CASE STUDY 3A – EAST ANGLIA, UK

Case study area: East Anglia, UK

Main geomorphological types: Soft cliffs, shingle and sandy beaches, shingle spits, creeks, estuaries and saltmarsh.

Main coastal change processes: Coastal erosion, cliff instability, beach change.

Primary resources used: Art, Archaeology.

Summary: The study area comprises extensive clifflines of glacial till which are subject to erosion and instability. Artistic depictions have enabled us to see the rate and scale of this erosion over the last few hundred years. This has been complemented by the extensive archaeological record demonstrating this loss particularly from the Medieval period.

Recommendations: Coastal managers should use these resources when predicting future rates of erosion as they provide hundreds of years' worth of data to assist in the understanding of the rate of change. Further work into historic maps and charts is recommended as this can provide even more detail particularly from the 19th Century.

Coastal managers face an ongoing battle to moderate impacts from the sea in the face of a changing climate and pressures from human use of the coastal zone. The challenges that lie ahead are forecast to increase while resources are being forced to go further.

This case study report is part of the technical report on the Arch-Manche project, which quantifies the value of under-used coastal indicators that can be applied as tools to inform long term patterns of coastal change. In addition, it provides instruments to communicate past change effectively, model areas under threat and interpret progressive coastal trends.

East Anglia is one of six UK case study areas for the Arch-Manche project. This case study report introduces the study area and why it was chosen as part of the project, the results of the archaeological and palaeoenvironmental study are then presented along with the results of the art, photographic, and map and chart studies. The analysis of these results and the potential for demonstrating the scale and rate of coastal change are then presented. For further details about the project methodology see Section 2.

Within the East Anglia area the archaeological and palaeoenvironmental resource and the available art resource have been researched, ranked and analysed. The extents of the detailed study areas are shown in *Figure 3A1* below. The area considered for archaeology and palaeoenvironment has been selected to provide a representative range of types of evidence across a range of periods spanning from Palaeolithic through to more recent coastal heritage. The art, photograph and map and chart case study area encompasses a broader stretch of the coastline to reflect the various coastal morphologies and features which have been depicted over time.

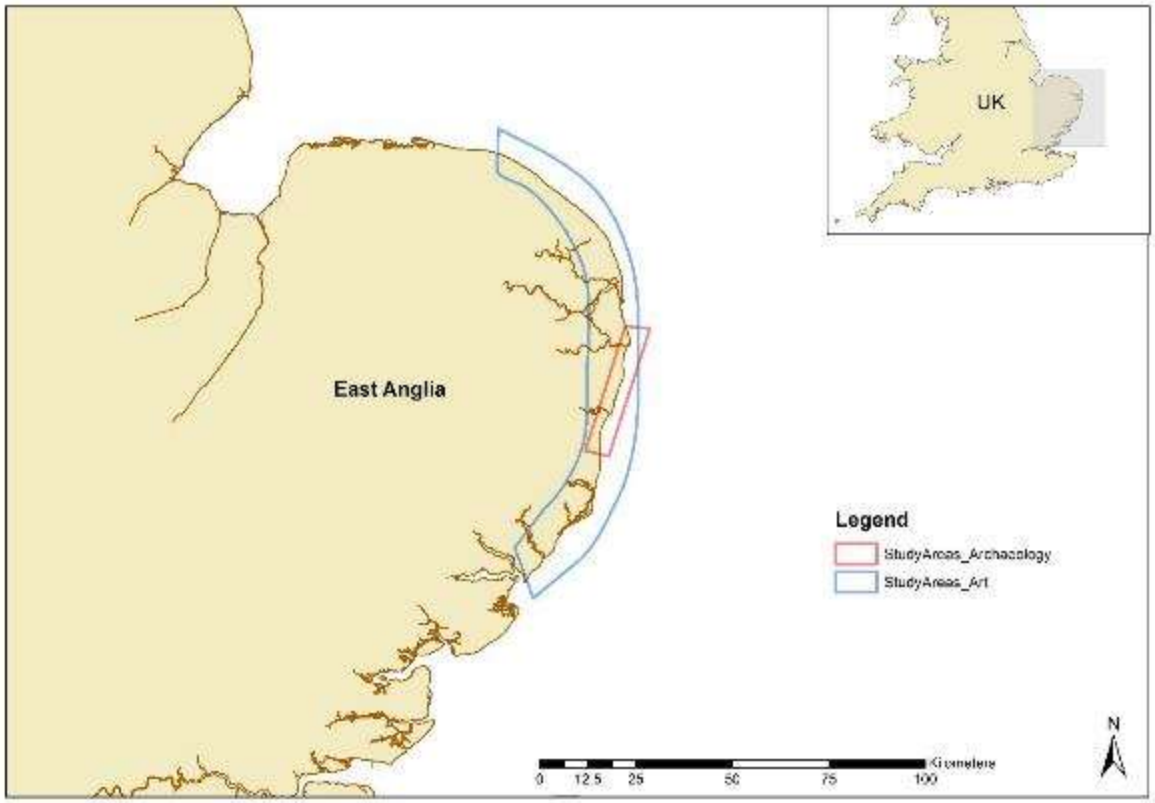


Figure 3A1. Map of the East Anglia Study Areas

3A.1 Introduction to the East Anglia Study Area

The coastline of East Anglia has been subject to urban development progressively over the last 1,000 years. The coastal zone makes a very significant contribution to the economy of the East Anglian region, as well as providing opportunities for relaxation, recreation and enjoyment within an outstanding natural environment. The coastal local authorities have been actively involved in encouraging improved integrated management over the last two decades, and this has led to the production of strategies for the coast in support of the principle of sustainable development. On account of the physical problems arising along this coastline, thorough consideration has been given to existing and potential impacts on people, property and the natural environment. Risk management strategies, known as *Shoreline Management Plans* (SMPs), provide a framework for addressing the hazards of erosion, flooding and coastal instability along this coastal frontage.

There is little doubt that climate change will exert an increasing influence on the lives of East Anglian coastal residents and businesses over the next decades by affecting the pace of coastal erosion, the frequency of sea flooding events and increased landsliding, comprising both first time failures and the reactivation of currently dormant coastal landslides. This will impose increasing pressures on the study area coastline and, as a result, has necessitated changes in the approach to the management of risks. In East Anglia it has been recognised that it is impossible and, indeed, undesirable to defend all parts of this coastline, and the development of shoreline management plans for East Anglia is helping to ensure wise coastal decision-making, which has been based upon a growing understanding of coastal evolution and natural physical processes.

Residents and businesses along the East Anglian coast are becoming increasingly aware of the risks posed by coastal erosion and flooding by the sea. Along this frontage some developments have taken place, historically, in vulnerable coastal locations, and this has increased the risks to both commercial development and residential properties. Along those parts of the Norfolk and Suffolk coasts where development has taken place, efforts have been made over the last few centuries to protect people, property and assets from the impacts of erosion and sea flooding. Traditionally this has been achieved through the construction of sea walls, which still provide vital protection for many of the historic coastal towns and seaside resorts and other key infrastructure, alongside residential properties. However, in some locations construction of defences has, inevitably, had an effect on the natural coastal systems such as longshore drift, causing an adverse impact on coastal frontages down-drift including beaches and salt marshes, and sometimes resulting in increased erosion or instability problems further along the coast.

East Anglian coastal engineers have been at the forefront in helping to advance coastal science in these areas. Research has led to the recognition that, where possible, natural physical processes such as erosion, sediment transport and deposition, should be allowed to continue uninterrupted and that coastal defence can be achieved quite effectively by trying to *work with nature*, for example, by encouraging the build-up of beaches as a very effective form of natural coastal defence. Clearly the situation will vary from one part of the coastline to another, and the most appropriate solution to any coastal defence problem must be considered, taking account of all relevant factors along the whole of the coastal frontage.

In recent centuries and decades the most usual response to protection of property and assets has been the construction of coastal sea walls and flood defences. This has been necessary because East Anglia experiences some of the fastest rates of cliff retreat and most serious flooding problems around the coastline of North-Western Europe. There is a long-term chronology of coastal change, which is evidenced from early maps, sea charts and historical literature accounts. For example, the ancient, lost city of Dunwich on the Suffolk coast was destroyed through progressive marine erosion in the Middle Ages; at this location the coastline has retreated by some 2km since Roman times. Whilst, on parts of the North Norfolk coastline nearly 200 metres of cliff recession has taken place since the late nineteenth century.

Coastal risk problems have often arisen because of a lack of co-ordination in the past between land use planning and development proposals. Parts of the East Anglian coastline developed rapidly, particularly in the Victorian and Edwardian periods when the seaside became popular, and this led to an inheritance of unplanned communities and developments, a number of which were built on eroding cliff tops and in other less sustainable locations. Alongside erosion, coastal flooding is a longstanding problem and historical accounts dating back to Medieval times mention flooding in East Anglia *"houses were destroyed... some 500 people perished"* in 1287 (Brooks, 2007).

During the early medieval period the Middle Peat in the upper valleys of Broadland was extensively excavated to provide fuel (Lambert and Jennings 1960), as shown by borehole data, topographic studies and historical sources. The first phase of peat extraction had ceased by the end of the 14th century, after which the peat pits became flooded and then partly infilled with sediment, forming the present Broads.

The most serious flooding event in East Anglia occurred in 1953, and is regarded as the worst national peacetime disaster to hit the United Kingdom. Exceptional weather conditions, coupled with poor communications, meant that whole communities were given insufficient warning of the advancing threat; the Storm Tide Warning Service was set up after this flood. The government

has now put in place a coastal risk management framework, which gives overall responsibility to the Environment Agency, which will work in partnership with the East Anglian coastal local authorities to ensure its successful delivery. It will have to implement policies that address the increasing risks facing the study site frontage whilst also meeting the inevitable financial constraints (Defra, 2007).

It is now widely agreed by those involved in coastal risk management that meeting the challenges of coastal climate change is the most important issue to be faced by decision-makers and the communities they represent. In recent years a significant amount of research and investigation work has taken place in East Anglia in order that appropriate decision-making can be put in place through the planning and political processes. Steadily improving forecasting now being achieved at the sub-regional scale will be a particular value, alongside strategic coastal monitoring programmes, and the investigation of practical solutions involving adaptation to coastal climate change (North Norfolk District Council, 2012). The justification of need for forecasting storm events along the East Anglian coastline, and its efficacy is demonstrated by the response to the most serious storm surge event in the North Sea since the 1950s floods, which occurred in December 2013.

3A.1.1 Geology and Geomorphology

This section outlines the key geological and geomorphological features and processes of the study area. These factors have a significant impact on the on-going changes to the coastline and associated sites, deposits and features preserved related to the archaeological and heritage resource, in addition to being depicted through a range of art sources.

Geological History

The geology of Norfolk and Suffolk dates back to the Cretaceous period and, although masked by more recent glacial deposits, the earliest rocks are approximately 140 million years old. In Norfolk sands and clays were deposited in a shallow tropical sea during the Cretaceous period, particularly in north-west Norfolk, whilst elsewhere expansive spreads of sediments deposited during the Ice Age covered the chalk bedrock, which underlies much of the County. The relatively flat surface created by these deposits together with the immense physical power of the ice sheets, resulted in the wide coastal plain of North Norfolk, which meets the sea as a series of spectacular coastal cliffs in the north-east of the County. The array of surface sediments has given rise to varying soil conditions, land cover and habitats in the coastal zone, a number of which are designated for their environmental significance.

During the Tertiary period, from 65 million years ago, there was a significant fall in sea level, and the area now occupied by the County of Norfolk became land. The incoming of a shallow sea later in the Tertiary and the earliest Quaternary, (approximately two million years ago), resulted in the deposition of shelly sands, known as the Norwich Crag. The subsequent cold and warm climatic phases during the Quaternary period led to deposition of complex sequences of sediments known as the Cromer Forest Bed Series.

Around 450,000 years ago a severe cold phase known as the Anglian Glaciation caused an ice sheet to spread across East Anglia, occupying the whole of Norfolk. As the ice advanced it eroded the ground over which it passed, the eroded material then being deposited at the base of the ice to form sheets of till (Boulder Clay). Associated with the tills are suites of gravel formed at the edge of the ice sheet; these gravels form the impressive Cromer Ridge. These vestiges of former glaciation, with a mix of till, sands and gravels, provide the complexity of soils that characterise the Norfolk coastal zone, and give rise to the great variation in land cover.

By contrast, the geology and geomorphology of Suffolk is relatively simple. Extensive spreads of till, or Boulder Clay, deposited over the last one million years, cover the gently undulating plateau (underlain by chalk) that forms much of the County. The late Tertiary to Quaternary Crag Deposits are marine sandstones, formed when much of Suffolk was below sea level. The variable nature of these sediments gives rise to mixed habitats and landscape types.

Over the last two million years the climate of Suffolk has varied tremendously with periods of temperate climate interrupted by repeated advances and retreats of glaciers and ice sheets. Collectively these periods have become known as the Ice Age, and the action of ice sheets has been instrumental in forming the landscape as we know it today. Deposits from the Ice Age (or Quaternary) are widespread in Suffolk, and comprise a large spread of till (or Boulder Clay) over much of the County, or as glacial gravels in the east. These gravels were deposited around 600,000 years ago.

Over the last 10,000 years the sea has risen by 30m, and is currently rising at an estimated 2mm per year. The relative levels of land and sea during this period have dominated the physical development of the Suffolk coast. Accumulations of shingle, known locally as ‘Nesses’, have developed at Benacre and Thorpeness, while at Aldeburgh the second largest spit in Europe, Orford Ness, commences. Orford Ness has diverted the mouth of the River Alde for a distance of about 20km south from its original outlet of Aldeburgh. Behind Orford Ness are salt marshes, which have developed in the calmer conditions provided by the spit. Along the cliffed part of the coast, erosion has been very active. Dunwich is one of the best known sites in East Anglia to be affected by erosion. It was an important city in the time of King Henry II, and has now almost completely disappeared.

Geomorphological Processes and Human Intervention

The northern extent of the Arch-Manche East Anglian study area is the town of Cromer, where coastal defences protect the weak cliffs composed of glacial tills, sands and laminated clays. To the east is the village of Overstrand, where the cliffs rise to approximately 35m and have been affected significantly by rotational landslide and mudslides. Processes of slope instability are particularly active along this part of the Norfolk coastline, producing failures of the over-steep glacial sea cliffs. The coastline to the east is marked by low crumbling cliffs and high sand dunes, which are particularly vulnerable to attack by storm waves from the North Sea.

In some locations efforts have been made to stabilise sand dunes through the planting of Marram Grass, whilst, elsewhere, such as at Sea Palling, substantial sea defences were undertaken, particularly between Happisburgh and Winterton, following the breach of the sand dunes during the tidal surges of January 1953. The villages along this coastline, particularly Happisburgh, demonstrate the force of the sea and the challenges of coastal risk management. The impracticality of continuing to defend some coastal communities has necessitated new solutions and the Council has been developing innovative approaches, with support from the Department for Environment, Food and Rural Affairs (Defra), towards adaptation to help sustain affected residents and businesses (North Norfolk District Council, 2011).

The coastline to the south consists of wide sandy beaches backed by low cliff lines and includes important resorts such as Great Yarmouth and Gorleston-on-Sea, where the River Yare meanders through a low-lying flood plain, before turning sharply south to create the peninsula on which the town of Great Yarmouth is built. The coastline to the south of Gorleston consists of low-lying crumbling cliffs with sandy beaches, and the ruins of ancient churches such as those at Hopton-on-Sea and Corton. The seaside resort of Lowestoft to the south is divided by a narrow strip of water called Lake Lothing, whilst, to the south, at Pakefield, a sandy, shingle

scattered beach lies below low grassy banks. The church of St Margaret and All Saints dates from the fourteenth century and stands close to the cliff edge which has, in the past, been affected by erosion and instability.

South of Lowestoft towards Southwold, the beaches are wide and composed of shingle, broken only by hamlets such as Covehithe where the ruined church of St Andrew is dramatically situated. South of Covehithe, a sand and shingle beach stretches down towards the historic town of Southwold, and a reedy lagoon amongst the sand dunes behind the beach is an important wildlife habitat. The coast between Covehithe and Southwold is backed by an undulating cliff line, and is intersected by a number of stretches of low-lying land backed by saltmarsh (for example, Easton Broad and Easton Marshes). Cliff recession here is very rapid, providing a supply of sand to the beaches at Southwold. Continued coastal retreat threatens the stability of the shingle ridges in the area, which protect the low-lying marshland from inundation by the sea.

The town of Southwold is situated on high ground and is fronted by a relatively narrow, well defended sand and shingle beach. To the south of the town, a wide sand and shingle beach has built up against the north pier of Southwold harbour. Some of this sandy material is transported in suspension by the sea across the mouth of the harbour to the community of Walberswick on the south side, where the beach remains relatively stable. Shingle ridges exist between Walberswick and Dunwich, which are occasionally overtopped by the sea. To the south the higher cliffs of Dunwich and Minsmere are eroding, and also provide a significant source of sediment for the beach. To the south of Minsmere cliffs is the low-lying land of the Minsmere valley, fronted by a shingle ridge. The land then rises at Sizewell, running into the Thorpeness Cliffs, down to Thorpe Ness (Royal Haskoning, 2009).

To the south of Thorpe Ness is the seaside town of Aldeburgh that is located on the promontory of Thorpeness. To the south of the town, a Martello Tower marks the start of Orford beach, and the massive shingle bank that extends south as far as Orford Haven to form Orfordness. This spit reflects the mouth of the river Alde from an approximate west to east alignment, to a roughly north to south alignment. The change in alignment occurs at Slaughden, south of the town of Aldeburgh. Orford Ness is a shingle foreland that shows changes in elevation attributable to changes in sea level rise over the time of its formation. The Ness has been formed over the last 6,000 years and has received sediment supply by longshore drift from the north. The location marks the southern end of the East Anglian study area.

3A.1.2 Summary of the Archaeology and History of the Study Area

The archaeological and palaeoenvironmental study area in East Anglia focusses on the Suffolk coast, extending from Lowestoft in the north to Dunwich in the south. The coastline consists of low-lying wetlands and Broads separating large stretches of cliff which reach up to 17m above sea level. These coastal cliffs have been subject to the fastest recorded recession rates in the UK. The study area also encompasses the estuary of the River Blyth, which is relatively narrow and largely embanked.

The study area was chosen due to the dynamic and rapidly changing nature of this coastline, as well as the presence of important archaeological sites such as Pakefield, with inter-glacial deposits containing some of the earliest evidence of human activity in Northern Europe as well as the well-known medieval town of Dunwich, now lost to the sea.

A report for the Crown Estate in 2010 recognised that ‘this coastline presents one of the greatest future management challenges for the region in particular and the UK as a whole as it

undergoes such rapid retreat' (Brooks, 2010:2). The presence of an array of archaeological and palaeoenvironmental features along this stretch of coastline, dating from 700,000 BP help to define the nature, scale and pace of coastal processes and contribute to the management of such a challenging and rapidly changing environment.

The area chosen also corresponds with one of the six areas covered by the Suffolk Coast National Mapping Programme (NMP) as part of the Rapid Coastal Zone Assessment (RCZA) of Suffolk commissioned by English Heritage.

Early Prehistory (Palaeolithic and Mesolithic)
Evidence for the Pleistocene period includes worked flints, butchered animal bones and plant remains now exposed in the cliffs along the Suffolk coast, in particular the area of Pakefield. This Lower Palaeolithic material has been found in-situ within the Cromer Forest-bed Formation and is thought to be the earliest evidence for human activity in northern Europe, dating to c. 700,000 BP (Parfitt et al. 2005; Lee et al. 2006; Wymer and Robins 2006). Excavations were carried out between 2001 and 2005 on the Pakefield site, and finds include a handaxe, several struck flakes, and faunal remains including rhinoceros and bison (Lee et al 2006). Prior to the discovery of in-situ material at Pakefield, the majority of Palaeolithic evidence consisted of sporadic finds of handaxes from the beaches on the Suffolk coast.

Evidence from the Mesolithic Period has mainly been found in plough-soil, where contextual material has been largely destroyed. There is thought to be potential for stratified material in the estuaries, where silts and peats formed over dry land as sea levels rose after the last glacial maximum (Good & Plouviez, 2007:8).

Later Prehistory (Neolithic, Bronze Age and Iron Age)
As with material from the Mesolithic period, evidence from the Neolithic has been largely affected by intensive agriculture and ploughing along the Suffolk coast. This period witnessed the introduction of agriculture and the construction of large monuments. Circular structures and causewayed enclosures have been recorded along with Neolithic artefacts on sites further inland, such as Hadleigh, Barking and Freston and flint scatters of Neolithic and Bronze Age types have been found at Hollesley, overlooking marshland (Medlycott, 2011: 11, Good & Plouviez, 2007:9). However, these fall outside the case study area.

Within the area, assemblages of Neolithic flints have been found, generally in the valleys around Kessingland, Gisleham and Benacre. No preserved settlements have yet been found, but the location of the flint scatters near grazing marshes highlights potential for preserved Neolithic material and environmental data.

Bronze Age barrows are located in the sandy upland areas, which have not been affected by cultivation, although not all have been individually dated due to a lack of archaeological excavation. In Walberswick two round barrows are scheduled, and are thought to date to the Bronze Age. Ring ditches and field systems have also been reported within the area. Excavations further inland on the terraces of the River Waveney have revealed Bronze Age ring ditches, settlement here is thought to have occurred over a long period with environmental evidence having the potential to inform on the changing landscape (Medlycott, 2011: 15).

A lack of dated evidence is also an issue for the Iron Age. Current evidence includes several settlements, which are generally unenclosed, although rectilinear field systems and enclosures have been identified through cropmarks along the coastal zone and are thought to date to the Iron Age. Material from the 1st Century BC to the 1st Century AD reflects a strong continental

influence and coins found have allowed for the identification of tribal areas prior to the Roman conquest. A late Iron Age site has been identified in Covehithe, numerous coins suggest that this was in the Iceni tribal area, however, this is now largely lost to erosion (Good & Plouviez, 2007: 9-10).

The National Mapping Programme (Hegarty & Newsome 2005) has identified extensive field systems, broadly dated to the Iron Age/Roman period, although this is based on morphology as opposed to absolute dating. The majority of these sites are further south and outside the study area and so far no large hillforts or defended settlements have been identified.

Roman Period

Following the 43AD conquest and the revolt of Boudica in 60-61AD a second Roman military occupation of East Anglia occurred, this is based on artefact evidence, no early forts have been discovered. Further south, outside of the study area, a shore fort thought to be from the late 3rd Century was identified but destroyed by coastal erosion in the 18th Century, only a few remains can now be seen at extreme low tide (Hegarty & Newsome, 2005:44).

Roman villas are not common in the study area and there is no evidence for formal towns. However, building material has been found along the current shoreline at Gisleham, which may suggest there were several smaller settlements, the date of the site has not been confirmed. In terms of coastal activity, the most common is salt extraction, most known sites are outside the study area, except for some on the Blyth estuary. Walberswick, also on the Blyth estuary, is thought to have functioned as a port, based on scatters of surface finds (Good & Plouviez, 2007: 11).

A report for the National Mapping Programme (Hegarty & Newsome, 2005: 43) recognised the probability that many sites located on the Roman coastline would have been lost, and military sites, roads and urban settlements appear to have been focussed in the west and beyond the study area.

Medieval Period (500AD – 1485AD)

For the early Medieval period there appears to be a marked drop in the visibility of archaeological monuments, although this could be due to low levels of investigation (Good & Plouviez, 2007:11-12). Most evidence from this period is from cemeteries such as the famous boat burial in Sutton Hoo. However, excavations at Bloodmoor Hill, Carlton Colville, revealed a very well-preserved early Anglo-Saxon settlement with associated high status burial and industrial activity (Lucy et al, 2009).

Overlooking the estuary of the River Blyth a possible Anglo-Saxon barrow and ship burial have been identified, although further work is needed to confirm this, the location close to the estuary highlights the potential for waterlogged deposits. Several items from the area around the River Blyth have been recorded including a writing styli and decorated whale bone, historical resources state that Blythburgh is the burial place of King Anna of East Anglia and his son in 654 AD (Good & Plouviez, 2007: 43).

With the known rates of erosion on this coastline, it is likely that any Anglo-Saxon coastal sites have now been lost to the sea. A trawler dragged up a complete dugout near Southwold which has been dated to the middle Saxon period (Good & Plouviez, 2007:13).

Records from the later Medieval period of Suffolk are dominated by the Medieval town of Dunwich now lost to the sea, other examples include Easton Bavents and Sizewell church, all of

which were lost by the 19th Century. Dunwich was a thriving port from the 11th Century, mainly due to its fishing industry. However, a storm in 1328 shifted coastal shingle banks, blocking the harbour mouth and consequently shifting trade to nearby Walberswick. The reduced economy meant that the town could no longer invest in sea defences and was quickly affected by coastal erosion, with several kilometres of coastal hinterland being lost (Hegarty & Newsome, 2005:7).

Eight churches and two priories were constructed in the Medieval town of Dunwich, of the two priories, Blackfriars and Greyfriars, only the remains of Greyfriars can still be seen on the cliff edge today, Blackfriars was lost to the sea in the 16th Century (Good & Plouviez, 2007:47). Prior to the growth of the town in the Medieval period it is believed that Dunwich was originally the site of a Roman coastal fort and later Saxon settlement, based on finds of Roman tiles at several religious sites (Sear et al, 2013:15).

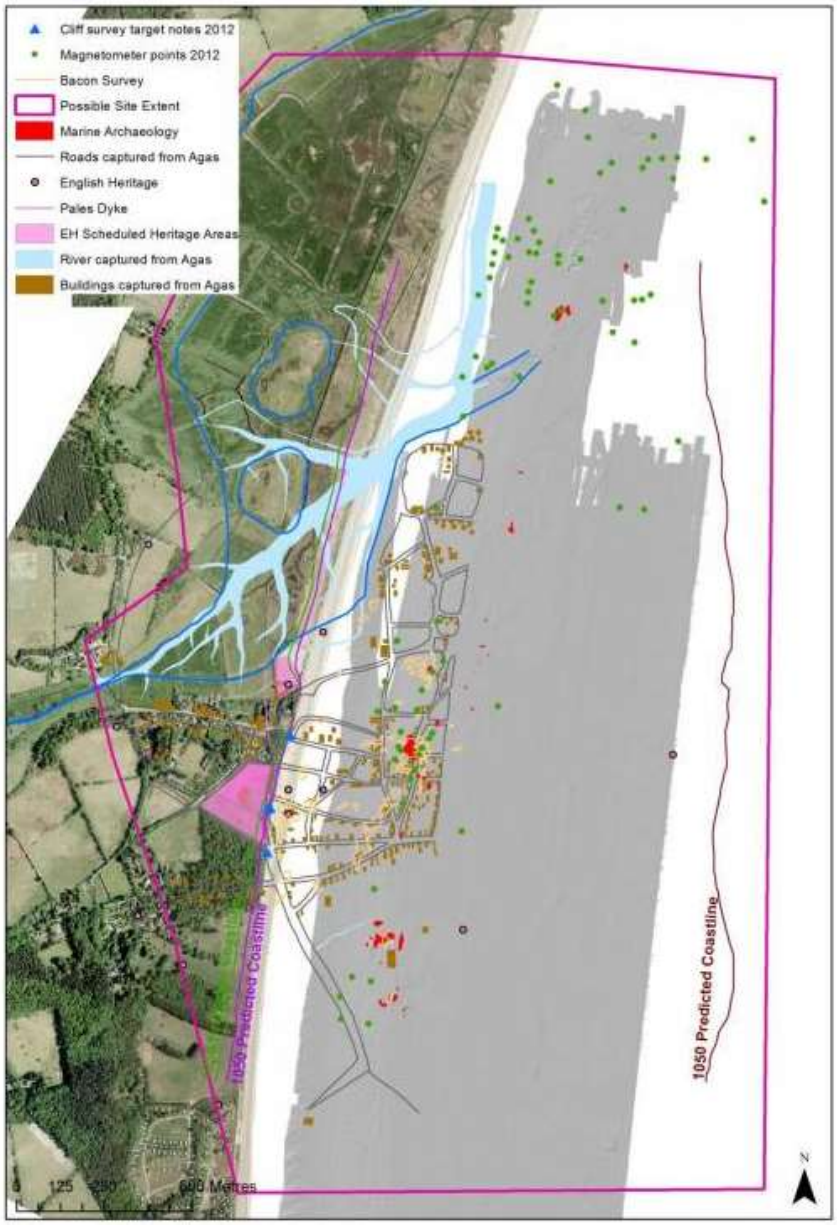


Figure 3A2. Reconstruction of the Dunwich boundary. (Sear et al 2013:Figure53)

Post-Medieval Period (1485AD – 1901AD)

The Post-Medieval period saw significant levels of construction of coastal military defences. The low lying nature of much of this coastline meant that it was seen to be vulnerable to attack, however, many of these defensive sites have now been lost through erosion (Hegarty & Newsome, 2005:14). Most notable are the Martello Towers built during the Napoleonic Wars as part of anti-invasion defences, many of which still survive but are located just outside the study area. The position of the towers was used to georeference historic maps as part of the Crown Estate study into coastal change (Brooks, 2010).

As well as defences from military attack, several modifications to the landscape were carried out in order to reclaim land, and defend the coast against the sea. Much of the Suffolk coast is now made up of drained, embanked and reclaimed land, within the study area this is particularly noticeable around the Blyth estuary.

Within the estuaries several timber quays and oyster beds have been identified, and many Post-Medieval wrecks have been recorded off the Suffolk coast. Most of these are from the late 18th and 19th Centuries. Some earlier shipwreck sites survive, for example, Dunwich Bank, a designated wreck site from an unknown 16th Century vessel, which can provide information on sediment processes off this dynamic coastline.

Coastal towns relied mainly on the fishing industry, although like Medieval Dunwich they were often faced with issues of silting, Walberswick was constantly battling with the silting up of the river and slowly decreased in size, although still remains as a small fishing village. However, several towns along the Suffolk coast flourished in the 19th Century. The building of the harbour and the railway in Lowestoft boosted the fishing industry but also led to the town becoming a popular seaside resort. Southwold, a prosperous port in the Medieval period also attracted visitors with its beaches, however, its importance as a harbour town decreased in favour of Lowestoft, which meant that the towns economy began to rely solely on tourism and a railway line was opened in 1879.

Modern

The majority of sites from the 20th Century comprise WWI and WWII defence systems on the Suffolk coast. These include pillboxes, batteries and anti-tank ditches. Many of these are being affected by the rapid erosion along the Suffolk coastline.

Other sites from this period include mills, often built earlier they have been used and modified in the early 20th Century. One such site is Marsh Mill, Walberswick, in use until 1940, and although damaged by fire and target practice during the war, the remains can still be seen today.

The major coastal town of Lowestoft continued to be important for trade until the start of WWI but had declined completely by the 1960's. Southwold continued to attract visitors as a seaside resort and the famous pier was constructed in 1900. The pier was severely damaged by a storm in 1934 and was also damaged during WWII, but was later refurbished and Southwold continues to thrive as a seaside resort.

3A.1.3 Archaeological, Palaeoenvironmental and Coastal Heritage Resources Consulted for the Project

Archaeological and palaeoenvironmental data has been obtained from the NRHE, UKHO and the Suffolk HER, further information about the data collected for the project is available in Section 2.1.

Several key projects have been carried out in East Anglia over the last twenty years which have been consulted. The majority of this work has been a result of the English Heritage Rapid Coastal Zone Assessment (RCZA) process. English Heritage recognised that there was a lack of understanding of the archaeology in the coastal zone and that the historic environment needed to be integrated into coastal management schemes, as a result a series of RCZA's were commissioned along the English coast. Alongside this, Suffolk Council also recognised the need to record coastal archaeology before it was lost to erosion. These programmes resulted in several reports including, *The Archaeology of the Suffolk Coast* (Good & Plouviez, 2007) and *The Archaeology of the Suffolk Coast and Intertidal Zone* (Hegarty & Newsome, 2005). The programmes included the study of aerial photography, an assessment of historic maps and documentary evidence, as well as a field survey of the intertidal zone, sites were then added or updated in the Suffolk HER. These reports have provided a general overview of the archaeology and history of the Suffolk coast, and the current management situations.

Alongside this, work has been carried out on the regional research framework for East Anglia, this appeared initially in two parts, a resource assessment (Glazebrook, 1997) and a research agenda and strategy (Brown and Glazebrook, 2000). This work was then reviewed and a revised framework was published looking at key projects since 2000 and assessing progress made on research topics identified in the previous reports (Medlycott, 2011). This provided an overview of the main archaeological projects as well as highlighting gaps in understanding and potential for further research.

The Suffolk Shoreline Management Plan was also consulted, the most recent being the SMP7 from 2010. This report identifies risks along the coast and preferred management policies.

Alongside these broader programmes several more specific research projects were consulted, on the key archaeological and palaeoenvironmental sites from the case study area; Pakefield and Dunwich. Simon Parfitt and Chris Stringer have worked on the archaeological deposits on land at Pakefield (Parfitt et al, 2005), demonstrating that the site contains the earliest evidence for human occupation in Europe. Further work by Wessex Archaeology (2008) through the Aggregate Levy Sustainability Fund aimed to assess the potential survival of similar deposits offshore.

A large collaborative projected funded by English Heritage was carried out on the historic town of Dunwich (Sear et al, 2013), this project included the use of marine geophysical survey techniques and diver surveys, alongside historical documentary and geospatial evidence, as well as land based archaeological evidence. This allowed the team to produce a map of the changing coastline and the current extent of the site (*Figure 3A2*).

3A.1.4 Art History of the Study Area

This section presents the background to artistic representations within the area including key schools and individual artists. This provides the background to the broader consideration of individual artworks within the study area.

Introduction

The art study area extends for a distance of 130km from Cromer in North Norfolk, eastwards and then southwards to Orford Ness in Suffolk. The site was selected on account of its varied geomorphological conditions, which include eroding clay and sandstone cliffs, coastal landslides, and low-lying land, which is prone to flooding by the sea. The location also has an outstanding art heritage resource.

The counties of Norfolk and Suffolk have a particularly rich art heritage comprising landscape paintings, watercolour drawings and prints, together with a large number of extensively illustrated topographical books. These works of art, which have been produced since the late eighteenth century, may be used by coastal scientists to provide supporting information to our understanding of long-term coastal change. Extending back long before the days of photography, images of the East Anglian coast depict physical and environmental changes over the last two hundred years as well as describing social change on the coast (McInnes & Stubbings, 2010). As well as depicting coastal erosion, flood events and natural change, works of art can illustrate progressive coastal development, as well as changes in landscape and agricultural practices. This additional information is particularly valuable in terms of supporting coastal monitoring programmes such as that of the East Anglian Coastal Group working in partnership with the Environment Agency (East Anglian Coastal Group, 2013). Through art it may be possible to take advantage of the wisdom of hindsight and examine the coastline before significant development took place, when natural coastal processes were free to operate in an unconstrained way. This approach for the East Anglian coastal study sites, therefore, aimed to:

- Demonstrate the role that historical works of art (oil paintings, watercolours and prints) can provide in terms of supporting understanding of long-term coastal change;
- Assist understanding of the chronology of coastal change in East Anglia; and
- Provide examples of those artists' works which form reliable records of coastal conditions at the time they were painted.

Literature Review

The coastline of East Anglia benefits from a rich landscape art heritage. This has been noted in a number of key reference works relating in particular to the Norwich School of Artists, art colonies that flourished along this interesting coastline, as well as the works of individual landscape painters residing or visiting the location (Rajnai, 1976; Hemingway, 1979; Walpole, 1997; Scott, 2002; Collins, 2005; Newton, 2005; Ellis (ed), 2005; Ellis (Ed), 2006; Munn, 2006; Walpole, 2009).

The coastline was explored from the late eighteenth century and numerous fine topographical books were published, often illustrated with engravings, aquatints or lithographs (Beatniffe, 1808; Parkin, 1788; Armstrong, 1791; Bell, 1807; Dixon, 1811; Britton & Brayley, 1812; Stark, 1828-1834; Lound & Ninham, 1831; Turner, 1838; Ewing, 1842).

Some artists and writers collaborated and undertook tours of the coastline of the British Isles, producing elaborate illustrated books, for example *'A Voyage Round Great Britain'* by William Daniell and Richard Ayton (Daniell & Ayton, 1814). Commencing in 1814, the voyage took ten years to complete, and the eastern coast of England was painted on the return journey in 1822. Daniell's delicate aquatints accompanied by Ayton's text, together provide us with an intriguing account of this part of the British coastline, including descriptions of coastal erosion events during the early nineteenth century. In 1838 the Finden Brothers published their *'Ports, Harbours, Watering Places and Picturesque Scenery of Great Britain'* (Finden & Finden, 1838), which includes steel engraved views of the East Anglian coast, together with the detailed accompanying descriptive account.

The East Anglian Art Resource

In addition to illustrated books, there is a wealth of paintings and watercolour drawings that form by far the largest number of illustrations of the study area coastline. In particular, East Anglia benefits from a rich resource of landscape painting, which dates back to the start of the nineteenth Century. East Anglia is regarded by some as the 'cradle of English landscape

painting' with celebrated artists from the Norwich School, together with Suffolk artists such as John Constable and Thomas Gainsborough exemplifying the art of landscape painting in this country. Although the latter two great artists rarely painted the coastline of East Anglia, there are, fortunately, a wealth of other painters who chose to illustrate the coastal scenery in sufficient detail.

The culture centre for the arts in East Anglia was the city of Norwich, which benefitted from the foundation of the Norwich Society of Artists in 1803, which held its first annual exhibition two years later in 1805, and continued exhibiting almost without interruption until 1833. The School of Artists was led by a number of outstanding artistic families and individuals including the Crome family, the family of John Stark, the Cotman's, John Thirtle, George Vincent and Robert Ladbrooke.

The most prominent figure in the Norwich School was John Crome (1768-1821) who met a fellow artist, Robert Ladbrooke, during the course of his artistic apprenticeship. With patronage from wealth families from within the County, Crome flourished as an artist and, whilst most of his views are of the city of Norwich and surrounding countryside, he also, painted the coastline, especially the activities of fishermen on the shore at Great Yarmouth beach and elsewhere. Robert Ladbrooke (1769-1842) also painted views of the coastline, particularly at Great Yarmouth. Another member of the same family, John Burney Crome (1794-1842), produced a dramatic painting entitled *'Great Gale at Yarmouth on Ash Wednesday 1836'*, which illustrated the devastating effects of the storm on the sea front properties in that year.

Other important artists of the Norwich School included James Stark (1794-1859) who, together with George Vincent, continued as the mainstays of the Norwich School after John Crome died. George Vincent (1796-c.1835) was, alongside Stark, one of the most important second tier artists of the Norwich School. He first exhibited at the Norwich Society in 1811, again favouring views of the coast such as *'The Fish Auction, Yarmouth'* (1827), which, along with his other works, provided not only an interesting social account but also details of the beach levels and coastal conditions existing at the time.

With John Crome, John Sell Cotman (1782-1842) is acknowledged by most as the leading artist of the Norwich School. Although painting widely in England, Cotman's East Anglian works tend to focus on architectural landscapes of the countryside rather than the coastal scenes. His sons, Miles Edmund Cotman (1810-1858) and John Joseph Cotman (1814-1878) were also prolific painters of the Norfolk landscape and the Broads.

Although the Norwich School flourished in Norfolk there was no similar formal school of artists working in Suffolk during the eighteenth and nineteenth Centuries, rather a number of distinguished landscape painters who were particularly well known, such as John Constable RA (1776-1837) and Thomas Gainsborough RA (1727-1788). Whilst Constable is well known for his magnificent landscapes of the Suffolk/Essex border, and other distinguished works of London and parts of the English coast, there are a few paintings that can assist in understanding coastal change in East Anglia. John Moore (1820-1902) painted coastal and shipping scenes, as well as accurate views of coastal towns such as *'Cromer-Sunrise'*, which clearly indicates the proximity of the town, the cliffs and the coastline in detail.

During the reign of Queen Victoria, and coinciding with the increasing interest in the seaside, sea bathing and natural earth sciences such as geology, many more artists turned to the coastline for inspiration and subject matter. Locations seriously affected by coastal erosion, such as the historic lost city of Dunwich in Suffolk, were painted by J. M. W. Turner as early as

1824. A succession of artists continued to paint the popular subjects of Dunwich, Southwold and Walberswick right through the nineteenth century and into the twentieth century. Well-known marine painters visited the Suffolk and Norfolk coasts including Edwina Hayes (1804-1904), Edwin Ellis (1841-1895), Charles Thorneley (1858-1898), William Anderson (1856-1893), Clarkson Stanfield (1828-1878) and George Stanfield Walters (1838-1924). All painted views along the coastline, many of which were set against the backdrop of the shore and the cliffs. Whilst such works do not necessarily provide the same detailed appreciation of the coast as some of the other artists, their works can give some appreciation of coastal geology, geomorphology and form, which is helpful in a general context.

Topographic artists continue to paint the Suffolk and Norfolk coasts, particularly the cliffed coastlines, ports, harbours and estuaries as well as the resorts. Henry Moore (1831-1895) painted *'Crossing the Bar, Walberswick Sands'* in 1857, whilst Walter Crane (1845-1915) painted a detailed watercolour of *'Eastcliff, Southwold'* in 1886. This illustrates the row of fisherman's huts that used to line the base of the cliffs before they were all washed away in the storms of 1905 (Munn, 2006).

An artist more associated with the Newlyn School of Cornwall, Walter Langley (1852-1922) visited Walberswick in 1891, and produced a number of views of the village as well as of nearby Southwold. Edwin Edwards (1823-1879) was an etcher and engraver who also worked in oils and exhibited views of Southwold and Walberswick at the Royal Academy in 1868 and 1878 respectively. His view of *'Southwold'* (c.1875) clearly shows beach levels, the development of the beach, the nature of the slopes and the cliff top development. Other leading artists who portrayed the coastline in considerable detail included Myles Birket Foster (1825-1899) who painted a view of Cromer as well as several scenes of Walberswick in the 1890s, whilst Charles Robertson (1844-1891), a follower of the Pre-Raphaelite School of Artists, painted a view of Southwold harbour with Walberswick and its windmill in the distance with the title of *'On the East Coast'* in about 1883.

During the late nineteenth and early twentieth centuries increasing numbers of colour plate book illustrations appeared in order to cater for the growing number of coastal visitors. This time period also saw the introduction of colour picture postcards produced by famous companies such as Raphael Tuck and J. & F. Salmon of Sevenoaks in Kent. Book publishers, including A. & C. Black and Salmon's, commissioned a range of artists to paint attractive views usually in watercolour, that could be used as book illustrations. A. & C. Black published their *'Norfolk'* and *'Suffolk'* volumes in 1821 and 1829 respectively; the Suffolk volume was illustrated with 40 plates by Alfred Heaton Cooper.

The keen interest in paintings of coastal scenery in this part of East Anglia continued through the early twentieth Century until the Second World War and beyond, with artists including Sir John Arnesby Brown (1866-1925) exhibiting views of the Suffolk coast, particularly from 1833.

It can be seen from this short overview of East Anglian coastal art that art and related media represent a substantial resource that can be interrogated to support understanding of coastal change. Clearly, works of art need to be proved to be of sufficient accuracy and, in order to address this requirement, a ranking system was refined as part of this project and is described in Section 2.2.

3A.1.5 Art Resources Consulted for the Project

In order to establish the art resource available for this study it was necessary to review the topographical paintings, drawings and prints held by the principal national, region and local

collections covering the Norfolk and Suffolk coastal frontages. To achieve this objective, on-line reviews were carried out of the collections held at the national level within key museums and art galleries including the Tate Britain, the Victoria and Albert Museum, the National Maritime Museum, the British Museum, the National Gallery and the Witt Library at the Courtauld Institute in London.

In addition it was necessary to establish if there were relevant artworks contained in museums and art galleries in East Anglia, including the Norwich Castle Museum and Art Gallery, the Great Yarmouth Museum's collection, King's Lynn Museum, Sheringham Museum, Aldeburgh Museum, Dunwich Museum, Colchester and Ipswich Borough Council museums and galleries, Lowestoft and East Suffolk Maritime Museum, Waveney District Council collection and, finally, the Southwold Sailor's Reading Room. The research has also drawn on findings from the study of the East Anglian Coastline sponsored by The Crown Estate (McInnes & Stubbings, 2010).

As part of the research it was necessary to contact museum and gallery curators and search available publications, as well as undertaking research on the Internet, taking advantage of new facilities such as the Public Catalogue's Foundation volumes and BBC Your Paintings.

Additionally an assessment has been made of art from the study area contained in important publications and, in particular, catalogues of exhibitions at principal London galleries and also in East Anglia itself. The literature sources relating to works exhibited are comprehensive and comprise reviews of the artists and their works (eg. Graves, 1901), together with catalogues and dictionaries published by the museums themselves and interested publishers (e.g. the Antique Collectors' Club). The published works of this kind do, therefore, represent a considerable resource of assistance to this study (Wood, 1978; Russell, 1979; Archibald, 1980; Lambourne & Hamilton, 1980; Mallalieu, 1984; MacKenzie, 1987; Ellis (ed), 2005; Ellis (ed), 2006).

In East Anglia itself the Norwich Castle Museum and art gallery holds a collection of approximately 1,200 oil paintings, 10,000 watercolour drawings, as well as over 8,500 prints. In particular the gallery holds an outstanding collection of the Norwich School of Artists. The breadth of the collection illustrates how the city of Norwich became the centre of a flourishing school of artists, the spirit of which continues today. These artists include Henry Bright, Frederick George Cotman, John Sell Cotman, Miles Edmund Cotman, John Crome, Thomas Lound, George Vincent, Alfred Stannard, Joseph Stannard and Joseph Stark.

The Norfolk Museums and Archaeology Service and the Borough Council own works held in Great Yarmouth Museum's collection, and include important marine painters such as William Joy, as well as coastal and topographical painters including Robert Ladbrooke and John Moore of Ipswich. On the north coast, the Sheringham Museum contains a number of oil paintings which illustrate the eroding coast of Norfolk including the view of Sidestrand church and Eccles church tower on the beach following coastal erosion taking place. The Aldeburgh Museum at the southern end of our study area frontage includes accurate depictions of the low-lying Suffolk coastline by the important artist John Moore of Ipswich. A small museum in the village of Dunwich contains oil paintings by Edward J. Lingwood depicting coastal erosion affecting the All Saints church.

One of the finest collections in East Anglia is held by Ipswich Borough Council museums and galleries, and includes over 900 oil paintings, 7,000 watercolours and 7,000 prints. Established in 1847 the collection also includes important works by the masters of English landscape painting, John Constable and Thomas Gainsborough, and members of the 'Suffolk School'.

Artists who depicted the coast in their collection include Walter Daniel Batley, Henry Davy, John Moore of Ipswich, Bertram Priestman and Henry Robert Robertson.

3A.2 Current Environmental Impacts/Threats and Coastal Management Approach

This section considers the current environmental impacts and threats along the East Anglian coastline and reviews the current coastal management issues and approaches.

3A.2.1 Review of Key Contributors to Coastal Change

It has been explained that the East Anglian study area coastline is affected by a range of physical processes, particularly coastal erosion, sea flooding and coastal instability. The soft rock geology, comprising silts, sands and clays and gravels, offer little resistance to the aggressive marine erosion, whilst the low-lying frontages are particularly prone to flooding as a result of surges in the North Sea. As well as this the coastline has been affected by relative sea level change, the alteration in the location of sediment sources and sinks, as well as the impacts of anthropogenic management (Brooks, 2010).

Coastal erosion over the centuries is evidenced through the losses of a number of communities including Shipden seaward of the town of Cromer, Wimpwell which used to lie off Happisburgh, Waxham Parva formerly situated off Waxham, the village of Ness off Winterton, and Newton Cross which formerly existed seaward of Hopton. Many of the existing coastal villages were originally also much larger in extent.

On the Norfolk coast the ruins of Eccles church existed on the beach for many years, whilst in Suffolk, the historic city of Dunwich, as well as other coastal communities, now lie beneath the sea. Records of erosion and flooding events, sometimes with disastrous loss of life, are recorded through time in journals such as the Anglo-Saxon Chronicles (Unknown Authors up to 1154) and a pamphlet describing the serious flooding affecting coastal communities such as Great Yarmouth in 1557 (White, 1607).

During the early 19th century Great Yarmouth experienced the highest recorded tides, resulting in extensive damage, with the same storm event also affecting Gorleston and the cliff line of Cromer. During the twentieth century coastal defences have been attacked by a succession of severe gales and storms, such as the event in 1938 when cliff instability at Sidestrand saw 20,000 tonnes of the cliff face collapse along a frontage of 120 yards (Brooks, 2007). The most serious storm event to affect the east coast of England was the flooding event of January 1953, and is regarded as one of the biggest environmental disasters to have occurred in the United Kingdom. Over 300 people lost their lives, and 24,000 properties were flooded, with a further 40,000 people being evacuated from their homes. The same storm also had impacts elsewhere around the Channel – Southern North Sea coastlines. In 1994 major coastal slope instability occurred on the cliffs at Overstrand to the south of Cromer. This led to cliff top retreat of some 20 metres, and necessitated major cliff stabilisation works.

A 2010 report for The Crown Estate presented the major factors affecting the East Anglian coastline, this report recognised that there is a combination of sea level change, variations in wave, tidal and surge conditions, changes in the location of sediment sources and sinks, influences from nearshore bathymetry as well as anthropogenic management (Brooks, 2010).

3A.2.2 Summary of Current Coastal Management Approach

Coastal risk management is a responsibility of coastal local authorities in partnership with the Environment Agency, which has an over-arching supervisory role. The East Anglian Coastal Group fulfills a coordinating role in bringing together coast protection authorities and other key agencies along the East Anglian frontage. Coastal risk management policy is being addressed through the preparation of forward-looking shoreline plans, which provide a basis for policies for this length of coast and set the framework for managing the risks along the coastline for the future. In particular, the shoreline management plans set out the risks from flooding and erosion to people in the developed, historic and natural environment within the shoreline management plan area. The plan also identifies opportunities to maintain and improve the environment by managing the risks from flooding and coastal erosion, looking ahead over the next century.

The East Anglian plans identify the consequences of putting the preferred policies into place and set out procedures for monitoring how effective these policies are. Importantly the plans discourage inappropriate development in areas where flood and erosion risks are high, and ensure that international and national nature conservation legislation and biodiversity objectives are met. The study area frontage falls within the jurisdiction of two shoreline management plans; SMP6 Kelling Hard (to the west of Cromer) to Lowestoft and SMP7 Lowestoft to Felixstowe. The lead authority for SMP6 is North Norfolk District Council and for SMP7 Suffolk Coastal District Council.

Coastal change in East Anglia has been monitored in a comprehensive way since 1987. This has comprised a range of activities including survey and monitoring activity such as topographical surveys, bathymetric surveys, aerial photography, wave monitoring and data analysis. More recently, the Strategic Regional Coastal Monitoring Programme has been rolled out around the whole of the English coastline, with financial support from the Environment Agency and Defra. Large-scale coastal monitoring, such as that existing for East Anglia, now provides a systematic approach to the collection, management and analysis of data for strategic and operational management of coastal erosion and flood risk. The monitoring programme is risk-based and integrates the requirements of the coast protection operating (authorities) with coastal defence responsibilities at both strategic and operational levels, technical and financial benefits are evident at a range of temporal and spatial scales.

Through the shoreline management planning process the need for upgrading of coastal defences can be identified and a number of major projects have been undertaken along the Suffolk and Norfolk coasts, such as at Cromer, Thorpeness and other locations. Coastal risk management falls within the overall framework of integrated coastal zone management, which has been actively developed along the study area coastline.

3A.3 Archaeological and Palaeoenvironmental Ranking

This section outlines the results of the archaeological and palaeoenvironmental ranking from the East Anglia study area, followed by a discussion of the results. The ranking methodology applied is detailed in Section 2.2.

3A.3.1 Results of the Archaeological and Palaeoenvironmental Ranking

Within the East Anglia study area data was obtained from the local Historic Environment Record (HER), the National Record of the Historic Environment (NRHE), the United Kingdom Hydrographic Office (UKHO) and the English Heritage Peat Database. It should be noted that where the data obtained from the HER was limited, and where sites ranked highly, further research was then required in order to understand the full nature and extent of the site. Each

dataset went through a process of cleaning, in order to prevent the duplication of sites. A total of 783 sites and records were assessed.

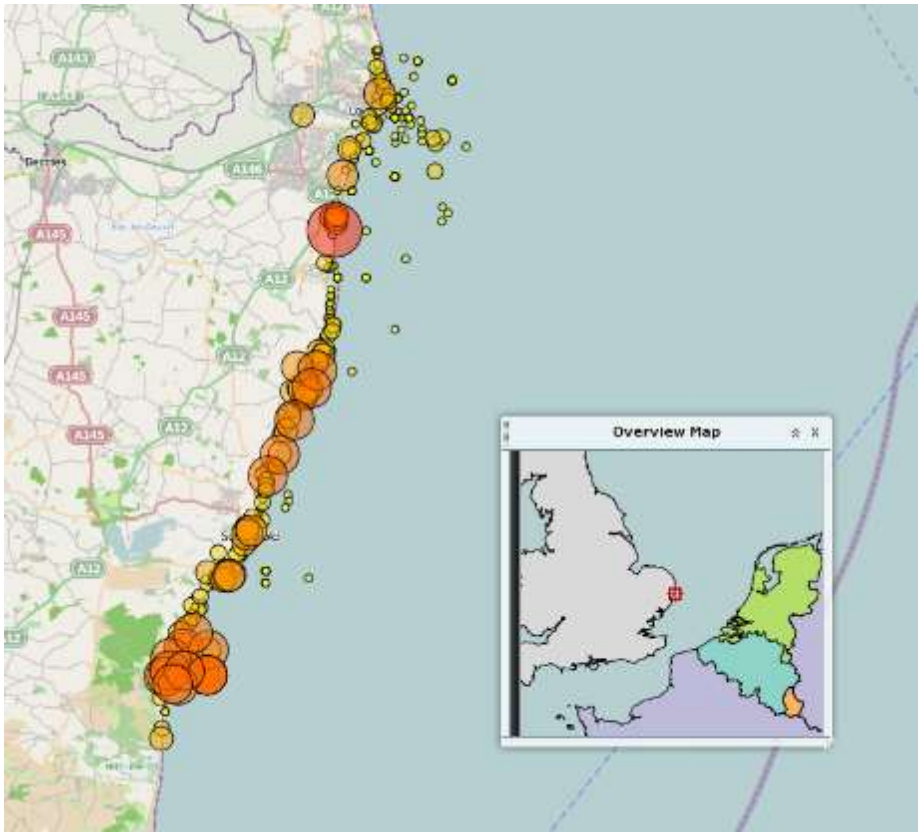


Figure 3A3. Map showing the distribution of all archaeological and palaeoenvironmental sites within the East Anglia study area

The highest ranked sites are listed in the table below, the total score has been normalised to give each site a score out of 100.

APE uid	Site Name	Site Type	Period	Score – Sea Level	Score – Environmental	Score – Temporal Continuity	Total Score	Coastal Context
1581	PAKEFIELD - Forest deposits	Buried Landsurface	Lower Palaeolithic	Medium	High	High	88	Intertidal
706	BENACRE BROAD - Core sample	Submerged Landsurface	Prehistoric	High	Medium	Medium	77	Marine
710	EASTON BROAD - Peat	Submerged Landsurface	Prehistoric	High	Medium	Medium	77	Intertidal
1790	EASTON BAVENTS - Deserted Medieval Village	Submerged Landsurface	Medieval	Medium	High	Medium	77	Marine
1734	DUNWICH - Greyfriars Friary	Monument	Medieval	Medium	High	Medium	77	Above HW
1771	COVEHITHE – Well	Monument	Medieval	Medium	High	Medium	77	Marine
1779	DUNWICH – Chapel of St Francis	Monument	Medieval	Medium	High	Medium	77	Above HW
1787	DUNWICH - Dommoc See	Monument	Medieval	Medium	High	Medium	77	Marine
1738	DUNWICH - St	Monument	Medieval	Medium	High	Medium	77	Marine

	Antony's Monastery							
1811	DUNWICH - All Saints Church	Monument	Medieval	Medium	High	Medium	77	Marine
1789	DUNWICH - Quay and Harbour	Monument	Medieval	Medium	High	Medium	77	Marine
1788	DUNWICH – Castle	Monument	Medieval	Medium	High	Medium	77	Marine
2329	DUNWICH – Hospital of the Holy Trinity	Monument	Medieval	Medium	High	Medium	77	Above HW
1808	DUNWICH - Sea walls and river cut	Monument	Medieval	Medium	High	Medium	77	Marine
2426	DUNWICH - Church St Peters	Monument	Medieval	Medium	High	Medium	77	Marine
1784	DUNWICH - Church St Nicholas	Monument	Medieval	Medium	High	Medium	77	Marine
2427	DUNWICH - St Katherine's Chapel	Monument	Medieval	Medium	High	Medium	77	Marine
2428	DUNWICH – Blackfriars	Monument	Medieval	Medium	High	Medium	77	Marine
2429	DUNWICH - Knights Templar	Monument	Medieval	Medium	High	Medium	77	Marine
709	COVEHITHE BROAD - Peat	Buried Landsurface	Prehistoric	High	Medium	Medium	77	Marine
2324	DUNWICH – Seabank	Monument	Medieval	Medium	Medium	Medium	66	Above HW
1530	SOUTHWOLD – Well	Monument	Post Medieval	Medium	Medium	Medium	66	Above HW
1551	SOUTHWOLD - Earthworks	Monument	Post Medieval	Medium	Medium	Medium	66	Above HW
1570	LOWESTOFT – Town	Monument	Medieval	Medium	Medium	Medium	66	Above HW
1710	COVEHITHE – Pit		Unknown	Medium	Medium	Medium	66	Above HW
1718	SOUTHWOLD - Find spot		Neolithic?	Medium	Medium	Medium	66	Intertidal
1793	DUNWICH – Kiln	Monument	Medieval	Medium	Medium	Medium	66	Intertidal
1714	WALBERSWICK – Peat	Buried Landsurface	Prehistoric	Medium	Medium	Medium	66	Intertidal
1563	PAKEFIELD – Church	Monument	Medieval	Medium	Medium	Medium	66	Above HW
1578	BENACRE - Linear lines in peat	Monument		Medium	Medium	Medium	66	Above HW

Table 3A1. Results of the highest ranking archaeological and palaeoenvironmental sites within the East Anglia study

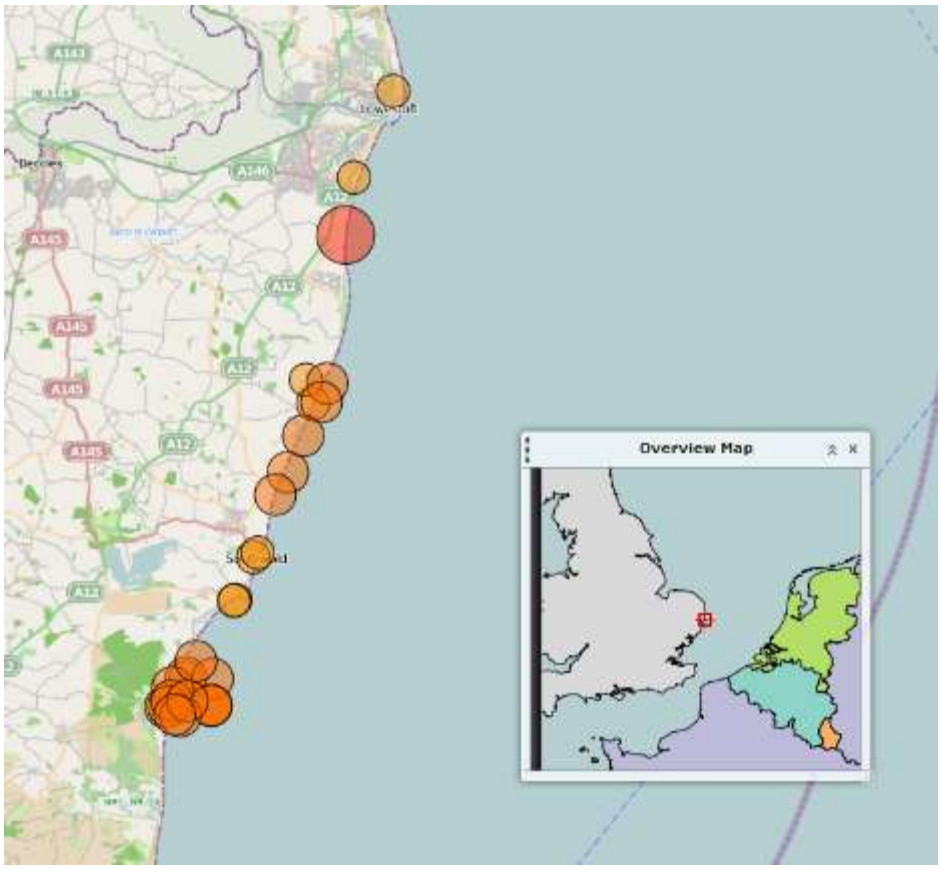


Figure 3A4. Map showing distribution of highest ranking archaeological and palaeoenvironmental sites within the East Anglia study area

Rank for sea level change

	High	Medium	Low
Number of sites	3	118	676

Rank for environmental change

	High	Medium	Low
Number of sites	17	16	740

Rank for temporal continuity

	High	Medium	Low
Number of sites	1	104	678

Table 3A2. Results of the three archaeological and palaeoenvironmental ranking categories

3A.3.2 Discussion of the Ranking Results

The table of highest ranking sites is dominated by medieval monuments, mainly from the town of Dunwich but also the medieval village of Easton Bavents. The Suffolk coast is witnessing some of the most rapid rates of coastal recession in the world, it is due to this that so many sites have now been destroyed or exist as ruins on the seabed. This is also reflected through the large number of sites ranking high for environmental change, the medieval monuments were not simply inundated by a rising sea-level, but lost due to a rapid recession of the coastline caused by a combination of wave action, storm surges and sediment dynamics eroding and undercutting the soft cliffs which make up the majority of this coast.

Alongside the medieval monuments other top ranking sites include buried or submerged prehistoric material, including the Lower Palaeolithic site of Pakefield where material is being eroded along the cliff. The site at Pakefield however, is the only site containing in-situ and dated archaeological material. Other sites such as Covehithe, Benacre Broad and Easton Broad do have high potential to provide further information about the changing landscape, but there is currently little analysed material.

This data can provide information, which will enable the development of modelling coastal change. The medieval town of Dunwich is well known and has been subject to large-scale research most recently through a joint project between English Heritage, GeoData, the National Oceanography Centre and Wessex Archaeology (Sear et al, 2013). The project involved the assessment of archaeological material, as well as historic maps, charts, paintings and sketches in order to determine the position of the coastline at various times since 1587. So the potential of this data is already well known. The ranking has however, highlighted the potential for prehistoric material to provide an understanding and modelling of coastal change over a longer time period. Peat deposits have been noted at low tide at Benacre Broad and Covehithe Broad. Apart from Pakefield, the Suffolk coast contains little dated and in-situ archaeological material from the Palaeolithic to the Neolithic. Such sites may have been lost due to rapid erosion of this coastline, however, records of peat deposits identified at low tide demonstrate the potential for further prehistoric material to provide an understanding of coastal change in the longer term.

Wessex Archaeology (2008) recognised the potential for further material to survive offshore at Pakefield due to the nature and location of the Lower Palaeolithic material found at the base of the cliff, a geophysical survey and vibrocoring was carried out. Sediments matching those at the base of the cliff were noted and highlight potential for further submerged archaeological material which have not been destroyed by erosion or glacial processes.

Other sites which ranked lower but still have the potential to provide information on coastal change include WWI and WWII gun emplacements, anti-tank blocks, pill boxes and air raid shelters, these are found all along the coast from Lowestoft to Southwold and can provide information on the rate of coastal change over the last 100 years. Many wreck sites were also assessed, although the majority are modern (1901-Present), around twenty medieval and post medieval wrecks were ranked. Located just south of the study area, the 16th Century protected wreck site Dunwich Bank, discovered in 1993, has been subjected to ongoing monitoring and may offer some potential to assess the history of seabed processes since the date of wrecking.

It should be noted that not all monuments that were investigated as part of the 2012 Dunwich project (Sear et al, 2013) are contained within the HER or NRHE, however all medieval monuments in this area attained the same ranking score so provide a reflection of site types and their potential value.

3A.4 Ranking Artistic Depictions

The focus on artistic depictions of the East Anglia study area has been on historic paintings, however, several historic photographs, maps and charts were also assessed in order to highlight the potential of this resource. The results of the ranking for each of these is presented below followed by a discussion.

3A.4.1 Historic Photograph Ranking

As part of Activity Two a ranking system was developed for historic photographs, the development of the system and proposed methodology is set out in Section 2.2. The ranking system has been applied to a selection of historic photographs within this case study area.

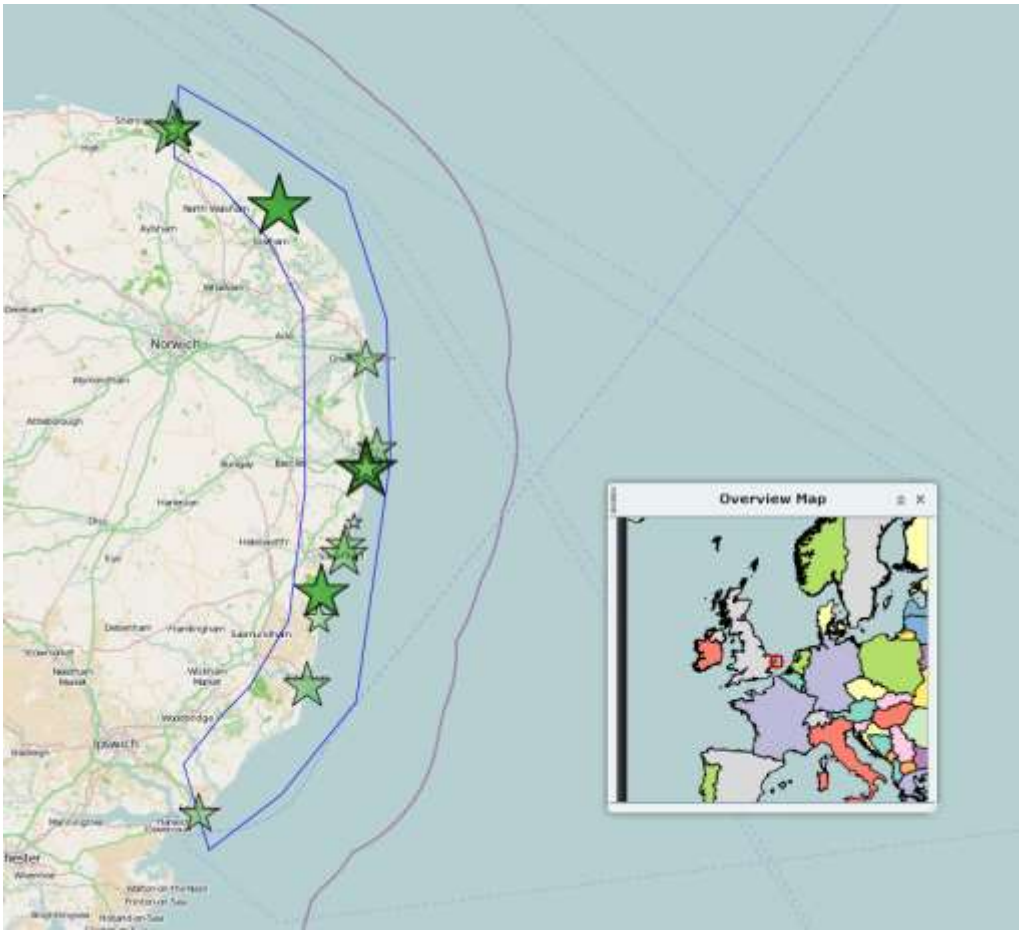


Figure 3A5. Location of historic photos in the East Anglia case study area

A total of 28 historic photos were assessed as part of the project, images were primarily chosen from locations along the East Anglian coastline where historic paintings and archaeological sites were also known. The photographs were collected and then ranked. Hundreds of historic images exist for this stretch of coastline, it should be noted that this study is not intended to be exhaustive, it simply aims to highlight the potential for historic photos to provide information on coastal change. A brief search of resources available online was carried out, although further research online, in museums and galleries, as well as private collections has the potential to provide many more.

The table below outlines the results of the ranking, note that photographs were ranked as either a heritage view or a non-heritage view.

Img_ uid	Title	Year	Score Heritage View	Score Non Heritage View	Physical Image State	Total Score
1178	Happisburgh Beach	1965	High		Good	100
1181	Lowestoft from Pakefield	1890		High	Good	100
1187	Well shaft, Happisburgh	1947	High		Good	100

1169	Dunwich All Saints Church	1904	High		Fair	88
1166	Dunwich Church	1914	High		Fair	88
1176	Golden beach Happisburgh	1955		High	Fair	88
1185	Pakefield	1906		High	Fair	88
1168	Dunwich Beach	1960	Medium		Good	77
1167	Dunwich Beach	1955	Medium		Good	77
1175	Southwold from the pier	1919	Medium		Good	77
1172	Felixstowe Pier	1906	Medium		Good	77
1174	Southwold from the Old Lighthouse	1890	Medium		Good	77
1180	Lowestoft	1955	Medium		Good	77
1182	Martello Tower at Felixstowe		Medium		Good	77
1184	Pakefield	1903		High	Poor	77
1161	Cromer Beach	1901	Medium		Fair	66
1162	Cromer Beach	1954	Medium		Fair	66
1163	Cromer Pier	1901	Medium		Fair	66
1170	Easton Bavents	1936	Medium		Fair	66
1171	Felixstowe beach from the pier	1920	Medium		Fair	66
1173	Felixstowe Pier	1919	Medium		Fair	66
1177	Great Yarmouth	1928	Medium		Fair	66
1165	Lowestoft	1928	Medium		Fair	66
1183	Minismere near Dunwich	1960		Low	Good	55
1186	Slaughden Quay	1894	Medium		Poor	55
1164	Cromer Rock Garden	1960	Low		Fair	44
1160	Covehithe Cliffs			Low	Poor	33

Table 3A3. Results of the historic photograph ranking

The majority of photos assessed were of heritage views, containing features which can be identified today, the oldest photo assessed was taken in 1890.

3A.4.2 Maps and Charts Ranking

A ranking system was developed for maps and charts, the development of the system and methodology is set out in Section 2.2. Several historical maps exist of the East Anglian coastline, with some going back over 400 years. Two maps were assessed as part of the project. It should be noted that this study is not intended to be exhaustive, it simply aims to highlight the potential for historic maps and charts to provide information on coastal change in this area. A brief search of resources available online was carried out, although further research online, in museums, libraries and galleries, as well as private collections has the potential to provide many more. This could also be combined with the study of historic maps and charts as part of the larger Dunwich project (Sear et al 2013), where searches were carried out at the National Archives, National Maritime Museum, the Admiralty Library and the British Library. The focus of this project was on the town of Dunwich, but the majority of maps consulted depict the whole of the Suffolk coastline. The maps were assessed and digitised to create map regressions of the coastline, this was later combined with all other data sources.

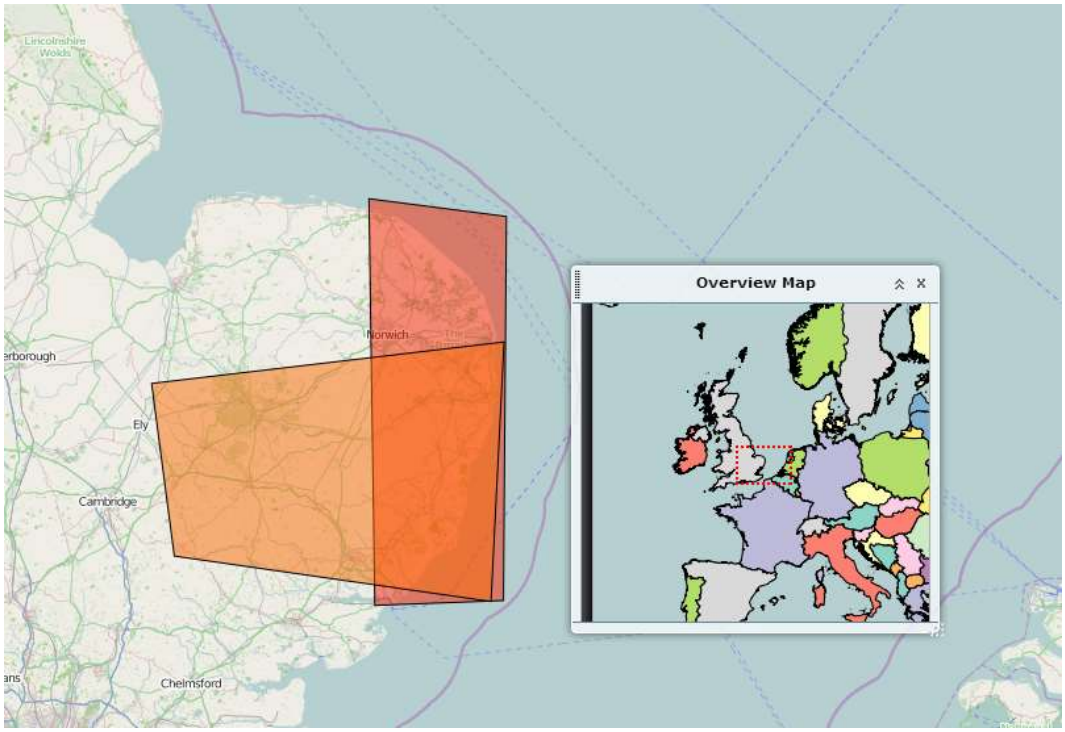


Figure 3A6. Location of the two maps assessed along the East Anglian coastline.

MAP_ uid	Title	Year	Score Chronometric Accuracy	Score Topographic Accuracy	Score Detail in non-coastal area	Score Geometrical Accuracy	Total Map Score
141	OS map 1st edition	1880-1890	60	100	100	66.66	81.66
120	Hodskinson's map Suffolk	1783	60	63.88	66.66	50	81.66

Table 3A4. Results of the map ranking

3A.4.3 Art Ranking

The research has identified 248 exhibiting artists who painted on the coastline of East Anglia between 1880-1940. The names of these artists have been obtained from an examination of the main art dictionaries and listings of the principal exhibitions such as the Royal Academy (RA) as well as from auction house records. However many of these artists painted genre subjects, shipping and fishing scenes or buildings, which provide only marginal information relating to coastal conditions whilst for others only a painting title was available rather than image.

The development of the ranking system has been described in Section 2.2. The highest ranking artworks, usually gaining 60-70 points are detailed watercolour drawings, lithographs and steel engravings from the mid to late Victorian period. These are followed by oil paintings from the early and mid-nineteenth century that were painted by artists or followers of the Norwich School who, although painting in oils rather than watercolour, were, nevertheless, able to capture a significant amount of coastal detail.

Artists tended to paint attractive or dramatic coastal locations as well as meeting specific demands of their patrons. On the East Anglian coast they were drawn to the coastal towns and villages either on account of their locations or because of the interest in the activities of fishermen and their craft working along the shoreline. The result has been that many of the sites of key geomorphological and coastal risk management interest have been painted by artists

particularly during the nineteenth century. Within the higher ranking artworks there are examples, which include locations affected by coastal landsliding, marine erosion, flooding and beach change. Where a particular location has been painted by a limited number of artists or perhaps just one artist that work has been included to illustrate a particular feature or issue.

These differing coastal landforms and processes and their impacts on coastal residents, assets and infrastructure could not have been easily matched to the most informative works of art without the provision of the ranking system. The ranking system has identified ten case study locations and at each at least one artwork has been examined in more detail below as follows:

Case Study Number	Location	Artist	Date	Score type	Score period	Score style	Score enviro	Total Score
1	Cromer Beach, Norfolk	John Varley	1802	Water-colour	Early	Topog.	Detailed View	74
2	Cromer Cliffs and Beach	John Moore	1850	Oil	Mid	Topog.	Detailed View	66
3	Great Yarmouth Beach	Rock & Co	1850	Steel Plate	Mid	Topog.	General View	55
4	Gorleston-on-Sea	Joseph Lambert	1822	Copper Plate	Early	Topog.	General View	44*
5	Pakefield Beach and Cliffs	Alfred Stannard	1882	Oik	Late	Topog.	General View	55
6	Southwold Cliffs, Suffolk	Helen Clarke	1889	Water-colour	Late	Topog.	Detailed View	74
7	Southwold Beach	J.B Crome	1838	Lithog.	Early	Marine/shipping	Detailed View	66
8	Southwold Harbour	William Daniell	1822	Aqua-tint	Early	Topog.	Detailed View	66
9	Slaughden Quay	John Moore	1883	Oil	Late	Topog.	Detailed View	74
10	Orford Ness	William Daniell	1822	Aqua-tint	Early	Topog.	Detailed View	62

*Table 3A5. Top art ranking results. (*This image, although lower scoring, provides the only known view of the Lowestoft cliffline prior to its substantial alteration; hence it was selected.)*

A more detailed explanation of each site and the interpretation of the individual artworks is provided below. The assigning of scores to each artwork suggests names of those artists who have depicted different aspects of the East Anglian coast across the timeline 1770-1920. These artists include John Varley (1778-1842), William Daniell (1769-1837), Henry Davy (1793-1865), John Moore of Ipswich (1820-1902), Thomas Smythe (1825-1906), Helen Clarke (Flourished 1880-1890) and Alfred Heaton Cooper (1864-1934). These artists can be relied upon in terms of the accuracy of their depictions of the East Anglian coastline.

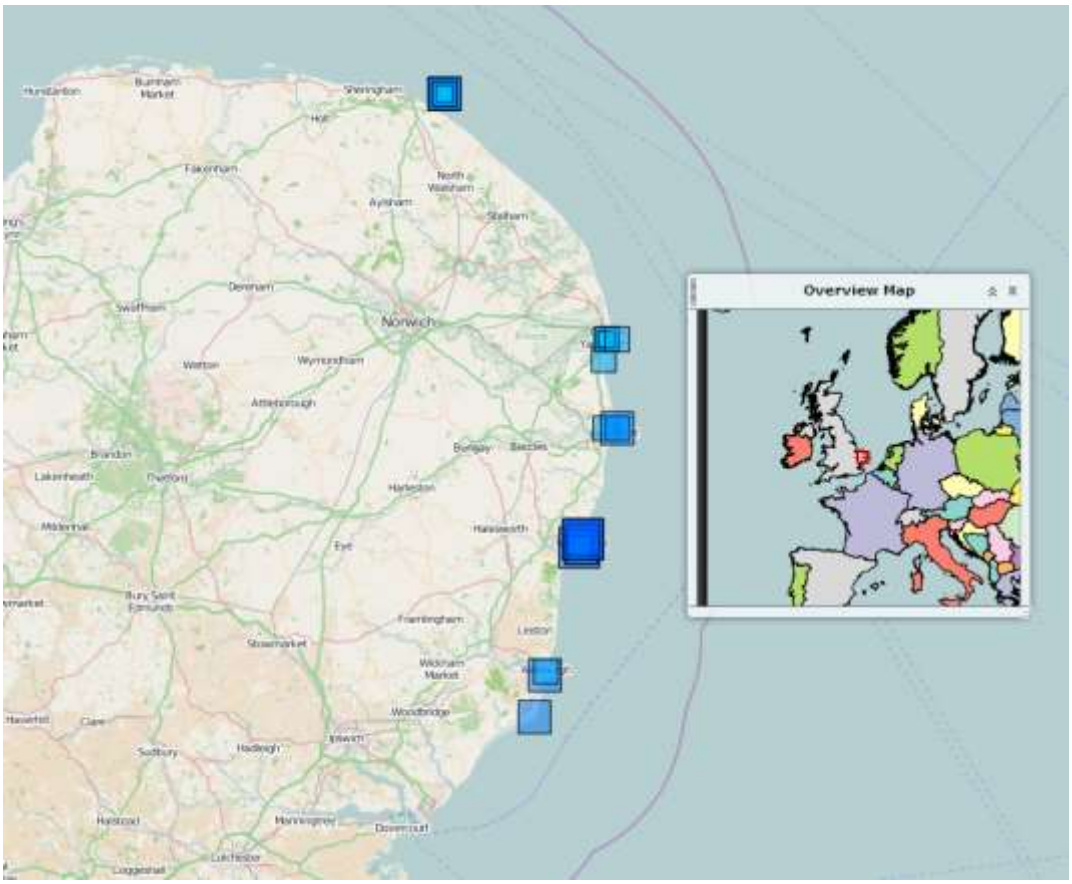


Figure 3A7. Location of the artistic depictions

3A.4.4 Discussion of Ranking Results

Through the East Anglian case studies the value of various artworks has been tested at sites of differing geomorphology. The combined approaches of desk-based research, museum and gallery searches and field visits have confirmed the added value of art from the period 1770-1940 to support other coastal surveying and monitoring technologies (e.g. Space-borne, air-borne, ship-borne and terrestrial). It is important to remember that artists in the late Georgian and Victorian eras worked for very demanding, wealthy clients who often sought exact views of the coastal landscape to remind them of their visit. Before the days of photography precise images were, therefore, a prerequisite in most cases. The examination of the works of many East Anglian artists testifies to their considerable artistic skills in capturing accurately the coastal topography.

Some of the artworks examined in these case studies show significant coastal change over time as well as telling the story of human intervention on the coast. Other artworks show very little change over the last two hundred years and this information is of equal interest to the coastal scientist. Importantly also the artworks illustrate in many cases the nature of the natural undeveloped coastline and suggest what conditions might be experienced if coastal defences were not maintained in the future. This is particularly significant as along certain coastal frontages it will not be possible to continue to defend the coast as has been the case in the past for physical or environmental reasons.

The East Anglian study focused on the use of historic paintings, however a selection of historic maps and photographs were also consulted to review the potential of these data sources.

Because of the dynamic nature of this coastline historic photographs can be a valuable resource with many historic photos containing depictions of the cliff with recognisable heritage features nearby, including churches, wells and houses. These can be compared to the modern situation and from this an accurate idea of the rate of erosion since the date of the photograph can be gained. Historic maps and charts have been used successfully in the Dunwich project (Sear et al, 2013), these can provide an indication of the cliff retreat, however, it is often difficult to make out more detail regarding the current shoreline, beach elevation etc.

Two maps were assessed, Hodskinson's map of Suffolk from 1783 and the 1st Edition Ordnance Survey Maps of the East Anglia coastline. Hodskinson's map from 1783 gives a good impression of the county as a whole, but the detail in the coastal zone is lacking. Although it can tell us about the settlement patterns, details of the parks, gardens and houses, it is unclear where the high or low water mark is, the extent of beaches and marshland, and inlets and estuaries are also lacking in detail. The OS map provided more detailed information and dates from the 1880's. According to a study by Oliver, R (1996) it is from this period that mapping surveys became accurate enough to be used in the study of coastal change. A more comprehensive study for The Crown Estate has been carried out to assess the use of historical maps to assess coastal change in Suffolk (Brooks, 2010), such data can be combined with the artistic depictions, photographs and archaeological material gathered as part of this project in order to gain a more comprehensive understanding of the long and short term changes along this dynamic coastline.

3A.5 Art Field and Research Studies

No archaeological or palaeoenvironmental fieldwork was carried out for the East Anglia case study area, this section outlines the field studies undertaken as part of the art study.

3A.5.1 Key Research Questions to be Addressed from Artistic Depictions

Having established, through the art ranking system that the images are likely to be true representations of the conditions that would be seen at the time they were painted, the research questions to be answered through examination of the artworks at the case study sites were:

- What information can the historical images provide to support understanding of long-term coastal change?
- How can the potential of this resource be used most effectively by the end-user?

In order to identify the most suitable artworks that could be studied in more detail at the field study sites a national search was undertaken involving an extensive review of landscape paintings, watercolours and prints held in public and some private collections. Following ranking of over forty artworks ten examples have been the subject of more detailed analysis involving site visits.

Along the East Anglia study area coastline there are a range of physical conditions to be found including eroding cliffs, cliff instability problems, beach change and flooding of low-lying land by the sea. In order to reflect these varying conditions art images have been selected from across the East Anglian study site. Sites A1 and A2 at Cromer consider eroding, unstable cliffs and the nature of the beach. Sites A3 to A6 examine cliff behaviour and beach change at Great Yarmouth, Gorleston-on-Sea and Pakefield. Sites A7 and A8 investigate cliff erosion and beach levels at Southwold. Site A9 assesses issues relating to low-lying land at Slaughden near Aldeburgh and, finally, Site A10 assesses coastal change at Orford Ness. Each site considers the potential of the artwork to be used as a qualitative or quantitative tool to support understanding of long-term coastal change and coastal management more widely.

3A.5.2 Approach to Information Gathering and Fieldwork for Assessing Coastal Artworks

Where it has been practical to gain access and relevant to the study, present day photographs were taken in the field to try, as far as possible, to match the views painted by the 18th, 19th and early 20th Century artists. It also provided the opportunity to assess the conditions of the cliffline and beach and changes that may have taken place over time. In terms of work in this field each of the locations has been visited and photographed in varying weather conditions. Inspections were timed to coincide with Low Water and a walk-over survey was made along the beach and base of the cliff returning along the cliff top. This ensured that thorough comparison could be made between the geomorphological conditions depicted in the artwork and the present day situation.

3A.5.3 Art Field Data Gathering Results

The selected sites in the East Anglian case study area were chosen to reflect a range of geomorphological types. Site inspections have confirmed that the locations selected do provide a good representation of coastal geomorphology against which the value of historical artworks can be tested.

This fieldwork element has been largely visual in terms of identifying the location of the paintings and making judgements, on site, of the role that art can fulfil as a qualitative or quantitative tool to support coastal risk management. The field inspections allowed a more accurate appraisal to be made of current physical conditions rather than relying upon written accounts and reports particularly as storm events can cause significant alterations over relatively short time periods.

The main focus for each case study has been the examination of one particular artwork and to make an assessment of what it tells us about changes over time from field observation. However, for some of the study sites it has been found that several artists painted the view from the same or a similar spot. This helps us to establish a chronology of coastal change through the nineteenth and twentieth centuries. The results for each case study location are described below. The art case studies are numbered from A1 to A10.

A1. Cromer Beach, Norfolk

Location

'*Cromer Beach'*, looking from the south northwards towards the pier and the town in 1802, from a watercolour drawing by John Varley (*Figure 3A8*).

Why was the study site selected?

The town of Cromer is located close to the top of unconsolidated soft cliffs, which range in height between 20 and 50m. In places the cliffs contain large boulders of chalk (erratics), which are a result of previous glaciations. The cliff line is currently protected by a concrete seawall, which is vital to prevent coastal erosion and further instability causing problems for valuable cliff top properties and infrastructure. If the current policy of maintaining the coastal defences is continued, the cliffs would be held in their current position, however, there is likely to be some narrowing and lowering of the beach as a result of the impacts of storm waves reflecting off the hard structure. A large amount of work is necessary to maintain the condition of the seawalls and prevent outflanking of the walls, due to the cutting back of the cliffs to the east and the west of the frontage. The aim for the frontage is to continue to maintain the coastal defences in the

long term. However, this will result in the loss of beach along the frontage and have adverse impacts in terms of sediment transport, geology and geomorphological processes, as well as the natural landscape and the seascape. Any information to improve understanding of long-term coastal change at Cromer is, therefore, particularly valuable.

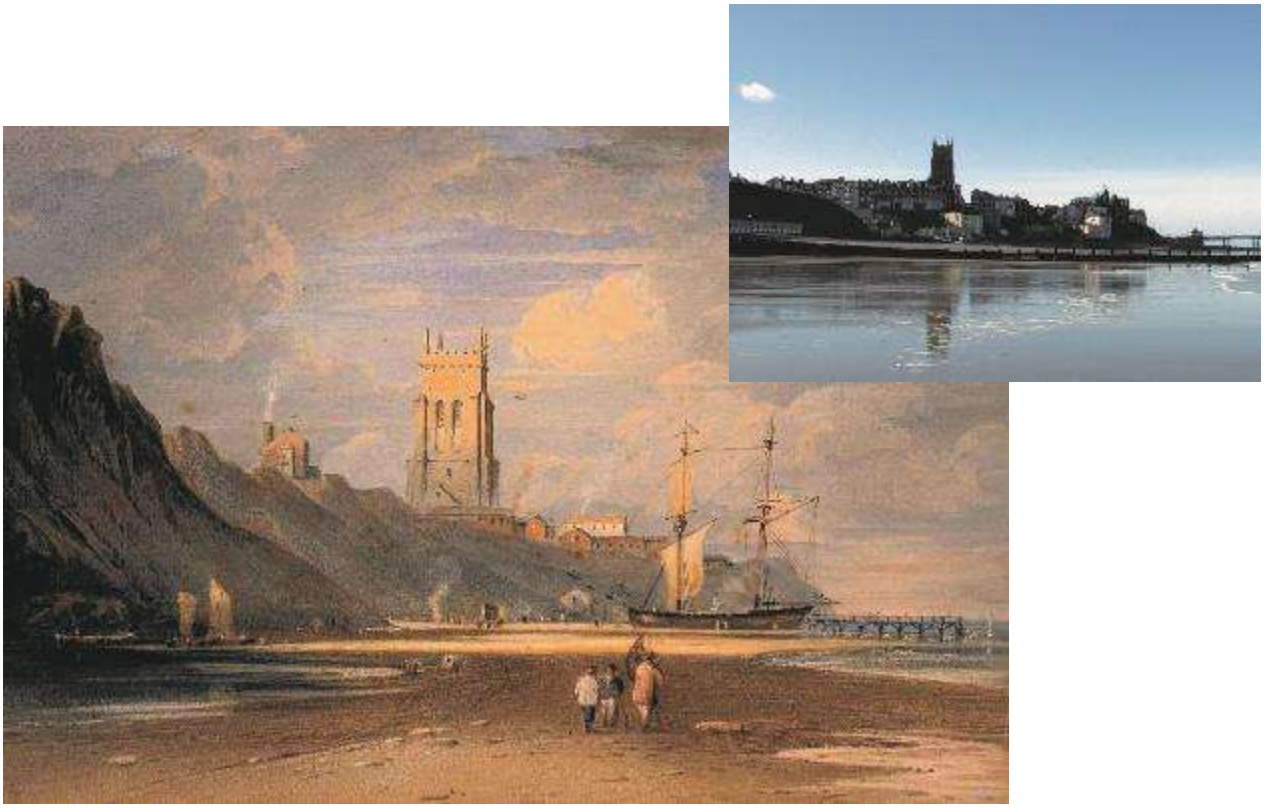


Figure 3A8. 'Cromer Beach' by John Varley, watercolour 1802. Courtesy: Norwich Castle Museum.

Geomorphological setting

The cliff line along this section of the North Norfolk coast comprises 20-50m high loosely consolidated cliffs and slopes. The glacial till cliffs rest on a chalk outcrop, which can be found at the base of the cliff itself. The beach is predominantly sandy with a thin layer of shingle at the base of the cliff. Prior to coastal defences being constructed, sediments from the eroding cliffs were carried eastwards and southwards around the North Norfolk coastline, in the direction of Suffolk. A wide sandy beach exists at present, although this is prone to lowering as a result of both rising sea levels and scour against the existing seawall.

Key coastal risk management issues for the frontage

The key issue is how to maintain adequate protection in the long-term for the town of Cromer. This is achieved through the maintenance of the coastal defences themselves and of a healthy beach, which can form a valuable form of coastal defence.

How the artwork can inform coastal risk management

The watercolour by Varley is of interest because it provides detail of the condition of the beach at the beginning of the nineteenth century as well as the state of the cliff line. The beach is composed of sand and appears to be in a healthy state with a slight crest towards the centre of the beach, witnessed by the pool of water trapped at the back of the beach in the left foreground of the watercolour. The cliffs can be seen in their natural state before coastal defences were

constructed and the proximity of the development to the cliff top is clearly visible. The level of the beach against the piles of Cromer pier can be seen to the right.

Over the intervening period a seawall was provided along the foot of the cliffs to prevent erosion at their toe and groynes have been constructed to control beach levels. It is interesting to note that the artist, Varley, returned to Cromer and painted a view from the similar spot in 1830, which showed little apparent change to the cliff line or the beach. The weak cliffs along this part of the North Norfolk coast reach heights of up to 70m but the seawall prevents coastal erosion. Where the cliffs are undefended the rate of retreat experienced would be of the order of 2-2.5 metres a year. The construction of the sea wall during the Victorian period would have the effect of reducing the sediment supply to the beach as erosion could no longer take place. This would have the effect of reducing sediment inputs with implications for Cromer beach and beaches to the south. Despite this the beach at Cromer appears in a healthy condition. There has been some accretion on the upper part of the beach but also some steepening (Environment Agency, 2013).

The watercolour by Varley shows us what conditions might be expected to look like along the Cromer town frontage if the sea wall and groynes were not maintained in the future. There would be significant erosion and reactivation of the instability problems in the cliffs with consequent risks to people, property and assets.

Where can the original artwork be viewed?
Norwich Castle Museum and Art Gallery.

Cromer Beach - Ranking score achieved: 74

A2. Cromer Cliffs and Beach, Norfolk

Location
'Cromer Sunrise' and 'Cromer Sunset' – A pair of oil paintings by John Moore of Ipswich, c.1850 (*Figure 3A9* and *Figure 3A10*). Whereas the previous case study site at Cromer was observed from beach level, this pair of views illustrate the conditions along this frontage taken from the cliff top to the west and the east of the town.

Why was the study site selected?
This site was selected because it illustrates how historical landscape paintings of the coastline can provide information on cliff processes as well as beach conditions.

Geomorphological setting
The cliffs of Cromer are composed of unconsolidated glacial tills, which are seated on a foundation of chalk; this outcrops at the base of the cliffs. The beach is predominantly sandy but with some extent of shingle, particularly at the base of the cliffs.

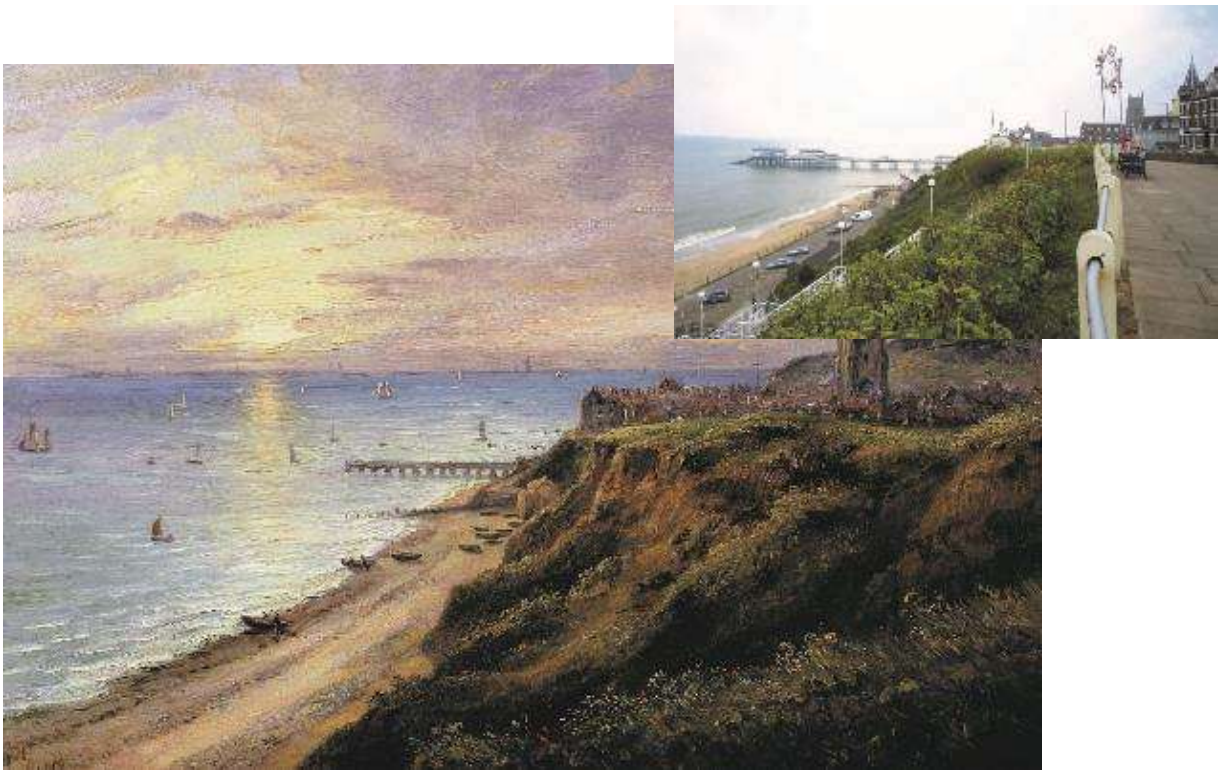


Figure 3A9. 'Cromer' by John Moore of Ipswich, c.1850, oil on canvas. Photography courtesy of Mandell's Gallery, Norwich. Private Collection.

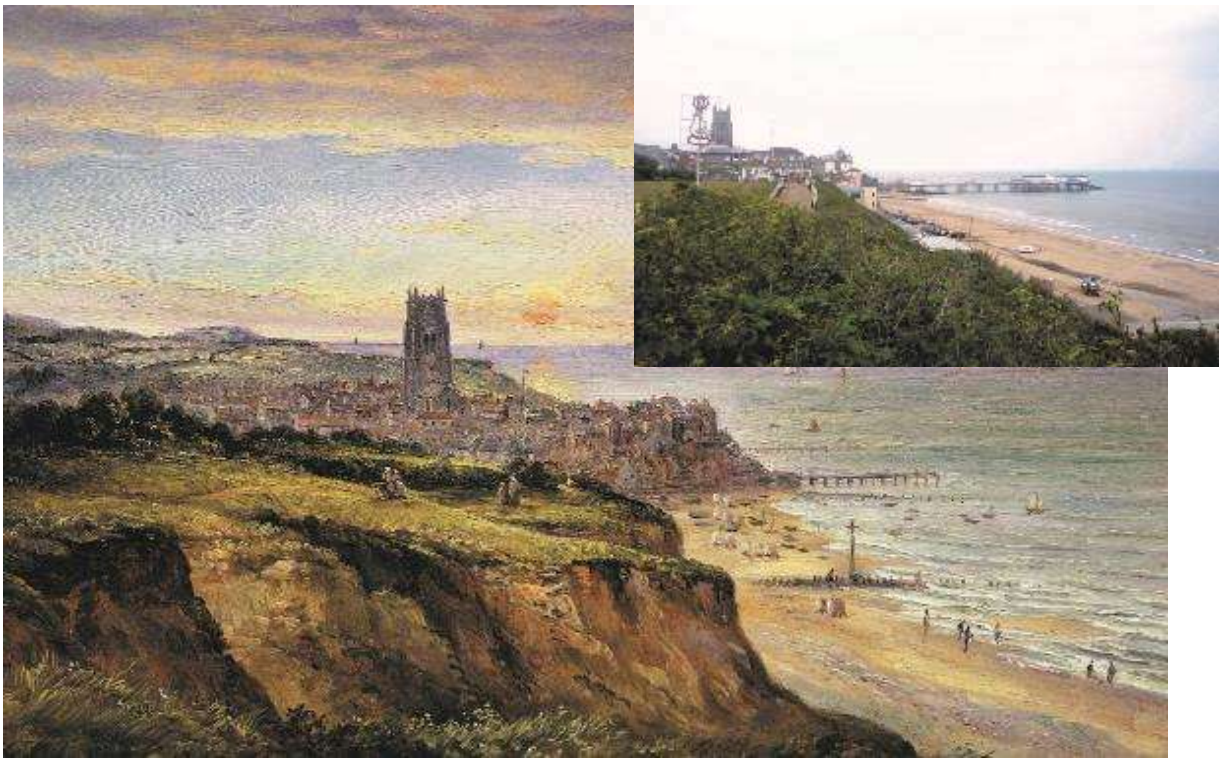


Figure 3A10. 'Cromer' by John Moore of Ipswich, c.1850, oil on canvas. Photography courtesy of Mandell's Gallery, Norwich. Private collection.

Key coastal risk management issues for the frontage
The key issue is how to maintain adequate protection in the long-term for the town of Cromer. Essential to this is the maintenance of the coastal defences themselves and a healthy beach, which can form a valuable additional form of natural coastal defence.

Observations on the artwork
For this case study there are two paintings viewing the town of Cromer from the west and from the east. In the case of the cliffs, the natural processes of cliff erosion and weathering can be clearly seen. Large sections of the 30 – 35m high cliff can be seen spalling away by a process known as mass wasting, particularly in the painting from the west. The indentations in the face of the cliff shown in the two paintings suggest that cliff conditions are influenced strongly by the local geology and groundwater conditions. The back scars of small slides and slips can be seen at the top of the cliff adjacent to the grassy land in the front of the church. These processes will have been speeded up through a lack of toe support, which is resulting in removal of support for the cliff line above by marine erosion. The artworks also illustrate how the steep clay cliffs are attempting to re-grade naturally to a more stable angle of repose by the processes of slope failure. The accumulation of slope debris at the foot of the sea cliffs is, however, being quickly removed by coastal erosion and as a result the cliff face is unable to achieve equilibrium, and therefore, remains actively unstable.

Historical evidence suggests that the rate of cliff retreat at this time could have been of the order of 1.5m-2m a year based on erosion rates of undefended frontages to the east. This gives an indication of the potential risks if the coastal defence policy of '*Hold the Line*' was discontinued.

Also of interest is the depiction of the beach, which shows the extent of the sand and shingle ridges running along the beach parallel with the cliff line. The careful painting of the groynes and the pier also give an indication as the extent of the beach and the way the sediment is being retained by the groyne, particularly in the view from the east, at that particular time. This pair of paintings can, therefore, provide useful indications of conditions prior to coastal defences being constructed. The present day views illustrate how the cliff face has become almost completely vegetated over the intervening period, largely as a result of protection at the toe by nineteenth century or earlier sea wall construction. Along part of the town coastal frontage a large car park has been constructed, which has had the effect of advancing the coastal defence line seawards, and this provides additional support for the previously unstable cliff line.

How can the artwork inform coastal risk management?
The artwork describes very clearly the conditions that were being experienced along the frontage before areas were defended. It suggests what conditions might be experienced in terms of the re-activation of cliff instability problems if coastal defences are not maintained or are removed at some time in the future. This would lead to significant toe erosion of the cliff line and instability problems, which would impact upon people, property and assets in the town.

Where can the original artworks be viewed?
Private collection.

Cromer Cliffs and Beach - Ranking score achieved: 66

A3. Great Yarmouth Beach and Jetty

Location

'Great Yarmouth Beach and Jetty, Norfolk' views by Rock & Co (
Figure *3A11*) and by Edward William Cooke (Figure 3A12). Great Yarmouth is a large and popular seaside resort, located at the mouth of Breydon water, lying between the town of Caister-on-Sea to the north, and Gorleston-on-Sea to the south on the east coast of Norfolk.

Why was the study site selected?

This site was selected on account of the contrast with the high cliff frontage to the north (Case Studies A1 and A2 – see above), and Great Yarmouth is located on a low-lying frontage with a wide sandy beach.

Geomorphological setting

The town of Great Yarmouth is located within a coastal policy unit that is generally characterised as a dune coastline. However, during the nineteenth century and onwards, substantial development has taken place for tourism purposes alongside the historical importance of the town as a port and fishing settlement. The town has a linear structure developing on a piece of land, which is separated from the hinterland by a river emerging from the Breydon Water immediately to the west. The original flow from Breydon might have been directly into the sea but sediment transport from north to south has led to the creation of a long spit, forcing the river to take a southerly course to emerge nearer to Gorleston-on-Sea. Great Yarmouth frontage is characterised by a very wide sandy beach.

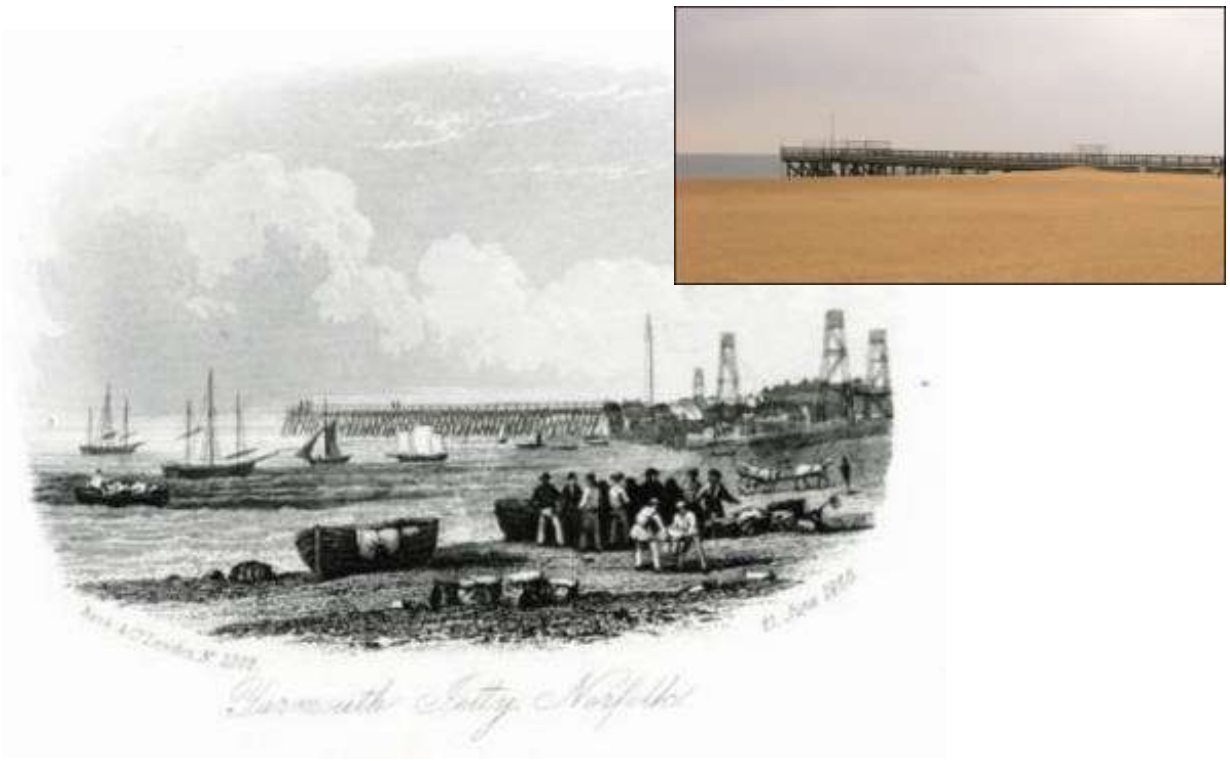


Figure 3A11. 'Yarmouth Jetty, Norfolk'. Rock & Co., 1850

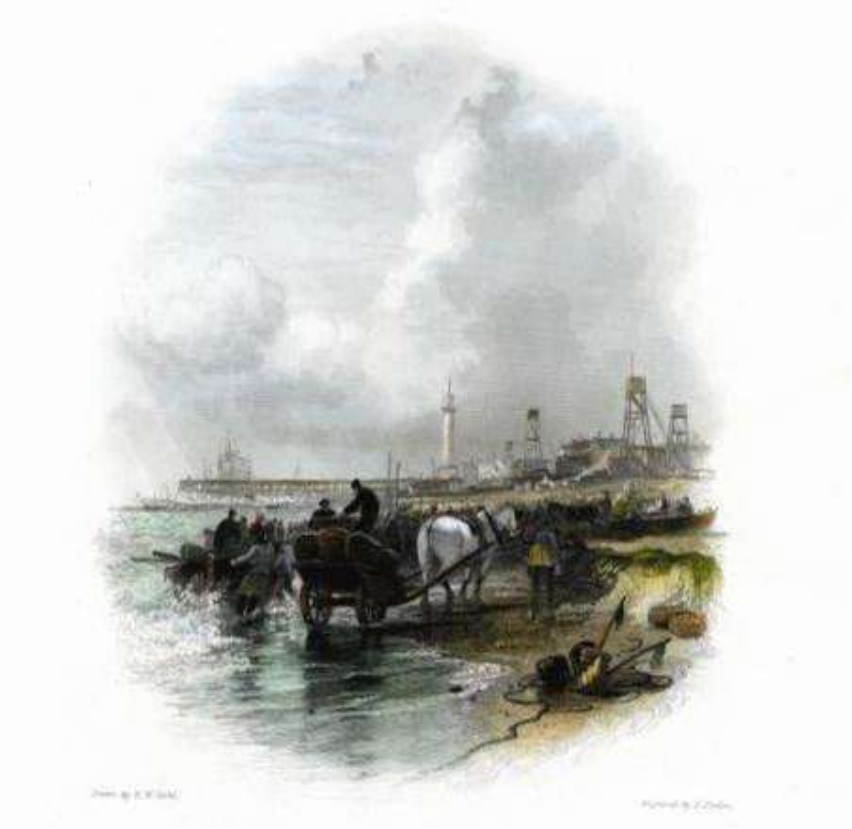


Figure 3A12. 'Yarmouth' by Edward William Cooke, RA, 1838, steel engraving

Key coastal risk management issues for the frontage

A low concrete wall and promenade extends along the whole of the Great Yarmouth seafront and the structure has a remaining life of approximately 50 years. The frontage also has a field of timber groynes, which have a residual life of up to 20 years. Over the next decades, the beach at the southern end of the frontage is likely to narrow and steepen, and improvements may be required to the defences in order to maintain their integrity. Rising sea levels will have an impact on the frontage, particularly at the southern end, posing increased risks of flooding. The issue of risk was highlighted by the December 2013 storm surge.

Observations on the artwork

There are a large number of views taken of Great Yarmouth beach on account of the location of the fishing village on the shore adjacent to the pier. It is possible to note beach levels against the timber pier structure and make comparisons through the numerous artworks that exist of this particular location. The view by Rock & Co. Engravers, dated 21st June 1850 (Figure 3A11), shows the timber fishing jetty and beach levels at the time. This compares with the present day view, which shows the healthy condition of the beach. An even earlier view of Yarmouth Beach by Edward William Cooke RA, published 1838 (Figure 3A12), also shows the relatively low beach levels against the timbers of the jetty.

How can the artwork inform coastal risk management?

A critical issue for coastal managers is maintaining the quality and volume of beaches along low-lying frontages, which may otherwise be prone to flooding. Therefore, monitoring of beach levels over time is particularly important. Whilst for the last 20 years in particular, sand

monitoring systems have existed around much of the coastline of England, there are very few cases where longer term records exist. As a result, historical images, which indicate beach levels, extending back into the 19th century, can be particularly valuable for comparative purposes. An examination of these engravings seems to suggest that beach levels have increased over time. This is also inferred through recent beach monitoring (Environment Agency, 2013), which states that moderate to massive accretion has occurred along the Great Yarmouth frontage although there has also been some beach steepening.

Where can the original artwork be viewed?
This engraving and similar views appear in many nineteenth century topographical books. Examples can be seen at Norfolk County Museum or on the Internet.

Great Yarmouth Beach and Jetty - Ranking score achieved: 55

A4. Gorleston-on-Sea Beach and Cliffs

Location
'Gorleston-on-Sea Beach and cliffs, Suffolk' by Joseph Lambert, 1822 (
Figure *3A13*). Gorleston is a seaside town almost contiguous with Great Yarmouth, but lying at its southern end at the mouth of the Great Yarmouth harbour.

Why was the study site selected?
In contrast to the site at Great Yarmouth to the north, which is very low-lying and has had a history of flooding problems over time, Gorleston is fronted by low, now heavily defended, cliffs, and offers a comparative approach in terms of coastal defence policy.

Geomorphological setting
Along this frontage there are unconsolidated cliffs, which range in height of between 10-15m; the whole frontage is now heavily defended. There is a narrow sandy foreshore but a wider flat backshore at the northern end, which narrows considerably towards the south.

Key coastal risk management issues for the frontage
The seawall and the harbour arm at the entrance to the port both have an estimated residual life of about 20 years, although the life of the groynes may be only up to ten years.

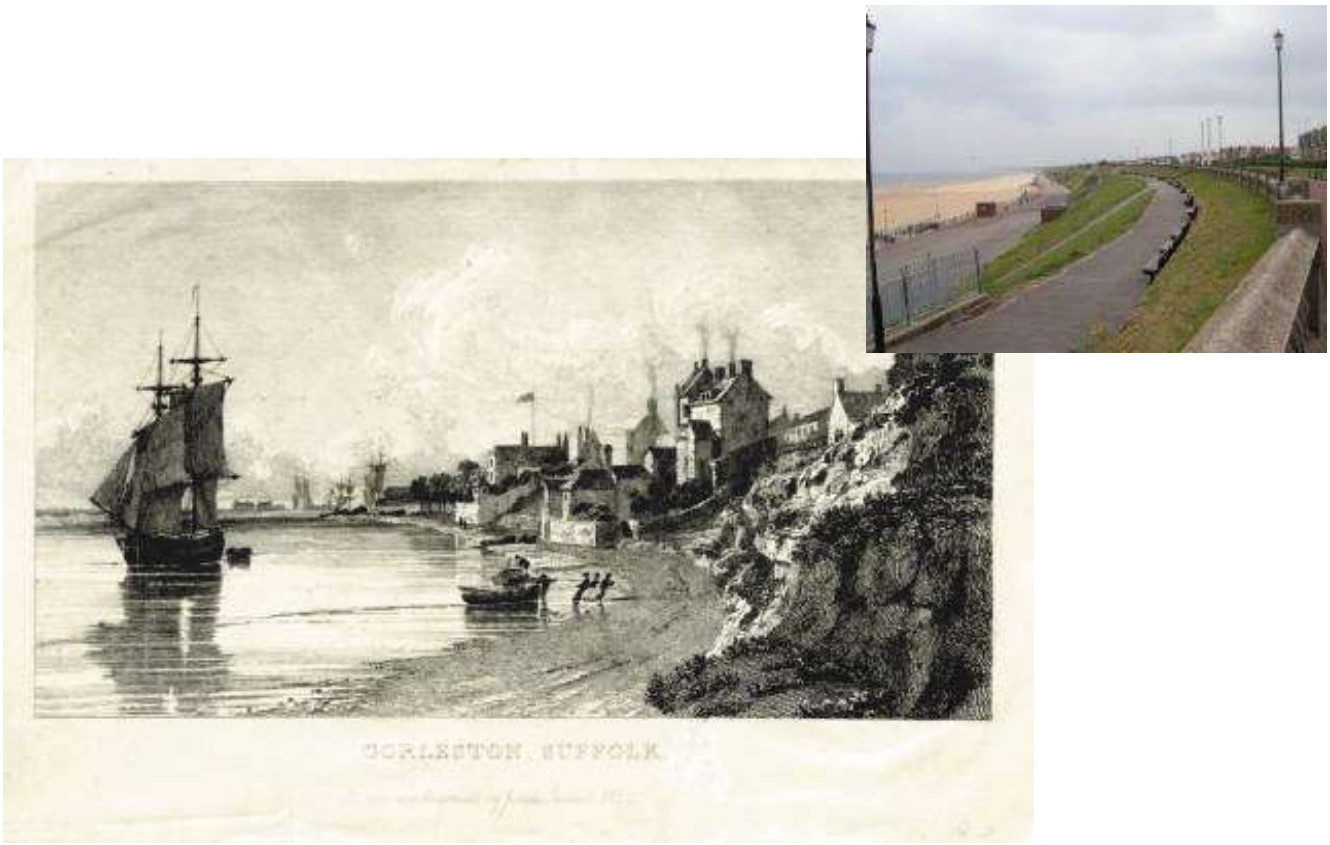


Figure 3A13. 'Gorleston, Suffolk'. Joseph Lambert, 1822. Copper plate engraving.

Observations on the artwork

This early copper plate engraving c.1822 shows the coastal village of Gorleston with only rudimentary defences at the foot of the slope on the beach fronting certain properties. The natural form of the cliffs can be seen in the foreground. A narrow beach exists between the cliff line and the sea. The interest in the early view is in the marked contrast with the present situation where the whole of the coastal slope is now heavily defended with a seawall and substantial slope re-grading and grassing in a series of terraces and paths with the properties redeveloped and now set well back from the cliff line.

The site is interesting as it illustrates the dramatic change as a result of development along this coastline, particularly in the twentieth century. It is interesting to note that, despite the defences being put in place, an extensive wide sandy beach exists along the frontage. A series of monitoring surveys undertaken since the 1990s attest to the steady accretion of the frontage amounting to an increase of approximately 100m since 1996 (Environment Agency, 2011). This has been accompanied by some beach steepening.

How can the artwork inform coastal risk management?

The engraving from 1822 illustrates the risks that existed to coastal properties at the time and the necessity for subsequent coastal protection measures. Although probably engraved at High Water the view suggests that significant changes to the beach morphology have taken place over the last two hundred years. It also illustrates how risks have been reduced over time through the necessary improvements to coastal defences.

Where can the original artwork be viewed?
This is an example of one of many nineteenth century engravings that are found in topographical guide books for the area. Such views can be seen in the reference library in the Norwich city reference library.

Gorleston-on-Sea Beach & Cliffs - Ranking score achieved: 44

A5. Pakefield Cliffs and Beach

Location
'Pakefield Cliffs and Beach, Suffolk' by Alfred Stannard, 1882 (*Figure 3A14*). Pakefield is, in effect, a southern extension of the town of Lowestoft located to the north. The town is famous for St Margaret's and All Saints Church, which is located immediately adjacent to the beach at the top of a low cliff.

Why was the study site selected?
This site was selected on account of the coastal geomorphology, which comprises a low cliff line, backing a wide shingle and sand beach. It is a location, which has, in the past, been affected by significant erosion and cliff instability problems leading to the loss of cliff top properties (*Figure 3A15*).

Geomorphological setting
Pakefield is characterised by a sandy beach with scattered shingle deposits located below low grassy banks and cliffs. Over the last century the cliffs and slopes have become increasingly vegetated in market contrast to the situation in the late nineteenth century.

Key coastal risk management issues for the location
It is necessary to continue to maintain the stable backshore and cliff line in order to protect the historic church and cliff top assets existing along the frontage. In the past the cliffs at Pakefield have been the subject of severe coastal erosion, with a number of properties being destroyed as a result of the retreat and rotational landsliding.

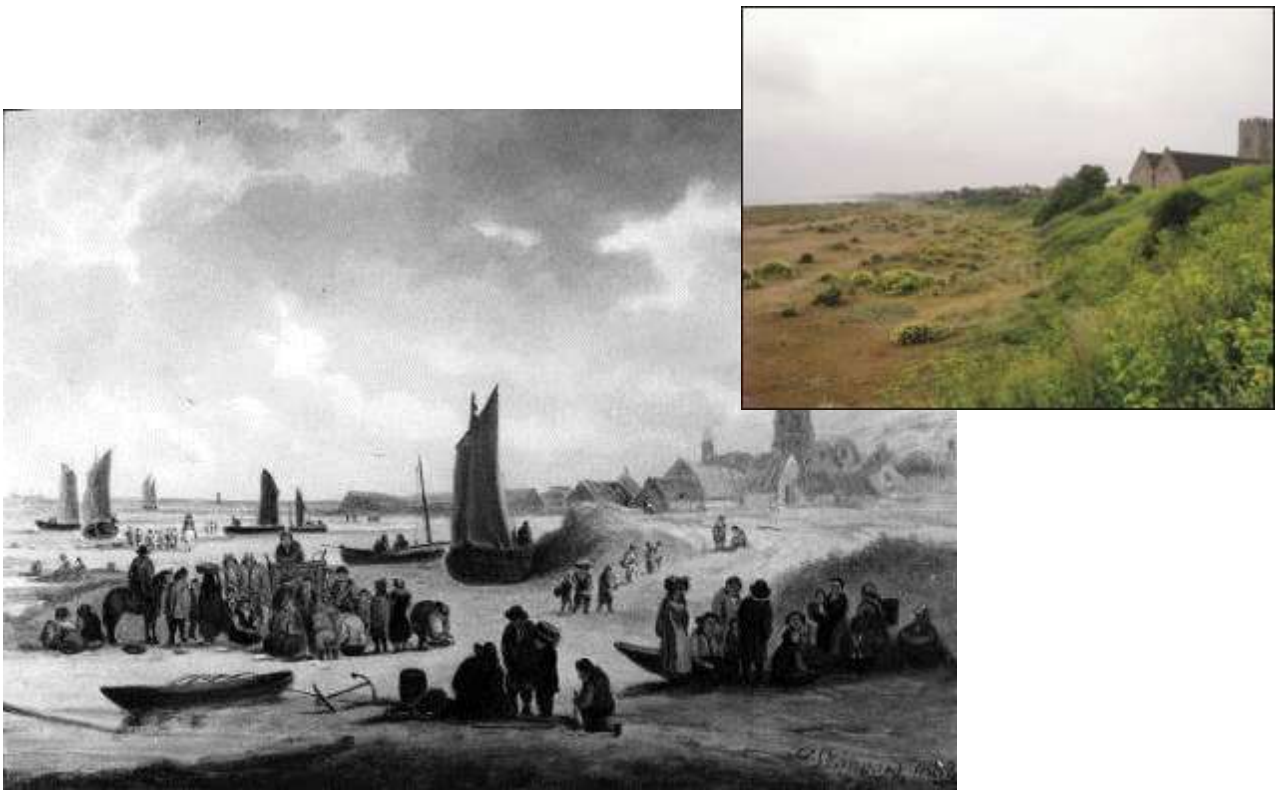


Figure 3A14. 'Pakefield' by Alfred Stannard, 1882, oil on canvas. Photograph courtesy of Mandell's Gallery, Norwich

Figure 3A15. Coastal instability at Pakefield, early twentieth century

Observations on the artwork
The painting by Alfred Stannard shows a busy scene with a fish market on the beach below the church. The beach appears wide and sandy, which lacks the vegetation cover that exists today. Although the painting by Alfred Stannard is not particularly detailed, it does suggest that since this date the beach has been accreting and, therefore, makes an interesting comparison with the present day coastal environment.

How can the artwork inform coastal risk management?
This painting informs us of the changing beach conditions at Pakefield since the 1880s. In particular the beach appears more extensive today and the backshore and coastal cliffs appear to be extensively vegetated. This appears to be supported by evidence from coastal surveys since the 1990s, which show significant rates of accretion at the northern (Lowestoft) end although there has been some erosion at the southern end (Environment Agency, 2011).

Where can the original artwork be viewed?
Private collection.

Pakefield Cliffs and Beach - Ranking score achieved: 55

A6. Southwold Cliffs

Location
'Southwold cliffs, Suffolk' by Helen Clarke, 1899 (Figure 3A16). Southwold is situated on the open Suffolk coast. The town is almost an island as, on its north side, it is cut off from the hinterland by Buss creek, and on the south by the river Blyth. Southwold is an important historic coastal town containing many listed buildings, as well as being a popular seaside resort.

Why was the study site selected?
Southwold and the village of Walberswick to the south have been favourite locations for artists since the early 19th century. As a result, there is a rich art heritage, which can illustrate the changing cliff and beach conditions over time. The many artworks painted at Southwold can, therefore, illustrate the Arch-Manche concept particularly well.

Geomorphological setting
Southwold is situated on the open coast and is almost separated from its hinterland by Buss Creek to the north, and the river Blyth to the south. To the north of Southwold a small community at Easton Bavents is located along an undefended cliff frontage, whilst the town of Southwold itself is defended by a concrete sea wall with an extensive natural beach to the south. The boundary is the mouth of the Blyth Estuary with its estuary mouth being channelised with hard defences (see case study A7 below).

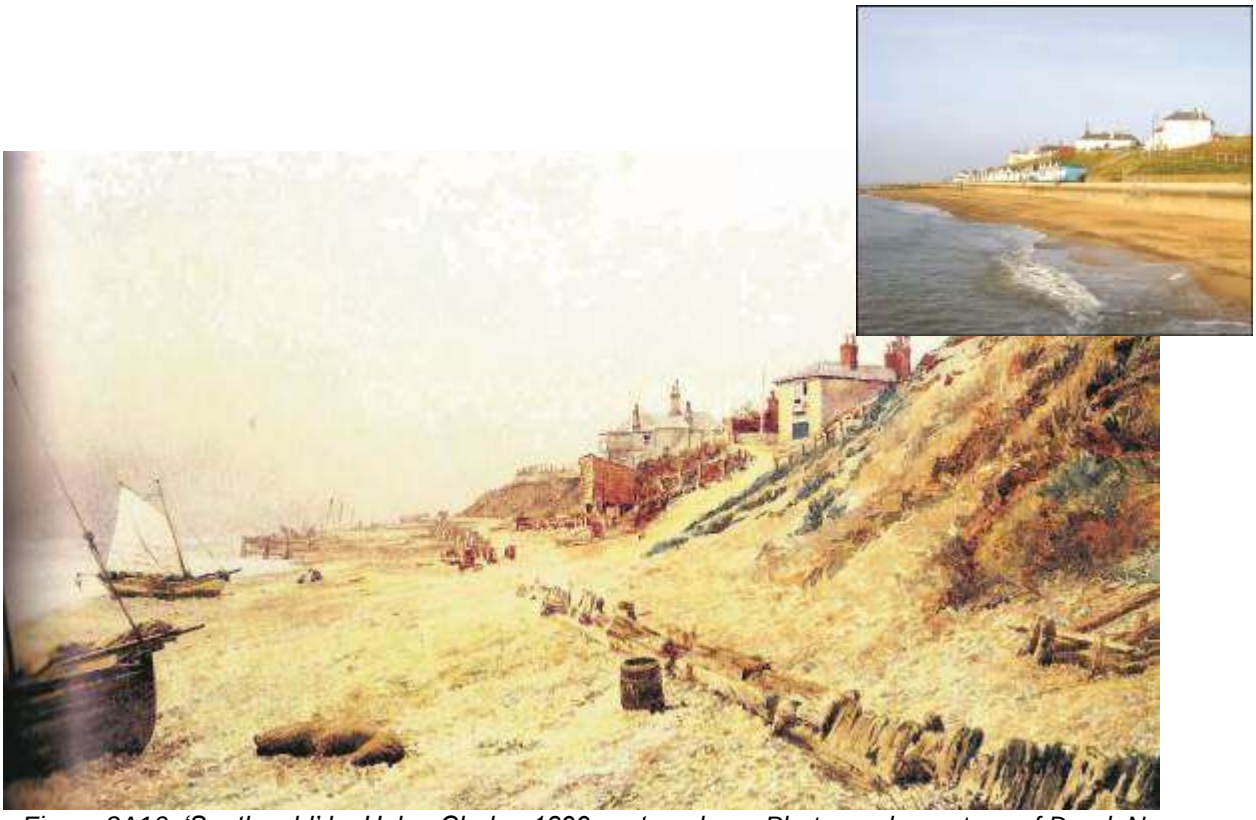


Figure 3A16. 'Southwold' by Helen Clarke, 1899, watercolour. Photograph courtesy of Derek Newman Fine Art. Private collection.

Key coastal risk management issues for the location

To continue to manage the existing coastal defences, looking ahead over the next 100 years, including 'holding the defence line' along the town frontage.

Observations on the artwork

This view by Helen Clarke was painted in about 1899, and provides a detailed illustration of the conditions on the cliff line and the beach at that time. Rudimentary coastal defences line the foot of the cliff and the beach appears to be of shingle; although the more vegetated cliffs appear relatively stable in the foreground they are more susceptible to active erosion beyond. Some further coastal defences and a groyne can be seen projecting into the sea in the middle distance. The situation in 1899 can be compared with the present day view below, which shows a new concrete sea wall and re-grading and stabilisation of the coastal slope. The beach appears lower in the present day view, which may perhaps be a result of wave reflection from the hard structure causing some scour, or other factors including a reduction in the supply of sediment feeding from the north, as well as rising sea levels.

The watercolour by Helen Clarke suggests that the defences would provide little protection against the force of the North Sea and the fact that the defences in the middle distance and beyond appear some way seaward of the cliff would suggest that waves have been breaking through the timber breastwork and eroding the cliff behind.

How can the artwork inform coastal risk management?

The watercolour shows the form of the beach, which appears more stable and steeper than in the present day photograph. The vegetation on the cliff in the foreground suggests that waves

are not undermining the cliff at this location compared with further along the coast. The picture illustrates how the coast might look if defences were not maintained.

Where can the original artwork be viewed?
Private collection.

Southwold Cliffs - Ranking score achieved: 74

A7. Southwold Beach, Suffolk

Location
'The Wreck of the Princess Augusta*'* by J. B. Crome, 1838 (Figure 3A17). This view shows the beach frontage immediately to the south of the town of Southwold, which can be seen in the distance.

Why was the study site selected?
This detailed lithograph illustrates conditions on an extensive open beach facing the North Sea, which is backed by a concrete sea wall. It contrasts with the narrower beach to be found abutting the town to the north.

Geomorphological setting
The site comprises a very extensive sand and fine shingle beach to the south of the town of Southwold, and to the north of the harbour. At the back of the beach the cliffs rise gently towards the grassy slopes of Gun Hill.

Key coastal risk management issues for the location
To maintain the quality of the beach and the existing coastal defences to protect the town, looking ahead for the next 100 years.

Figure 3A17. 'Wreck of the Princess Augusta on Southwold Beach' by J. B. Ladbrooke, 1838, lithograph

Figure 3A18. 'The beach at Southwold' by Thomas Smythe', c.1860, oil on canvas. Private collection. This view is taken from the same location as Figure 3A17

Observations on the artwork
This view is of interest because it illustrates both beach conditions and also the occasion of the wreck of the '*Princess Augusta*' on Southwold beach in October 1838. In the foreground, the wreck has taken place in a shallow bay but, overall, in the middle distance and beyond, the very extensive beach, leading toward the town of Southwold, can be seen. The southern edge of the town with some buildings and the church is visible. Beach conditions appear healthy at the time, although the whole frontage is quite low lying.

How can the artwork inform coastal risk management?
This 19th century lithograph provides us with an interesting depiction of the shipwreck set against the coastline at Southwold. It provides only a general view of the beach but together with other artworks of the location it demonstrates healthy beach conditions at the time.

Where can the original artwork be viewed?
Southwold sailor's reading room or on website.

Southwold Beach - Ranking score achieved: 66

A8. Southwold Harbour

Location
'Southwold Harbour' by William Daniell, 1822 (*Figure 3A19*). Southwold harbour lies at the mouth of the River Blyth to the south of the town of Southwold, and separates Southwold from the village of Walberswick to the south.

Why was the study site selected?
The site was chosen because it allows comparison of the present day with an early 19th century image of the harbour infrastructure, with the town of Southwold beyond.

Geomorphological setting
It has been explained that the town of Southwold to the north is situated on rising ground between the Buss Creek and the River Blyth. To the south of the Blyth and Southwold harbour the land is low lying comprising saltmarsh, dunes and low cliffs leading towards the historic medieval town of Dunwich.

Key coastal risk management issues for the location
Maintenance and management of the harbour and harbour mouth for the future, and to ensure that properties in the vicinity of Southwold and Walberswick receive a sufficient standard of protection from the risk of flooding.

Figure 3A19. 'Southwold Harbour' by William Daniell, RA, 1822, aquatint

Observations on the artwork

This detailed aquatint engraving by William Daniell shows the view looking across the mouth of Southwold harbour towards Southwold in the distance. The extensive low lying land beyond the harbour arms, comprising a beach backed by fields, is also the location of the previous case study. This view shows the form of construction of the harbour, as well as the conditions for craft entering the harbour during rough weather.

How can the artwork inform coastal risk management?

The artwork shows the nature of construction of the original mouth of the river. This has since been replaced with a reinforced concrete structure that can be seen in the present day view. Where historical coastal defences, such as sea walls and harbour walls are being replaced, it can be useful to understand how the original structures were erected and the materials used. This knowledge can sometimes help to reduce the costs of investigations.

Where can the original artwork be viewed?

This aquatint is one of 308 views of the British coast contained in *'A Voyage Round Great Britain'* by William Daniell and Richard Ayton (Daniell & Ayton, 1814). The images are represented in the Arch-Manche database.

Southwold Harbour - Ranking score achieved: 66

A9. Slaughden Quay

Location

'Slaughden Quay' near Aldeburgh, Suffolk by John Moore of Ipswich, 1883 (*Figure 3A20*). Slaughden is a small community located on the Suffolk coast to the south of the seaside town of Aldeburgh on the River Alde.

Why was the study site selected?

The site is typical of the low lying saltmarshes and mudflats to be found on the southern part of the Suffolk coastline. This work by John Moore of Ipswich illustrates the coastal geomorphology and environment of the area. Such artworks provide the opportunity to consider not just the physical changes that have taken place over time but also environmental changes.

Geomorphological setting

Slaughden Quay is located on the River Alde and is situated on a massive shingle spit, which extends for some 16km south of Aldeburgh to Orfordness and Orford Beach. The shingle spit is separated from the hinterland by the River Alde, which flows eastwards, through Snape, before broadening into a wider estuary and narrowing again and turning sharply south as a result of longshore drift.

Figure 3A20. 'Slaughden Quay' by John Moore of Ipswich, 1883, oil. Photograph courtesy of Colchester and Ipswich Museums

Key coastal risk management issues for the location
There are complex issues associated with a potential breach by the sea through the estuary to the south of the Slaughden Martello tower in the medium to long term. These issues are being explored in more detail following the completion of the Suffolk Coast Shoreline Management Plan (Suffolk Coastal District Council, 2010). The long-term coastal risk management strategy for this frontage, looking ahead for the next 100 years, is 'no active intervention'.

Observations on the artwork
This quite detailed oil painting shows a tranquil scene at Slaughden Quay by John Moore of Ipswich, painted in 1883. The painting illustrates, in a general way, the nature of conditions at this site, which appear to have remained relatively unchanged.

How can the artwork inform coastal risk management?
Artworks do not just have to illustrate significant coastal change, be it coastal erosion, instability or indeed accretion. If they illustrate that conditions have remained relatively unchanged over time this is equally important information that can contribute to our understanding of long-term coastal change. This would appear to be the case in this particular work.

Where can the original artwork be viewed?
Ipswich and Colchester Museums, BBC Your Paintings.

Slaughden Quay - Ranking score achieved: 74

A10. Orford Ness, Suffolk.

Location
'Orford Ness, Suffolk' by William Daniell RA, 1822 (Figure 3A21). Orford Ness is a very extensive cuspate foreland shingle spit located in southern Suffolk, extending south from the seaside resort of Aldeburgh for a distance of 16km. It is separated from the hinterland by the River Alde, which has been forced to flow southwards parallel with the coast, as a result of the historical longshore drift and build-up of the Ness itself.

Why was the study site selected?
This is one of the most important geomorphological features of its kind in Great Britain and is a location where there is a coastal policy of '*No active intervention'.* Orford Ness is Europe's largest vegetated shingle spit covering an area of 900ha and includes a range of internationally designated habitats.

Geomorphological setting
The site is located on a major shingle spit, which has the potential to breach between the shore and the estuary as a result of its exposed location, and particularly in the face of rising sea levels and a potential increase in the frequency of storm events. The Alde/Ore estuary runs behind this massive shingle ridge to emerge at the coast at North Weir Point to the south. The spit was formed almost entirely by waves through the process of longshore drift. The main influence has been storm waves throwing shingle over the top of the beach crest, where it is protected from the more usual wave action. Over the last two hundred years historical evidence suggests that the spit has extended southwards at between 64-183 metres per year. Over the years this leads to the formation of stable shingle ridges of finer material and swathes of coarse shingle, which may then be colonised by vegetation.

Figure 3A21. 'Orford Ness Lighthouse, Suffolk' by William Daniel, RA, 1822, aquatint. Private Collection

Key coastal risk management issues for the frontage

The need to manage access to Orford Ness and to gain a more detailed appreciation of physical processes taking place in this area.

Observations on the artwork

This aquatint engraving by William Daniell shows the 'Orford Ness Lighthouse' in 1822 with its neighbour, the 'Low Light', about 1.5km beyond. Daniell's view shows a low shingle and sandy beach, with steps leading up to the entrance to the lighthouse. Comparison can be made with beach levels against the lighthouse structure compared with today. It appears that beach levels have changed little at the lighthouse since 1822.

How can the artwork inform coastal risk management?

The view of Orford Ness shows the nature of the shingle spit at this point in the year 1822. The view is finely depicted and allows comparison of long-term beach change to be made. The fact that there appears to be no significant change over such a long period is important in terms of understanding the evolution of the spit.

Where can the original artwork be viewed?

Available to be viewed via the Arch-Manche portal. Original aquatints can be obtained relatively easily via Internet searches.

Orford Ness - Ranking score achieved: 62

3A.6 Analysis

The East Anglia study has combined the use of archaeological and palaeoenvironmental data, paintings, historic photographs, maps and charts in order to demonstrate how these tools can be used to improve our understanding of coastal change in the long and short term. The coastlines of the study area are constantly evolving, analysis of the past enables us to assess progressive changes and alterations to the coast and by understanding past coastal change it is possible to predict future changes and potential impacts more accurately.

The study area contains some of the oldest evidence of human occupation in Europe, now eroding from the modern cliffs, as well as evidence of more recent towns and villages now lying in ruins on the seabed. Much of the more recent erosion has also been captured in historic paintings and photos, and a variety of maps and charts have helped to record the rate and scale of this change over the last few hundred years. This section examines the most informative and reliable data gathered from this study area for contributing to understanding of the scale and pace of coastal change.

3A.6.1 Archaeology and Heritage Features

As described earlier the archaeological assessment focussed on the Suffolk coast from Lowestoft to Dunwich. The highest ranking sites were prehistoric buried and submerged landsurfaces which have the potential to provide information on past environments and sea-level change. The discovery of in-situ material at Pakefield pushed back the accepted dates for evidence of human occupation in Britain from around 400,000 years ago to 700,000 years ago. The discovery of mammal bones and other environmental material has allowed for the reconstruction of the climatic conditions which show similarities to the Mediterranean climates of southern Europe today and the assessment of plants and insects indicates the presence of marshy areas fringing a slow-flowing meandering river (Parfitt et al, 2006).

Work to identify whether the deposits from the cliffs at Pakefield continue offshore has been successful, proving that these early sediments, now submerged, have not been completely destroyed by glacial processes or marine erosion (Wessex, 2008:20). The in-situ material at Pakefield is therefore a reliable example of how archaeological and palaeoenvironmental data can be used to show how this area has changed in the long term both in terms of environmental change and relative sea-level change.

Submerged deposits further south at Benacre Broad, Covehithe and Easton Bavents can also inform environmental change and relative sea level change. These deposits contain peat which has the potential to provide datable environmental evidence and the location of this deposit relative to the current coastline can also provide information on relative sea-level change in the longer term. Further research is required to understand the full extent and current condition of these deposits.

Other high ranking material was from the medieval town of Dunwich, extensive work has already been carried out within a collaborative project funded by English Heritage (Sear et al 2013). The project combined archaeological and geophysical data with historic maps, charts, photos and documentary evidence. The project has been able to demonstrate the location of the coastline over the last few hundred years based on a combination of all these datasets and can therefore be used as a tool to assist with management of this coast in the future.

Dunwich and Pakefield are not the only sites which can be used to inform coastal change. Further work to establish the coastline at various periods all along the Suffolk coast was carried out by The Crown Estate (Brooks, 2010) looking at not only the coastline position but also the

associated nearshore bathymetry, a detailed historical investigation of the coastline retreat was carried out using historic data including maps and charts, however, no attention was given to the value of archaeological material in improving our understanding of coastal change. The Arch-Manche project has highlighted that many sites and deposits exist in the coastal, intertidal and marine zone of Suffolk which could add to our understanding of the coastline position, for example in the area of Covehithe (see Figure 3A22).

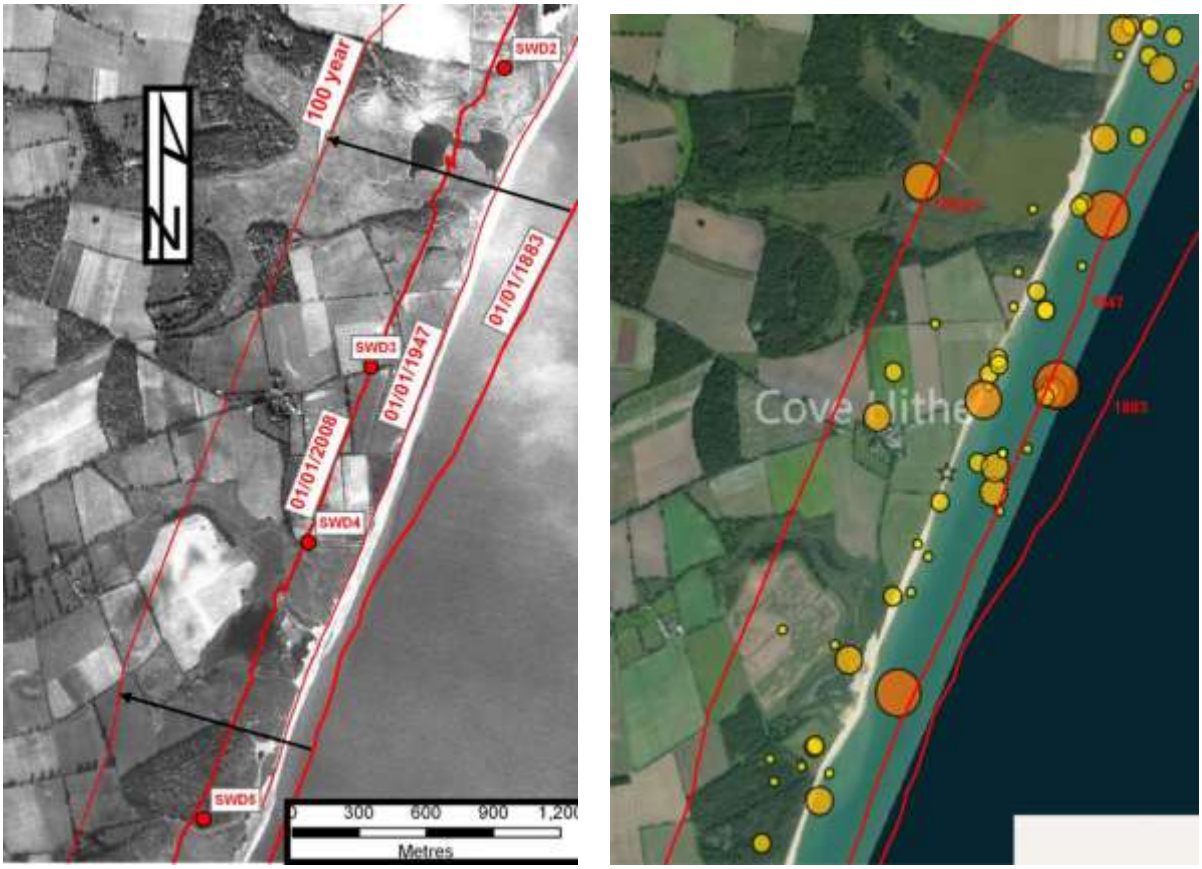


Figure 3A22. Covehithe. The image on the left (© Crown Estate, Brooks, 2010) shows the coastline near Covehithe in 1947, past shorelines are derived from historic maps, as well as a prediction of the shoreline in 100 years. The image on the right shows the same area today, with the historic and projected coastlines overlaid. The circles represent archaeological and palaeoenvironmental material assessed during the project, the larger darker circles have scored higher, and include peat deposits and a medieval well lost to the sea

Although much work has been carried out on reconstructing the coastline from the medieval period, further work is required to understand the rate and scale of coastal change from the Palaeolithic, Pakefield contains a wealth of information and deposits are known to survive offshore. Records of peat deposits exposed at low tide in other areas of the Suffolk coast can also provide further information to improve our understanding of coastal change in the longer term. The Arch-Manche project has demonstrated that along the stretch of coast in Suffolk a wealth of archaeological material is available to improve our understanding of coastal change not just in the last few hundred years but in the last few hundred thousand years.

It is also interesting to note that a number of the archaeological sites which have significant potential for holding data to inform on coastal change are themselves likely to be lost through

continuing erosion of the coast. This highlights the need to gather data from those high and medium scored sites to capitalise on this information before it is lost.

3A.6.2 Artistic Depictions

Following the research and location of a large number of artistic images of the study area coastline it was possible to rank their relative importance in terms of their value in informing on long-term coastal change. The art case study area was extensive in East Anglia because of the range of geomorphological types exposed around its coast. These included estuaries, creeks, river mouths, shingle spits, saltmarshes and mudflats. Because of the volume of artworks produced it has been possible to illustrate change over time through ten case study examples reflecting the range of physical features.

The ranking system directed research to the higher ranking case study locations usually where detailed artworks were available, painted, often, in watercolour, or printed as aquatint or steel plate engravings. Where a particular site offered interesting potential for study of coastal change the highest ranking image available was selected for study.

At the project outset the main focus was on a qualitative assessment of the artworks. However, after a review of the works by some artists it is clear that they may also allow quantitative assessments to be made, particularly where structures such as sea walls, groynes or buildings exist and where, for example, beach levels are clearly indicated or where actual cliff retreat can be measured against a structure.

In terms of the case study examples for soft cliffs artworks display these particularly clearly, for example, in the watercolour drawing of Cromer by John Varley (*Figure 3A8*) and in the views of the town by John Moore of Ipswich (*Figure 3A9*, *Figure 3A10*). Here the geomorphological processes of mass wasting and slumping, taking place on an undefended cliff, are clearly visible. The paintings tell us what conditions might occur if the coastal risk management policy changed from *Hold the Line* to *No Active Intervention*. These views of Cromer also illustrate in some detail the beach conditions that existed through the nineteenth century. The beach remained healthy no doubt because of the ready supply of sediments from the naturally eroding cliffs. There appears to be some evidence of flattening of the beach since Victorian and Edwardian times probably as a result of wave reflection from the hard defences at the foot of the cliffs and as a result of sea level rise.

At Great Yarmouth the extensive sandy beach has provided an effective form of coastal protection for the frontage for centuries. The beach is reliant on the continuously eroding cliffs to the north to supply a feed of suitable beach material. There are many artworks of Yarmouth beach because a focus for artists right through the nineteenth century was the fishing community that worked from a location close to Yarmouth Jetty (pier) on the main beach. Most paintings illustrated the activities of fishermen with the jetty as a backdrop and it is, therefore, possible to view beach levels against the timbers of the jetty and examine fluctuations over time. Although the structure has been removed recently (2012) art records do provide evidence of the healthy nature of Yarmouth beach extending back to the early 1800s.

The low cliffs at Gorleston and Pakefield were also popular subjects for artists. At Gorleston there has been extensive coastal protection measures constructed since mid-Victorian times but before that engravings show the vulnerability of coastal properties and the need for defences to be provided. At Pakefield the retreat of the soft cliffs led to extensive damage to properties and infrastructure along part of the frontage in the period up to the 1980s. Most artworks here focus on the fishing activities on the shore below the historic church of St Margaret's and All Saints,

which is situated close to the cliff top. However, here the paintings show how the foreshore and cliffs have become increasing vegetated and thus more stable.

The town of Southwold to the south is, alongside Cromer, perhaps the most painted location along the Suffolk coast. The relatively prosperous town, with its steady flow of summer visitors, included many clients who wished to purchase art. This, together with the establishment of a flourishing art school at Walberswick immediately opposite Southwold on the south side of the mouth of the River Blyth ensured a rich resource of paintings, watercolours and prints. For Southwold it has been possible to compare changes along the cliffline below the town of Southwold and to demonstrate the valuable protection role that the sea wall plays, whilst along the beach to the south there are several views, which allow comparison of the shape and volume of the beach. The crested shape of the beach, a natural feature, is clearly visible in several paintings and watercolours, a feature still present today. Such artworks are important in showing that there has been relatively little change in the beach over the last 150 years; this is useful information for coastal engineers.

At Walberwick there are numerous views of the mouth of the River Blyth; perhaps the first being that by William Daniell in 1822 (*Figure 3A19*). It is possible to observe through successive artworks the history of construction of river defences over time. Such information is helpful to designers wishing to replace older structures.

At Slaughden Quay, to the south of Aldeburgh, we can observe the open low lying coast of creeks, estuaries and saltmarsh, a highly important environmental habitat. Such frontages are likely to be increasingly affected by sea level rise with resulting changes to the habitat and species. We can use artworks of natural environments such as this to contribute to the record of the changing environment and in some cases identification of particular plant and shrub species is possible.

At Orford Ness William Daniell also produced a fine aquatint engraving showing both the old and the new lighthouse. The level of the beach in 1822 can be directly compared against the foundations of the lighthouse itself; such works, where physical structures exist in the coastal zone, do allow a quantitative assessment to be made of conditions at that particular locality including an estimate in the level of the beach at the time.

In terms of the most helpful artworks for comparing coastal change the watercolours of John Varley, the oils by John Moore of Ipswich and the engravings by William Daniell and others stand out. Some of the highest ranking artworks of the East Anglian coastline can be viewed easily in the important art collections in the county museums and art galleries of Norfolk and Suffolk, in particular Norwich Castle Museum & Study Centre (eg: Varley) and Ipswich & Colchester Museums (eg: John Moore). All oil paintings can be view on the BBC Your Paintings website whilst the relatively rare and expensive aquatint engravings by William Daniell and others can be inspected easily on the Internet after searching the artists' name and title of the image.

Although not a comprehensive study, several historic photographs and maps were also assessed. First edition Ordnance Survey Maps from the 1880's provide a lot of detail on the coastline, including the high water mark, the location of beaches, dunes and spits. With recognisable heritage features such as lighthouses, these can be compared to maps from earlier and later periods. The historic OS maps are available digitally and have been georeferenced, allowing for the direct comparison with modern maps to compare change over time. Historic photos also often provide detailed information on the coastline, although only

relevant for around the last 150 years these can still show the position of the coastline in comparison to known heritage features, many of which survive showing the East Anglian coastline.

3A.6.3 Combined Resources

As demonstrated above, East Anglia contains a wealth of information which can improve our understanding of coastal change, ranging from prehistoric archaeology to 19th Century paintings. Combining this broad range of data it is possible to understand coastal change in both the long and short term. Several areas along the East Anglian coastline contain all types of data; archaeology, art, photographs and historic maps.

Southwold was an important harbour in the Medieval period, and although its importance later declined in favour of Lowestoft, the harbour remained in use at a smaller scale and the town has thrived as a seaside resort. Historic paintings and maps demonstrate how the entrance to the harbour has changed over the last two hundred years (Figure 3A23).

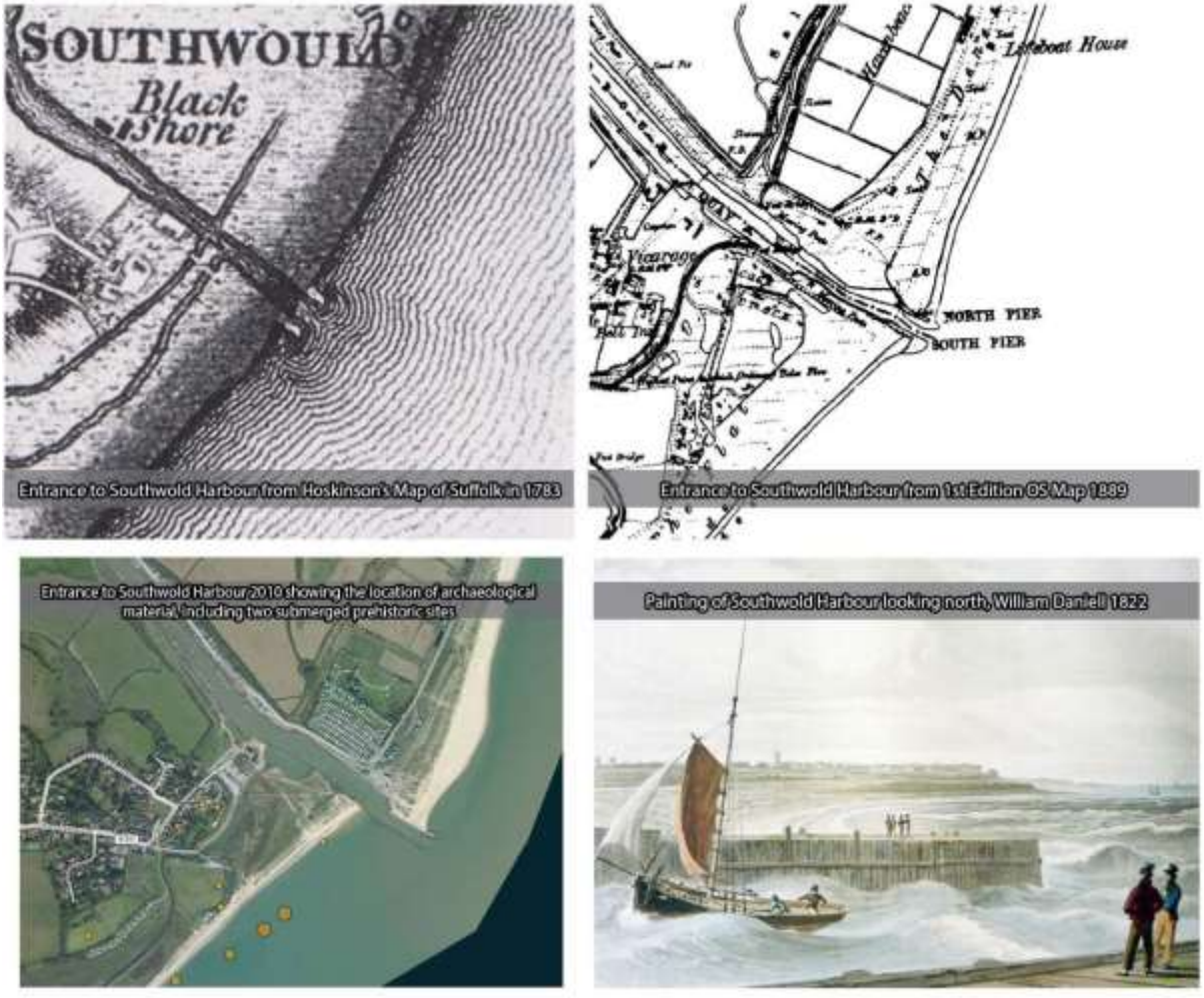


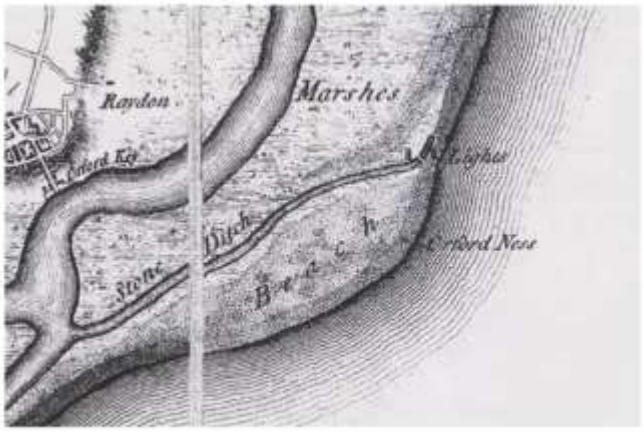
Figure 3A23. The use of historic maps and paintings showing heritage features can help understand coastal change at the entrance to Southwold Harbour. The location of archaeological sites is also shown on the bottom left image, this includes peat and possible Neolithic material exposed at low tide.

The timber entrance to Southwold Harbour has now been replaced with concrete and there appears to be a level of sediment accumulation at the entrance to the harbour since the map of

1783, this was known to be one of the reasons behind the decline of the harbour as sediment build up affected shipping. However, the map from 1783 may not be accurate enough to confirm this.

The area of Orford Ness is another good example of combining art, maps and heritage features to understand coastal change. Two timber light towers were constructed at Orford Ness in 1637, known as the High and Low lights, affected by coastal erosion they were replaced by brick towers in 1720 and 1792, but by 1887 the lower light was lost to the sea. The higher light can still be seen today, however, in June 2013 the lighthouse was decommissioned due to the threat of erosion, the following maps and paintings depict the lighthouses and coastline at various periods (Figure 3A24).

Orford Ness on 1st Edition OS Map from the 1880's. Both lights are shown



Hodskinson's map of Suffolk 1783 shows two 'lights' at Orford Ness

Current location of the higher Lighthouse, Google Earth 2013. Photo copyright Stuart Warrington.

Aquatint engraving of Orford Ness (high) lighthouse by William Daniell in 1822, the low lighthouse is shown in the distance

Figure 3A24. The lighthouses at Orford Ness depicted in 1783, 1822, 1880 and 2013. Such features are often depicted in historic maps and paintings and are good reference points when illustrating coastal change

The following image (*Figure 3A25*) shows a 1st edition OS map of Happisburgh, the high water line is marked on the map and the red line shows the current high water mark (2013), an early 20th century photo of the old coastguard station has also been found, the coastguard station was relocated in 2011 as erosion made access unsafe. Although outside of the archaeology study area for the project, Happisburgh also contains some of the oldest evidence of human occupation in northern Europe, similar to that described earlier in Pakefield. This site contains

evidence suggesting a much different environment to that seen today, consisting of a large river with a flood plain on the edge of a forest.

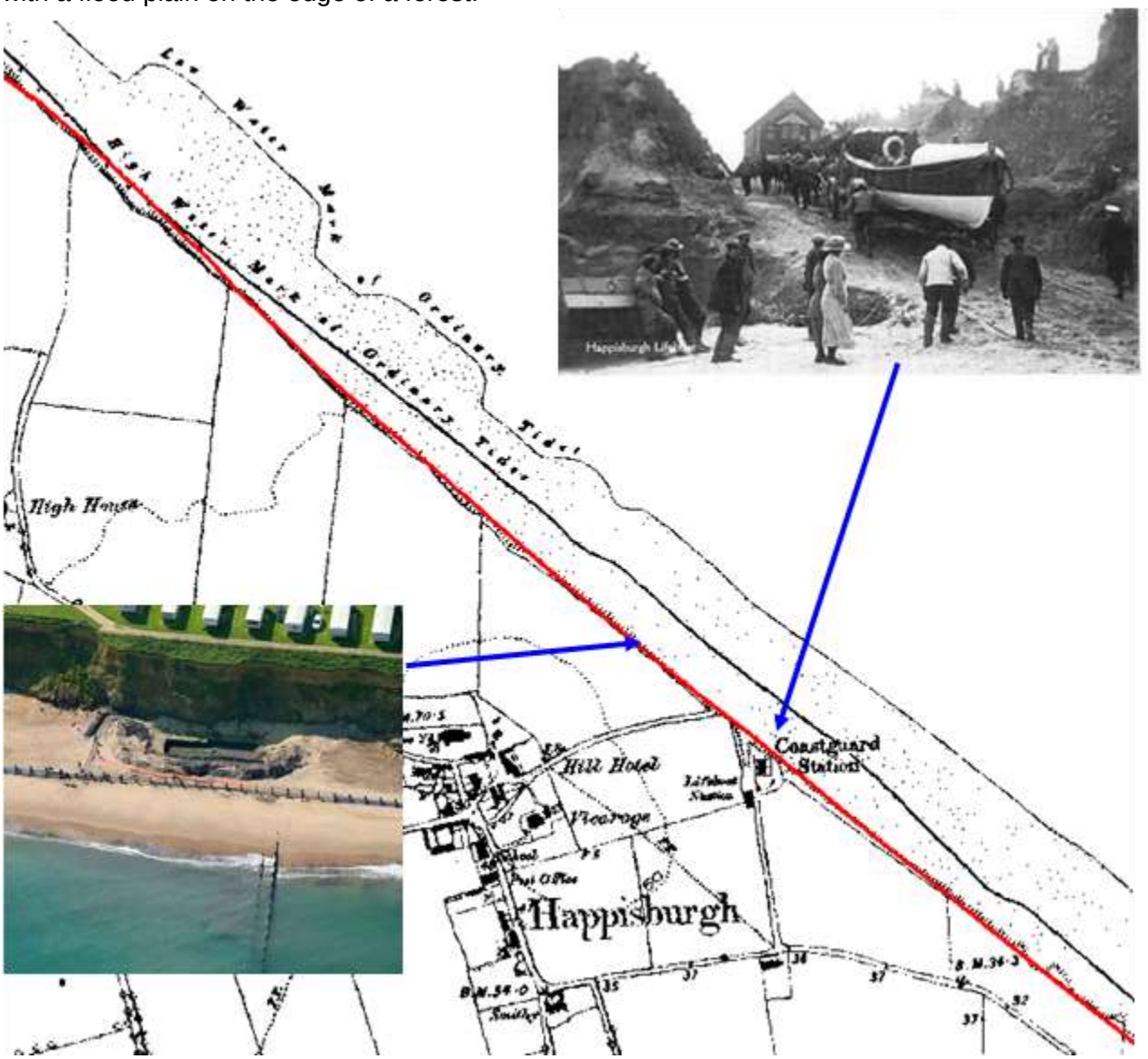


Figure 3A25. 1st Edition OS Map showing the high water mark at Happisburgh, compared to the high water mark in 2013 (red line). The photo in the top corner shows the old coastguard station, re-located in 2011 further inland due to coastal erosion. The photo in the bottom left is of the Happisburgh excavation courtesy of Mike Page

3A.7 Conclusions and Recommendations

The East Anglian Case Study area was chosen due to its dynamic coastline of varying geomorphological types with areas witnessing some of the fastest rates of erosion in the world. Although the focus of this study has been on archaeological evidence and artworks, the study has also demonstrated that there is a wide range of other resources which can be combined to provide even more detail on both long and short term changes, including historic photos, maps and charts. The following section will outline some of the conclusions and recommendations from this study to inform coastal management in this area.

The archaeological and palaeoenvironmental study focused on the Suffolk coast from Lowestoft to Dunwich. This area contains a wealth of information from 700,000 year old prehistoric sites to WWII defence systems. Although the area of Dunwich has been subject to detailed research in order to map the medieval coastline (Sear et al, 2013), the Arch-Manche project highlights the potential of other sites all along the coast which can tell us about the environment and coastline over the long and short term. Records of exposed peat deposits at low tide and archaeological material exposed along the eroding cliff lines have the potential to provide information on past environments. Further research would be required in order to obtain datable material and environmental evidence in order to reconstruct the prehistoric environment and map changes over time in more detail. With this it could then be possible to create 2, 3 and even 4-dimensional evolution models showing the changing landscape over time.

The art case studies in East Anglia clearly demonstrate the dynamic nature of the coastline and the impacts of coastal erosion, instability and flooding over the last 200 years. This region benefits from a rich resource of paintings, drawings and prints, which illustrate coastal conditions over the time period 1770-1940. A large number of artworks were ranked for accuracy and this helped determine which artworks and case study locations should be assessed in more detail also reflecting a suitable range of geomorphological conditions.

Only a small portion of historic maps and photos were assessed from the East Anglia study area. A larger study would be required in order to assess maps and charts from a larger time period, as well as further historic photos and postcards. Other resources could also provide detailed information, for example coastal pilot books, these publications contained detailed perspectives of the coast to be used in navigation and could provide accurate information on the East Anglian coast.

Each of the resources listed above can provide detailed information about past environments and the position of the coastline, through combining these resources it is possible to provide more accurate information not just from one time period but over a longer term, this can inform the rate, scale and pace of coastal change along the East Anglian coastline. The data can not only provide quantitative information on coastline position, but can also provide qualitative information that can assist in illustrating coastal changes to a large audience. While detailed coastal monitoring data is only available in East Anglia for the last few decades, the data assessed above can help fill the large ‘data gap’ for the earlier periods from the Palaeolithic to the 20th Century.

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