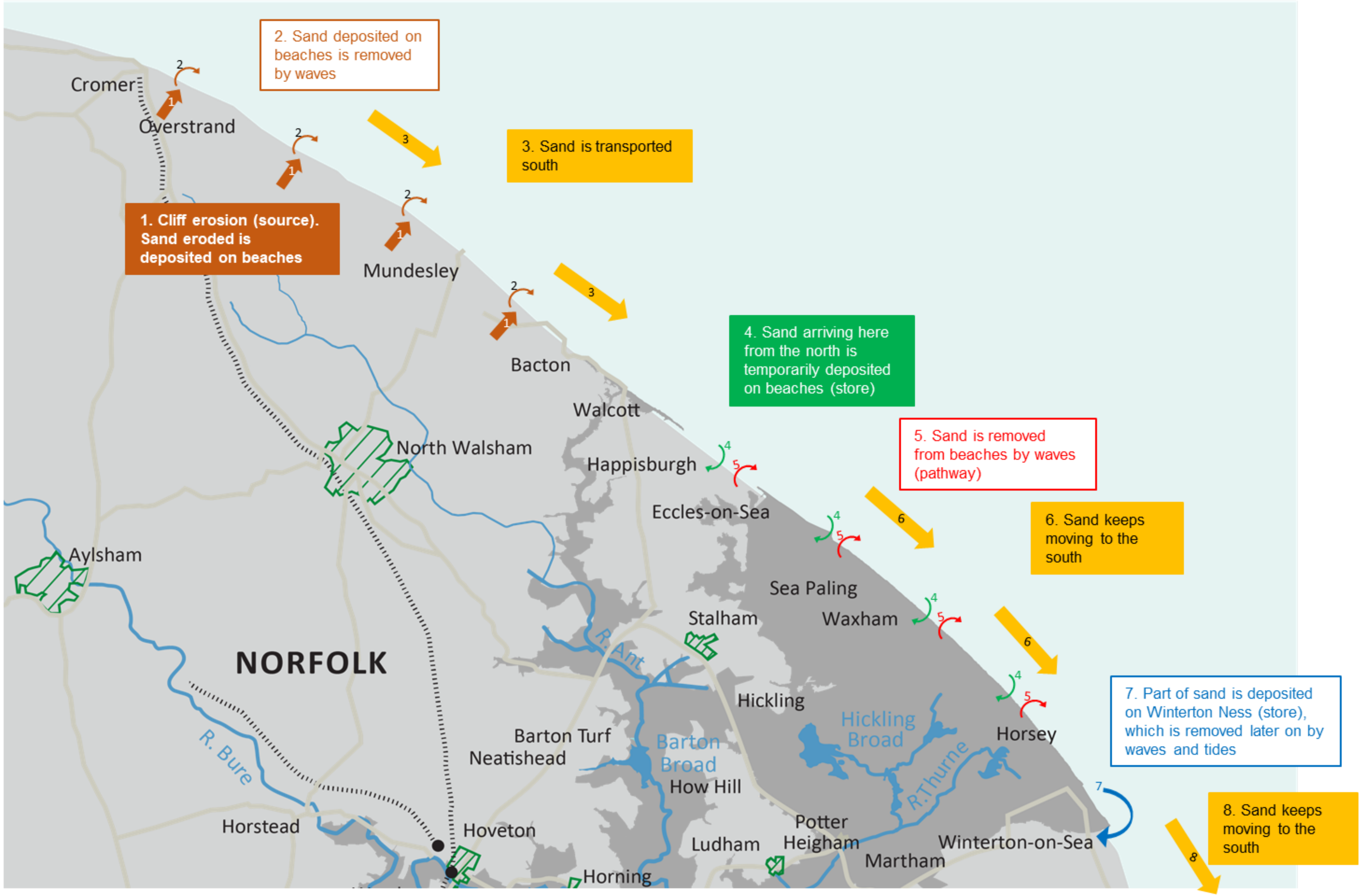
Historically, the sea could enter the low-lying areas inland via gaps in the high ground near Great Yarmouth (between Caister and Gorleston) and between Eccles and Winterton.



It is possible that an offshore sand bar was located in the area between Eccles and Winterton at that time, which would have been pushed inshore to form the current sand dunes.

It is also possible that dunes were located at the mouth of the ancient estuary in Roman times.

Summary of the coastal processes between Cromer and Winterton Ness



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Man-made Changes at the Coast

Beach and sea structures near Mundesley © Mat Fascione
www.geograph.org.uk

Management of the frontages between Cromer and Winterton, including actions taken along the Eccles to Winterton frontage, will have an influence on the coast between Winterton and Great Yarmouth. However, coastal management to the south of Winterton is not likely to affect areas to the north due to the dominant direction of sediment drift (north to south).

Seawall at Cromer © Rob Goodlife

Between Cromer and Winterton, the shore has been fixed at its current position in some locations to prevent erosion of towns and villages including Cromer, Overstrand, Mundesley, and Bacton. However, between these protected parts of the coast the management is to enable natural erosion of the cliffs, as they are a vital sediment source for beaches to the south.

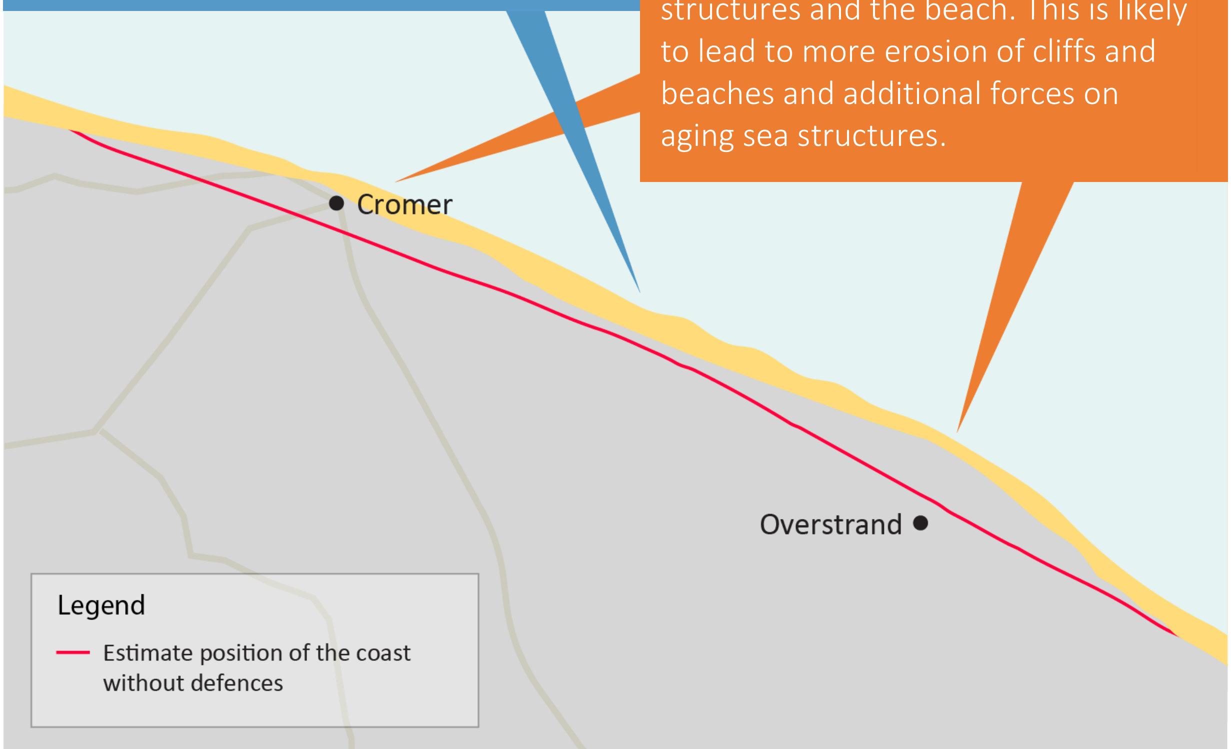
Maintaining and building flood and erosion management structures only provide a temporary protection to the coast. These structures can have implications elsewhere, providing or restricting sediment to move up and down along the coast. This is further explained in the next section.

In locations where there are no or unmaintained structures, the coast erodes more naturally. Where the supply of sediment from the unprotected coast is blocked by “headlands” of protected areas, sediment can become lost offshore.

Without the existing sea structures, rapid cliff erosion would be observed. In time, as the coast reaches a more natural shape, slower and more uniform erosion would be established. The erosion and release of more cliff material to the beaches would provide some protection, then reducing the cliff erosion in the future.

Over time, fixed locations (Cromer, Overstrand, Mundesley) become protruded seaward of the general line of the coast creating “headlands” while the adjacent unprotected areas have continued to recede. This may ultimately divert the supply of sediments, resulting in loss of beaches along the wider coast including the Eccles to Winterton frontage.

With the additional factor of sea level rise, it is also likely that the depth of water close inshore at these locations will get deeper, which would make it easier for large waves to reach the structures and the beach. This is likely to lead to more erosion of cliffs and beaches and additional forces on aging sea structures.



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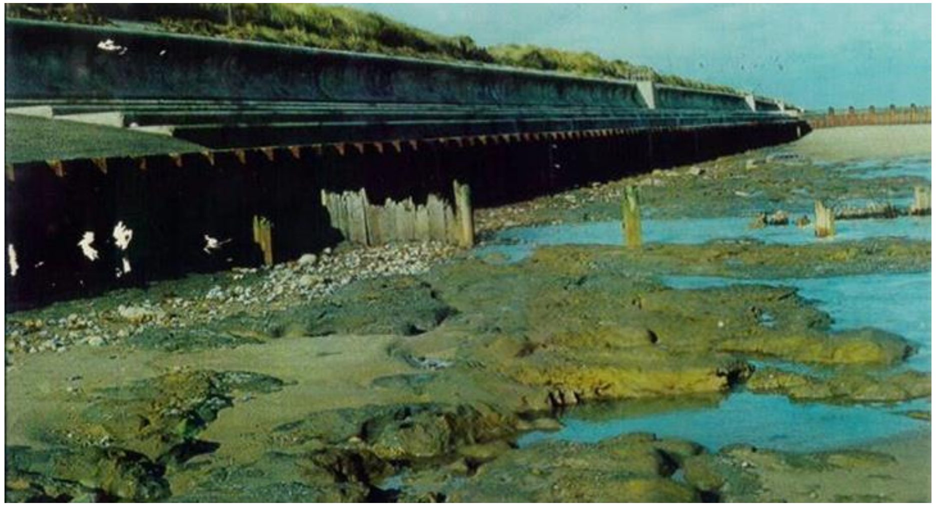
The challenge:

At Sea Palling, the current seawall was built in front of the narrow dunes and in the 1970s dune ridges covered the seawall (as can still be seen on some parts of the Eccles to Winterton coast). A series of timber groynes were also installed. The seawall aimed to protect the area behind from flooding; the groynes aimed to trap sand on the beaches by avoiding loss of sediment out of the area. In the 1990s, however, sand on the beaches of Sea Palling and Waxham was completely eroded by waves, exposing the underlying clay, which in turn was also removed by waves. The image below shows the uneven clay surface at the bottom of the seawall. Engineering tests at the time showed that the seawall was near failure point.

The intervention:

Nine offshore reefs and more groynes were constructed at Sea Palling between 1993 and 1997. To boost the natural beach levels, beach recharge campaigns (adding sediment onto the beach) were also undertaken. The last beach recharge campaign was in 2009, with sediment placed between Sea Palling and Poplar Farm. Offshore reefs were designed to stop the direct wave approach to the coast, which is the main way sand is removed from beaches in this area. Beach recharge campaigns aimed to help build up the beach between the offshore reefs and the coast. Although this intervention worked in this part of the coast, it might not work in others. Also, it could have implications elsewhere.



Sea Palling, 1990s © Kevin Burgess

Sea Palling, 2017 ©2019 Google Street View, Image capture: Jul 2017.

4. Predicting the Future under Different Scenarios

Coastal specialists use historical patterns and trends for a given area to help predict future evolution of the coast. This is called extrapolation and usually provides a reasonable and easily understood baseline of the current situation. From the baseline, many techniques can be used to try to predict the future, using computer modelling and comparing to monitoring data. Because of the level of uncertainty on various factors, modelling the future is simulated under multiple scenarios, as a way to inform decisions on future coastal risk management.

It is important to consider the potential effects of various uncertainties and how they could alter future patterns. In particular, we know that the **climate is changing, and the risk in coastal flooding will rise because of increases in mean sea level.** For example, the size and angle of waves are dependent on the water depths close inshore and wind direction. Therefore, higher sea levels resulting in deeper water and a change in wave conditions may lead to different rates of erosion and sediment transport rates. In conjunction with higher sea levels, the changes may result in greater damage to structures and higher rates and frequency of overtopping of the seawalls and increased erosion. Product 9 includes further analysis on the impact of climate change in the BFI area.

Future changes also depend on how coastal management is implemented in the area. Frontages fixed by structures with eroding areas between them will emerge as headlands, protruding seaward in comparison with the non-protected areas. These headlands will become more prominent in the future, and with current rates of erosion could protrude by more than 100 metres in coming decades. These locations are likely to become very exposed to the impact of the sea and may not have natural beaches. These headlands could also significantly interrupt or end the sediment supply to the beaches, including those further to the south along the Eccles to Winterton frontage and beyond.

Beach at Bacton looking towards Mundesley © Rob Goodlife

Other forms of human intervention can also affect how the coast changes. For example, the recently completed **Bacton Sandscaping project** has placed around 1.8 million m^3 of sand on the beaches in front of Bacton Gas Terminal providing wider beaches here and to the villages of Bacton and Walcott (note that during storms Walcott structures can be overtopped which then drains into the northern Broads). The effects of this project further along the coast are not yet fully understood. It is anticipated that it could have positive impacts such as providing additional sediment to areas south. However, monitoring will be needed to assess how the scheme performs and how the sediment moves with natural processes.

Other critical factors to be considered are the rise in sea levels and the scour of the sea bottom due to tidal currents and waves. This will affect the feasibility of continuing to maintain the current seawall alignment between Eccles and Winterton. With increasingly deeper water inshore, the energy from waves and extent of high water is greater and beaches become less stable. The potential to retain sand on beaches here reduces as the coast is prevented from naturally moving landward by the seawalls, which themselves become more exposed and vulnerable to damage. In this situation, the means of moving sediment along the transport pathway is disrupted, and sediment supply to beaches further south is also affected. The sea structures also become at risk of failing as described above at Sea Palling in the 1990’s.

Aerial photographs from Bacton in 2007 (top) and 2019 (bottom) during the implementation of the Bacton Sandscaping scheme

5. Summary

The key coastal processes and reasons why the coast is changing are:

- **The coast between Cromer and Great Yarmouth is a naturally receding coast**, as has been recorded for centuries, and the processes that have driven that recession since the last glaciation are still operating today.
- **Erosion of the North Norfolk cliffs are the main source of sediment to this entire coast**, with the sand and gravels coming from those cliffs to form beaches. The material is then moved south by waves, supplying the beaches along the Eccles to Winterton frontage. The sand and shingle keep moving along the coast, reaching Winterton Ness and the beaches all the way down to Great Yarmouth.
- **Man-made structures built on the coast between Cromer and Winterton in an attempt to prevent cliff and dune erosion**, impact on the amount of sediment supplying the beach and also on the longshore coastal processes. Over time beaches continue to erode along the wider coast leading to these structures become increasingly vulnerable and harder to maintain, alongside further erosion of beaches, cliff and dunes.

A strategic approach to the management of the coast is therefore fundamental to sustainable flood and coastal erosion risk management in the future. Although predicting how the coast will alter in the future is complicated by a number of uncertainties, including how climate change will impact the different processes, the underlying trends and challenges are well known and can be assessed. It is however clear that it is highly likely that it will become increasingly challenging to manage the coast as time progresses.

Sand dunes south of Happisburgh © Kelly Fisher

6. What is the Broadland Futures Initiative?

The Broadland Futures Initiative (BFI) is a partnership for future flood risk management in the Broadland area. Our main goal is to agree a framework for future flood risk management that better copes with our changing climate and rising sea level. The focus is to define a flood risk management plan for Broadland over approximately the next 100 years putting people at the heart of decision making.

BFI has been set up by organisations responsible for managing flood risk, working together with partners. The Environment Agency, Natural England, County and District Councils, Internal Drainage Boards, Broads Authority, National Farmers Union, Water Resources East, the Royal Society for the Protection of Birds (RSPB) and the Wildlife Trusts will work together in developing the plan.

Elected members representing local communities will be the decision makers. This will be a democratic process, with local politicians making the core decisions in order to agree the future flood risk management plan, having considered the latest projections on our changing climate.

The plan will be developed over a number of stages. This document is part of establishing the background to the plan. For more information about the BFI and how it's organised see our Frequently asked questions document.

Other documents to be produced during this initial stage are shown below. Some of these are aimed at the general public while others are more technical in nature. They will be available through the BFI website: https://www.broads-authority.gov.uk/looking-after/climate-change/broadland-futures-initiative

- Origins of the plan area
- Sources and nature of flood risk
- Current approaches to flood risk management
- The influence of flood risk management
- Strategic plans and documents review
- Existing key data sources and indicators
- The future impacts of climate change
- The result of initial stakeholder survey
- Objectives for the plan
- The methodology for options appraisal and preferred options selection
- Strategic environmental assessment scoping
- Frequently asked questions

7. Glossary

Broadland Futures Initiative (BFI): A partnership formed to agree a framework for future flood risk management in the Broadland area. The strategy aims to better cope with our changing climate and rising sea level. Planning has started now with the strategy to be implemented from the mid-2020s onward.

Climate Change: Any significant long-term change in the expected patterns of average weather of a region (or the whole Earth) over a significant period of time.

Coastal processes: The ways by which the coast changes. The main coastal processes in Norfolk are erosion, transportation and deposition.

Deposition: The process by which waves and tides lose energy, cease to transport and release eroded material, depositing it.

Foreshore: The zone between Mean Low Water and Mean High Water, usually seen between tides on a beach.

Embankment: An artificial, usually earthen, structure constructed to prevent or control flooding, or for various other purposes including carrying roads and railways.

Erosion: Process of breaking down of land by the force of waves.

Estuary: The wide mouth of the river where it joins the sea. Seawater and fresh water mixes, providing high levels of nutrients, making estuaries among the most productive natural habitats in the world.

Floodplain: Area of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding.

Flood risk management: Action that aims to reduce the likelihood and impact of floods. Experience has shown that the most effective approach is through the development of flood risk management programmes incorporating the following elements:

- **Prevention:** preventing damage caused by floods by avoiding construction of houses and industries in present and future flood-prone areas by adapting future developments to the risk of flooding, and by promoting appropriate land-use, agricultural and forestry practices;
- **Protection:** taking measures, both structural and non-structural, to reduce the likelihood of floods and/or the impact of floods in a specific location;
- **Preparedness:** informing the population about flood risks and what to do in the event of a flood;
- **Emergency response:** developing emergency response plans in the case of a flood;
- **Recovery and lessons learned:** returning to normal conditions as soon as possible and mitigating both the social and economic impacts on the affected population.

Habitat: Natural home or environment of an animal, plant, or other organism.

Inshore: The zone where waves steepen and break. Most of the sediment is transported within this zone (alongshore and cross-shore). Also known as "Nearshore".

Offshore: The zone beyond seawards of nearshore, where waves cease to have any influence on the seabed and in which activity is limited to deposition of sediments.

Protected areas: Areas with structures that protect the coast against flooding or erosion.

Risk: Combination of the probability that an event will occur and the consequence to receptors associated with that event.

Sediment: Grain material that can be transported in water or air. In Norfolk, sediments are clay, mud, sand or gravel. Along the Broads frontage, sediment is mainly sand with some shingle.

Sediment transport: The action of transporting sediment (sand or gravel) along the coast or across the coast by the action of waves and/or tides.

Storm surge: Rising of the sea as a result of wind and atmospheric pressure changes associated with a storm.

Transportation: The process by which eroded material moves somewhere else by the action of waves and tides.

Seawall at Horsey Gap © Jeremy Halls

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