Beach Sustainability and Biodiversity on Eastern Channel Coasts

Interim Report of the Beaches At Risk (BAR) Project

January 2005

BEACHES AT RISK

BAR: BEACHES AT RISK

Beaches at Risk is a partnership project part funded by the European Union Regional Development Fund, under the INTERREG III programme.

The principal partners are:

University of Sussex

East Sussex County Council

Université de Rouen

in association with the Université de Caen

Université du Littoral, Dunkerque

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PLAGES A RISQUE

Foreword

Beaches At Risk (BAR) is an Anglo-French project which provides a new and exciting opportunity for managers, scientists and users of the eastern Channel coasts to meet regularly to exchange information and expertise. It is designed specifically to enhance cross-Channel sharing of expertise and to provide long-term data on coastal dynamics of the region. The project is part funded by the European Regional Development Fund, under the Interreg III programme, and is supported by a wide range of partners. This Interim Report is for Phase I of BAR, started in February 2003 and finishing in January 2005.

The coastal zone is one of the most complex and dynamic natural environments where the sea interacts with geology, ecology and human activities at a range of spatial and temporal scales. The diversity of human activities on the coast means that a wide range of users are directly affected by natural processes. Effective management requires wide consultation as well as sound understanding of the dynamics of shoreline processes. Past management practices have sometimes been carried out without due regard to adjacent stretches of coast and today's coastal managers have to deal with the consequences. In recent years there has been a move towards creating well-integrated management structures, such as the Coastal Groups who prepare Shoreline Management Plans for the coastline of England and Wales, in order to ensure effective coastal management well into the future. The French and English eastern Channel coasts share many shoreline management problems for which good solutions need to be developed. The BAR project brings together those who have traditionally worked in isolation on either side of the Channel to share information and expertise.

Picture: Elinor Low

Beach depletion is a serious problem on both sides of the Channel. On the English coast artificial recharging is undertaken to restore many beaches. The photograph shows a barge recharging the beach at Sovereign Harbour, Eastbourne on behalf of Pevensey Coastal Defence Ltd.

BAR is planned to operate over three phases to ensure collection of adequate long-term data to inform the cross-Channel region's management requirements. Phase II is planned to run from February 2005 to January 2007 and will be a period of intensive data collection using the protocols established during Phase I. The project's Anglo-French communication network will also be significantly expanded, with a number of new partners joining the project team. Phase I has identified specific areas that require further in depth study during the planned Phase II. In addition to the regular project meetings and conferences there will, for example, be transnational workshops on vegetation sampling strategies, shingle beach characteristics and beach volume maintenance practices. More emphasis will be placed on studying the nearshore zone just beyond the low water mark, since this is where the waves that erode the shoreline are formed. In addition, the project's modeling capabilities will be significantly enhanced and more detailed storm-surge models will be developed for the eastern Channel coasts. Ongoing results will be disseminated and the final synthesis of the project's findings will be completed during Phase III, intended to start in February 2007.

Picture: Bob Seago

Councillor Anthony Reid, ESCC Cabinet Member for Transport and Environment, congratulates the Vice Chancellor of Sussex University, Professor Alasdair Smith, as he launches the BAR project in 2003. The launch reception was hosted by Councillor Michael Tunwell, Chairman of ESCC (left) and attended by local dignitaries including Mr Peter Field JP DL, Vice Lord Lieutenant of East Sussex (right).

Executive Summary

The BAR project is yielding important new insights into the geology, biodiversity, process dynamics and management of the eastern Channel coasts in Brighton and Hove, East Sussex, Kent, Seine Maritime, Somme, Pas-de-Calais and Nord. Phase I, started in February 2003 and finishing in January 2005, has established an effective communication network and is carrying out wide-ranging investigations. BAR researchers have conducted detailed surveys of existing knowledge of the region's coastal geology, beach and cliff dynamics, biodiversity and management practices. A comprehensive programme of data collection, including surveys of biodiversity, beach and wave climate, has been initiated at key study sites. Much of the initial field and laboratory work has already been completed.

Bringing together researchers and managers, BAR ensures that the results of scientific research meet the management needs of the region. The project's French coastline has more extensive stretches of sandy beaches and dunes, whilst the English coast has fewer sand beaches and more flint shingle. As a result BAR researchers in France have more expertise in measuring the dynamics of sand and the English BAR researchers have concentrated their efforts on shingle and mixtures of sand and shingle. Biodiversity expertise also reflects the distribution of beach materials. English BAR ecologists have much experience in monitoring the dynamics of vegetated shingle whilst the French project ecologists have much more experience in studying sand dune habitats. Ecologists on both side of the Channel are concerned about the impact of natural and managed changes on coastal ecology and are working together to ensure that this is carefully monitored.

Picture: Rendel Williams

BAR is studying the extent to which major headlands such as Beachy Head impede the natural longshore movement of flint shingle creating deficits further along the coast.

In addition, BAR researchers in France have modelled the risks of inundation and enhanced erosion on the coast of Haute-Normandie and Picardie caused by the combined effects of beach deficits, increased storminess and sea level rise. They are sharing their technical expertise with coastal managers in East Sussex and Kent, and working alongside the English BAR researchers to ensure comparable data collection. Similarly, English coastal managers have much experience of managing beaches using recharge strategies and are sharing their expertise with French colleagues who have only recently started to use beach recharge as a management technique. Beach volume maintenance practices have been identified as a key area for discussion and information exchange during the planned Phase II of the project.

Communication of the project's findings to the public and coastal managers is paramount and is carried out via the project web site, leaflets, walks, talks and educational and interpretative materials, in addition to more detailed scientific and management reports. To ensure that BAR meets the needs of coastal managers and users, four Collaborative Study Groups have been established to review key aspects of the work. The Geomorphology, Biodiversity, Education and Management Study Groups meet regularly to help direct the project and enhance cross-Channel links.

Picture: Bob Seago

Hands on experience is one of the best ways to engage the public and increase their awareness of coastal issues. BAR ecologist Tracey Younghusband (right) explains life on the sea shore.

Aims and Objectives of the BAR Project

The eastern Channel coasts share similar natural environments, and experience common coastal management issues. Beaches At Risk (BAR), an intended six-year, three-phase transnational project, is designed to enhance cross-Channel sharing of expertise and to provide long-term data on coastal dynamics specific to the region. It highlights the importance of effective beach management for coastal defense, dune rehabilitation, tourism and biodiversity conservation. BAR enhances understanding of the nature of the region and the risks it faces in the coastal zone. The project is multi-sectoral, bringing together scientists, managers, practitioners and coastal users to inform management and the public alike.

The overall aims of the BAR project are to:

- Bring together researchers, managers, practitioners and users of the eastern Channel coasts to ensure that the results of scientific research meet the needs of the region
- Identify current beach deficits (erosional losses) and their causes
- Assess future deficit risks resulting from increased storminess and sea level rise
- Assess the risk of storm wave inundation and coastal flooding (magnitude and frequency of storms and storm surges and the morpho-sedimentary responses of beaches)

Picture: Uwe Dornbusch

Beach erosion and cliff retreat are threatening properties, for example at Criel-sur-Mer (Somme), April 2001.

- Assess the importance of beach dynamics for biodiversity and nature conservation, with particular reference to vegetated shingle and dune building and rehabilitation
- Inform beach management policy and practice, particularly artificial beach replenishment and biodiversity conservation.

Location of the BAR Project

A Shared Geology

Northern France and South East England share a common geological heritage. The same rock types outcrop on both sides of the Channel, and the pattern of folds is the broadly same. The Chalk forms impressive sea cliffs in both countries. The White Cliffs of Dover are mirrored on the French side of the Channel by Cap Blanc-Nez, while the chalk cliffs of Haute and Basse Normandie are repeated on the Sussex side as the Seven Sisters and Beachy Head. The older rocks that underlie the Chalk are exposed between Eastbourne and Folkestone on the English coast, reappearing on the French side of the Channel between Wissant Bay and Equihen-Plage just south of Boulogne.

On the French coast the oldest rocks are sandstones, limestones and clays that were deposited in shallow seas and brackish lagoons towards the end of the Jurassic Period, around 150 million years ago. They are exposed at and to the south of Cap Gris-Nez, but in South East England they are only found inland to the north-west of Hastings.

Picture: François Moritz

Jurassic sandstone caps the impressive headland of Cap Gris-Nez between Calais and Boulogne.

Picture: Cherith Moses

Flint shingle beach fronting Cretaceous sandstone cliffs at Cliff End, East Sussex. Yellow horned poppy in the foreground. The erosion of these sandstone cliffs is believed to supply sand to Camber beach.

The Cretaceous Period, which followed the Jurassic, began with the deposition of a considerable thickness of sandy and clayey beds, deposited on river flood plains and in fresh water. The basal Ashdown Formation, consisting of beds of sand and sandstone with subsidiary clays, was succeeded by the clay and ironstone of the Wadhurst Clay Formation. All these rocks are well exposed in the sea cliffs east of Hastings, whilst on the French coast there is only a small exposure at Pointe aux Oies directly south of the Wimereux sand dunes. Next to be deposited were the sands, sandstones and clays of the Tunbridge Wells Sand Formation. These were followed by the clays and other rocks of the Weald Clay Group. Easily eroded, these clays give rise to lowland and potentially floodable areas of coast.

Picture: Alex Tait

Cuckmere Haven and the Seven Sisters, Sussex.

Erosion of the Cretaceous Chalk cliffs provides flint for the shingle beaches that protect long stretches of the Eastern Channel coast.

Picture: Rendel Williams

Pointe de la Courtine, Haute-Normandie.

In the middle of the Cretaceous period, around 110 million years ago, the sea advanced over northern France and South East England, depositing the marine sands and sandstones of the Lower and Upper Greensand Groups and intervening marine clay of the Gault Clay Group. The Greensand rocks form sea cliffs around Sandgate and Folkestone in England. Upper Greensand rocks are also just visible on the shore just north of Beachy Head, near Eastbourne. On the French coast these rocks are largely covered by sand dunes where they occur north of Wissant, but they also form low reefs on the foreshore and are visible near the low tide mark.

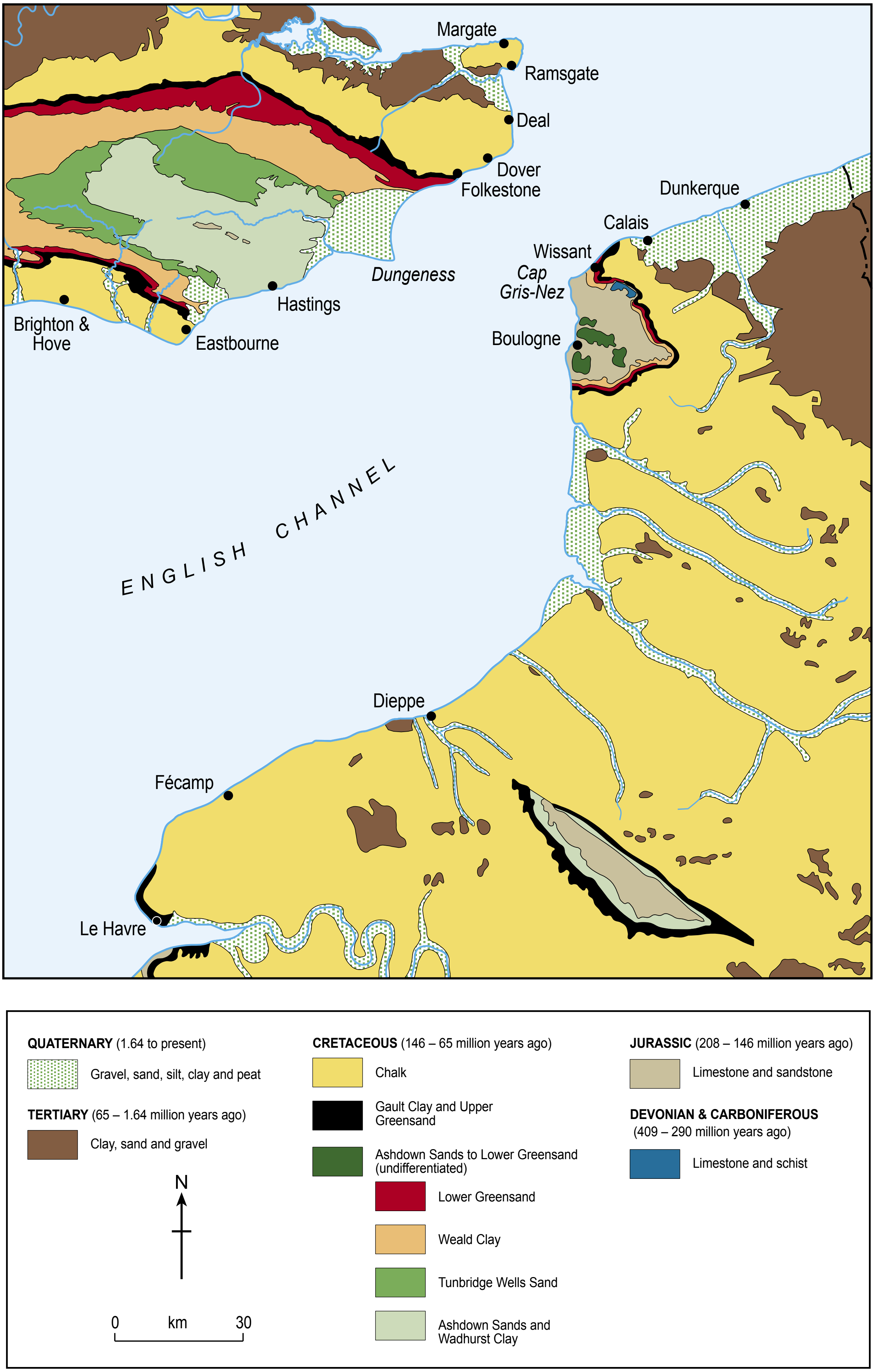
Starting about 100 million years ago, calcareous mud began accumulating on the Cretaceous sea floor, consisting mostly of tiny calcite crystals secreted by planktonic algae that lived in the surface waters of the sea. This mud later became consolidated to form the Chalk. Scattered within the mud were the remains of siliceous organisms, such as minute radiolaria. Circulating waters dissolved the silica, re-depositing it as nodules and layers within the mud while it was still accumulating and also after it had become consolidated as Chalk. The oldest Chalk, known as the Lower Chalk, is somewhat clayey and often grey in colour. Like the overlying Middle Chalk, which is purer, whiter and harder, it generally lacks flints. The youngest Chalk, or Upper Chalk, is more than twice the thickness of Lower and Middle Chalk combined, and contains abundant flints.

Near the end of the Cretaceous Period, South East England and northern France began to rise and the sea retreated. Uplift continued during the succeeding Tertiary Period, arching up the Chalk and older rocks into an elongated dome, called the Wealden Anticline, whose axis extends in a north-west to south-east direction across the Weald and the Boulonnais. Folding of the rocks and faulting reached a maximum in the middle of the Tertiary, around 30 million years ago, which was when the Alps were mainly formed. Rivers draining off the Wealden Anticline during and after the uplift eroded a great thickness of Chalk from the crest of the Anticline and also excavated deep into the underlying rocks, creating the basin-like Weald and Boulonnais. What had been once the highest ground in the region became some of the lowest. The Chalk, which once extended over the land surface was "peeled back" by erosion, leaving only the bounding rim of the North and South Downs in South East England and the chalk escarpment bounding the Boulonnais.

The Chalk eroded from the crest of the Anticline was dispersed far and wide, but the more durable flints, sands and other materials were deposited on the remaining areas of Chalk as the Tertiary Beds. The flints, for example, accumulated as banks of shingle pebbles. The warm, humid climate of the time weathered many of these pebbles giving them a yellowish, iron-stained exterior, in contrast to those eroded from the present chalk sea cliffs, which are generally black or blue-black in colour.

The western and central Channel developed as a result of crustal downwarping and faulting during the Tertiary, but the eastern end of the Channel, or Straits of Dover, is thought however to have a much more recent origin. At the end of the Tertiary, a chalk ridge seems to have existed in the Dover-Calais area, joining France and England. The waters of the North Sea were apparently separate from those of the Channel. During a particularly severe glaciation, ice advanced from Scotland and Scandinavia down the bed of the North Sea, which had drained away because world sea level was low. This ice is believed to have blocked the northwards escape of drainage water from the Thames and the Rhine. The waters, trapped between the ice and the chalk ridge, supposedly formed a vast lake, which eventually overflowed cutting a spillway through a low point in the chalk ridge between Dover and Calais. Opinions differ as to whether the cutting was a catastrophic event or quite slow, perhaps assisted by crustal faulting. When the climate warmed after the glaciation, global sea level rose and the spillway was flooded, becoming the Straits of Dover. During later glacial periods, sea level fell again and the Straits once more became dry land, only to be re-submerged with each interglacial. In each of these glacial periods, a river called the Fleuve Manche or Channel River crossed the area carrying the waters of the Thames and the Rhine south-westerly towards the distant Atlantic.

Geology of the BAR Project area



Historic Coastline Changes

The Channel River of the last glacial period carried the waters of both the Thames and the Rhine in a south-westerly direction to the sea, which then lay to the west of Brittany and Cornwall. The Seine, Somme and more minor rivers such as the Sussex Ouse were tributaries feeding into this great river.

Around 10,000 years ago temperatures rose rapidly, melting the ice-sheets and causing sea level to rise. The sea invaded the western Channel advancing eastward and reaching the eastern end between Dover and Calais around 8300 years ago. In the process, the sea drowned the lower sections of the main river valleys turning them into tidal estuaries. Other areas of lowland became wide, shallow bays. As a result, the coastline at the eastern end of the Channel was much more indented and embayed than it is today. Few parts of England and France have experienced so much change in the position of land and sea over the last 2000 years as this eastern part of the Channel. Even during Roman times the coast was quite different to that of today.

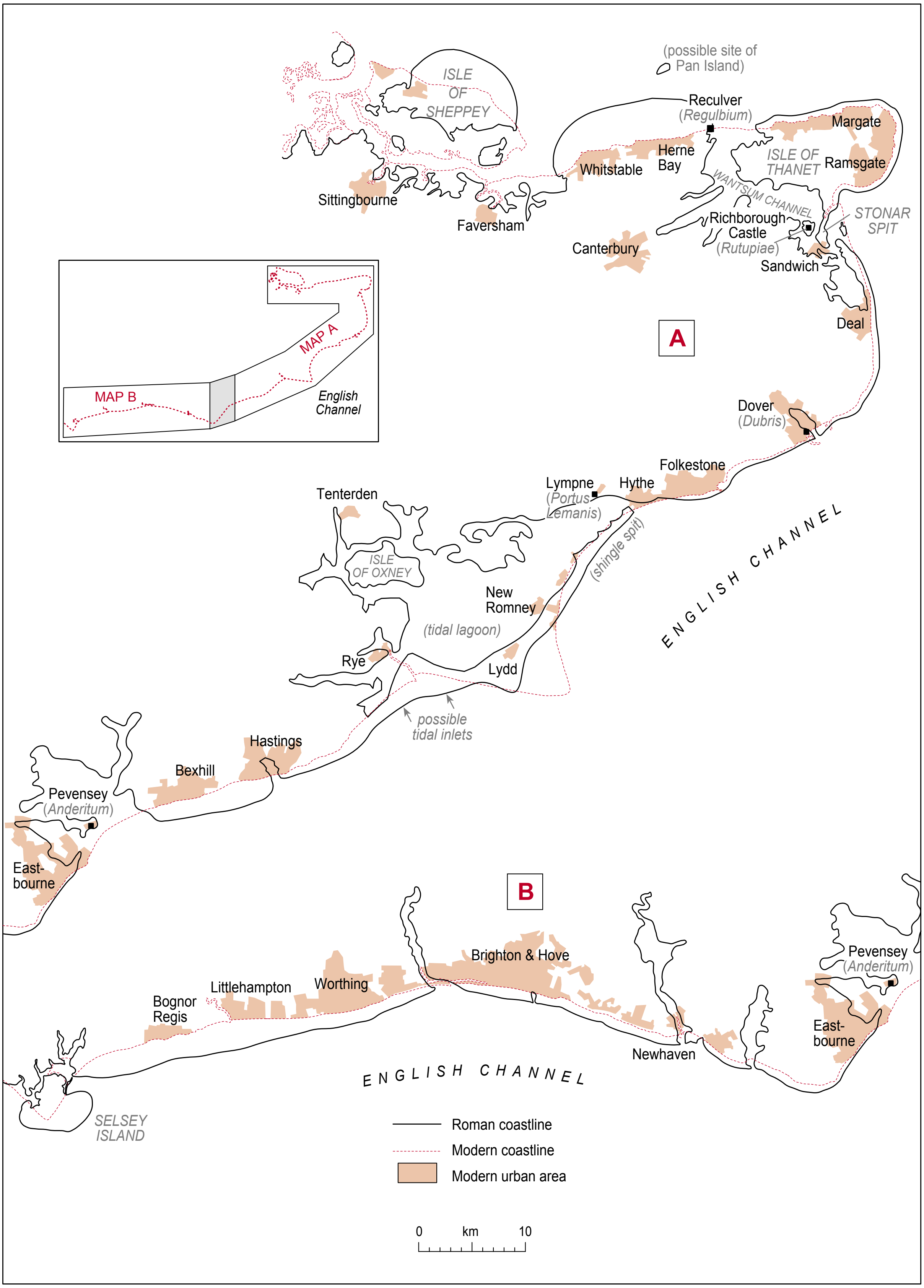
In Sussex, the lower Arun, Adur, Ouse and Cuckmere valleys remained tidal inlets until their reclamation in the 12th to 16th centuries. At Pevensey there was a broad tidal bay, perhaps partly protected by a shingle spit. Soon after the Norman Conquest, reclamation of the bay began in earnest and the greater part was turned into farmland by the mid-13th century. A large shingle foreland developed north of present-day Eastbourne at the Crumbles (Langney Point), but from the late 16th century onwards the sea eroded the shingle, largely destroying the foreland. Another wide bay existed in the Dungeness area, behind a shingle spit that was later breached and transformed into the vast Dungeness foreland. Reclamation of the marshes behind the shingle barrier began in Saxon times and continued through the medieval period.

Dover had a fine natural harbour in Roman times, which is now entirely silted up. According to legend, the Goodwin Sands formed part of the Kentish mainland in Roman and Saxon times, but this seems unlikely. Thanet, however, was very definitely an island. A wide sea strait, the Wantsum Channel, occupied what are now the Wantsum and lower Stour valleys. Gradually the strait silted up, but it remained navigable until at least the tenth century, possibly even the fifteenth century.

The Roman fort at Reculver was built on a headland that may have extended 1.5 to 3 km further out into the Thames estuary than it does at present. The sea has now half destroyed the fort. Near Herne Bay and Whitstable the coast is also believed to have retreated by several kilometres since Roman times. Herne Bay was supposedly flanked by two headlands, which were later removed by the sea. The coast is now so straightened that there is almost no bay.

The Isle of Sheppey in Roman times consisted of at least three islands that have since been joined as a result of salt marsh accretion and land reclamation. The cliffs that form the north coast of Sheppey are eroding rapidly, and may have retreated 3 or 4 km in the last 2000 years. Roman pottery recovered from the Pan Sand east of Sheppey suggests that the area may have been an island at the time, possibly the Caunos of Ptolemy's *Geographia* (AD 160).

The Roman coastline of East Sussex and Kent



BAR researchers have prepared this map using archaeological and geological data as well as cliff retreat rates calculated from historic maps. Despite many uncertainties, it is clear that the coastline in Roman times was more intricate than at present, with larger tidal estuaries and bays. Cliffed areas extended further out to sea, making France and England even closer neighbours. Beach shingle is likely to have been more plentiful.

The Channel Beaches

Beaches are of great value in helping to protect the land from the sea. They absorb wave energy, reducing wave impact on cliffs and sea walls, and protect low-lying areas of land from inundation during storms and high tides. In Kent and Sussex most beaches consist entirely of flint shingle or are composed of flint shingle overlying sand that is exposed at low tide. Pure sand beaches are rare. The beaches of northern France are much more sandy, especially to the east of the Somme estuary.

The flint shingle on the Channel coasts has more than one origin. Some derives directly from the erosion of the chalk sea cliffs and their associated shore platforms. As the chalk is broken up, the flints that it contains accumulate as beach material. Repeatedly moved around by the waves, the flints grind against each other, and are reduced to rounded pebbles and cobbles. Much beach shingle, however, derives from pre-existing flint gravels. Flints have been eroded from the chalk outcrops and deposited as beds of gravel at various stages in Earth history ever since the chalk was formed. In the last glacial period, for example, sea levels fell, exposing the floor of the Channel, which formed a huge lowland basin. The surrounding chalk hills suffered considerable erosion, and, unlike today, there were numerous streams and rivers to carry away the debris. Large amounts of flint gravel were deposited in the Channel basin. At the end of the glacial period, the sea re-invaded the basin, gathering up much of the flint gravel to form beach shingle. Even after the sea reached its present level around 5000 years ago, flint gravel may have migrated from offshore to supply the beaches.

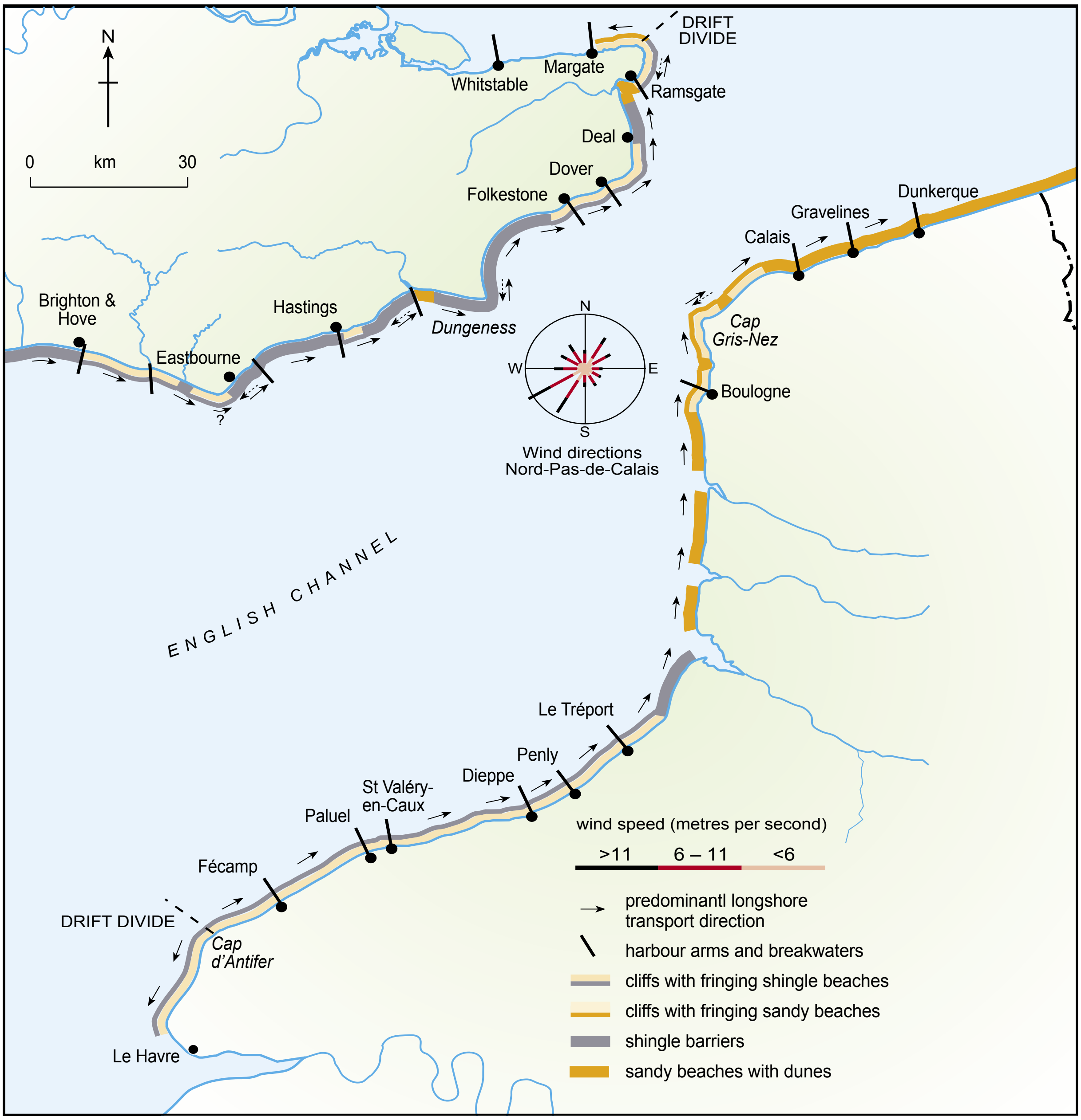
Beach pebbles and cobbles are steadily ground down by the unceasing action of the waves. Without adequate replenishment, the Channel beaches will become a rapidly diminishing resource. It is unlikely that they are continuing to receive much shingle from offshore; some experts suggest the supply failed about 300 years ago. There are also grave doubts as to whether current cliff erosion is supplying enough flints to maintain the volume of the present day beaches. The problem of beach sustainability is compounded, especially on the English coast, by coastal defence structures designed to halt the retreat of the cliffs. These often have the side effect of reducing the supply of flint shingle to the beaches.

The prevailing westerly winds drive waves eastwards up the Channel so that the waves run up onto many of the beaches obliquely, moving sand and shingle in an easterly or north-easterly direction. This "longshore drift", as it is termed, is an important element in beach dynamics. In a single storm individual pebbles may travel 100 m or more eastwards along the beaches. The beaches can be thought of as a moving conveyor belt of shingle and sand. Under natural conditions, as material moves away eastwards, it is normally replaced by material arriving from the west.

Although the longshore drift on the Channel coasts is dominantly eastwards, beaches sheltered from southwest winds and exposed to easterly gales experience westerly drift. At river mouths drifting shingle develops projecting beaches, known as spits. The Cayeux Spit, at the mouth of the Somme is a good example. At two places on the English coast, shingle also accumulated in past times as triangular forelands, projecting into the Channel. The smaller foreland at the Crumbles (Langney Point) north of Eastbourne has been greatly eroded by the sea, but the much larger foreland of Dungeness is relatively well preserved, although it too may now be eroding. The origin of these forelands is much debated.

Groynes intercept the longshore drift in many places along the Channel coasts, interfering with natural beach replenishment. The accumulation of shingle against harbour arms and breakwaters is also depriving beaches "down drift" of their shingle supplies. As a result falling beach levels have become a serious problem, increasing cliff erosion and the risk of flooding of low-lying land. In England, many beaches have had to be recharged with new supplies of shingle dredged from the floor of the Channel several kilometres offshore, but in France artificial beach recharge has yet to become common practice.

Longshore movement of beach material on eastern Channel coasts



BEACH SUSTAINABILITY AND BIODIVERSITY ON EASTERN CHANNEL COASTS

Disappearing Beaches and Eroding Shores: Two Examples

Kingsdown's battle with the sea

The old village of Kingsdown, between Dover and Deal, occupies a small valley that descends to the sea through a line of low chalk cliffs that must originally have formed the shoreline and been subject to wave attack. For some reason, the sea abandoned the cliffs and retreated, leaving an ever-widening bank of shingle in front. When the shingle started accumulating is not known, but by about 1800 the landward side of the bank was evidently beyond the reach of the waves because houses began to be built on it, extending the village beyond its original boundaries. During the nineteenth century, further quantities of shingle arrived, and many more houses were erected. Since then, numerous villas and bungalows have appeared, almost connecting Kingsdown with Walmer.

The amount of shingle that arrived at Kingsdown before the end of the nineteenth century was quite remarkable. The 1898 "six inch" Ordnance Survey map records that the shingle bank and beach was about 275 m wide at Kingsdown village and about 260 m wide at Oldstairs Coastguard Station, 600 m south. Picture postcards published in the early 1900s show that the bank was flat topped and seemingly devoid of surface ridges.

The plentiful supply of shingle to the beach at Oldstairs and Kingsdown ended as mysteriously as it began. Erosion had already set in by 1898 and continues to the present day. The erosion began to the south of the Coastguard Station, where the Royal Marines had a firing range, and gradually extended north, eventually threatening the village of Kingsdown. In the 1930s the military authorities built a sea wall to protect the firing range. Unfortunately, this acted as a barrier, stopping most, if not all, shingle from reaching Kingsdown by longshore drift from the south. A survey in 1953 showed that the beaches at Oldstairs and Kingsdown were losing shingle northwards, but not receiving any significant replenishment from the south. Fifty years on, this is still the case.

Between 1898 and 1953 the sea removed a 115 m strip from the shingle bank at Oldstairs, almost halving it in width. Since 1953 the sea has removed another 70 m of shingle, so that it is now quite close to the road that runs under the old cliffs. The erosion mainly results from shingle starvation, but is probably made worse by the scouring effects of waves refracted around the northern end of the seawall on the eastern side of the now abandoned firing range. To try to hold back the sea at Oldstairs, 3000 tonnes of Norwegian rock were brought in by road in 1998 and used to build a revetment around the northern end of the range. More recently, 11,000 tonnes of rock from a quarry near Boulogne have been delivered to the site on barges.

In the early 1950s, the sea was advancing at Kingsdown village by about 2 m a year, and by 1962 the rate had doubled. To protect the village, a lightweight concrete panel seawall was built in 1965, but this proved insufficient and it had to be extended and heightened. In 1998 the beach was recharged with 80,000 m^3 of shingle brought in by boat.

BAR researchers from the University of Sussex are studying the morphodynamics of the beaches along the coast between Dover and Kingsdown to establish the reasons for the accelerated coastal erosion. A popular theory is that the construction of Dover Harbour in the twentieth century cut off supplies of longshore drift to the coast further to the northeast, starving the beaches of shingle.

Beach erosion at Kingsdown, Kent

Picture: Rendel Williams

Picture postcard, ca. 1905, showing the shingle accumulation soon after erosion began.

Picture: Rendel Williams

Postcard view of ca. 1950, showing greatly increased erosion.

Picture: Uwe Dornbusch

All that survives in 2004.

Wissant's battle with sea and sand

Wissant Bay lies between the imposing sandstone headland of Cap Gris-Nez to the south and its chalk counterpart, Cap Blanc-Nez, to the north. Low tide reveals a wide sandy beach with a pronounced ridge and runnel structure. Behind the beach are extensive areas of sand dunes. The village of Wissant is about half way between the two headlands, flanked by the Dune d'Aval and Dune du Châtelet to the south and the Dune d'Amont to the north.

Wissant now caters mainly for holiday makers, but in the Middle Ages it was a thriving port, engaged in cross Channel trade. Unfortunately, the trade stopped by the fourteenth century when the dunes encroached and blocked the natural harbour. During the seventeenth and eighteenth centuries many houses in the village had to be abandoned because of the advancing sands. 1738 was a particularly bad year, with 43 houses destroyed in a single night by a raging wind. In 1777 the sand overwhelmed so many houses that the village had to be relocated.

In the nineteenth century it was the turn of the sea to menace the village. A promenade was built in 1910 with a sea wall beneath, which had to be strengthened and rebuilt several times since, most recently in 2001-2002, following serious damage by winter storms in 1999 and 2000. Up to now the sea has been successfully held at bay along the village frontage, but falling beach levels may well cause trouble in the future.

The sea front and promenade at Wissant then and now

Postcard mailed in 1910.

Aerial view, early 1950s, showing high beach levels and recent dune development at the back of the beach, now destroyed by the sea.

Picture credits: Paxion, K & Cohen, O., 2002. La baie de Wissant, cent ans d'evolution en images, Mammemonde, 67, 3, 24-27.

Postcard, ca. 1958.
Note the high beach levels.

Very low beach levels in 2000.
A concrete sea wall has since been built.

Picture: Olivier Cohen

Dune d'Amont, 2000.
New foredunes with marram grass have developed in front of older dunes covered in sea buckthorn.

Elsewhere in Wissant Bay there have been major changes. At the south end of the village the sea is encroaching rapidly into the Dune d'Aval. High tides now engulf the wartime bunkers that the German army built in the dunes overlooking the beach. To add to the troubles, wind erosion in 1984 caused the dunes to start advancing once again. Several houses were very nearly buried, but extensive marram grass plantings, directed by the Conservatoire du Littoral, have succeeded in re-stabilising the dunes.

Encroaching dunes, 1984

Picture: Olivier Beaulieu

Aerial view.

Picture: Port Autonome de Dunkerque

The "Sahara Dune" advancing on a house.

Further south the sea is advancing into the Dune d' Aval at a rate of up to 5 m a year since 1949. This is the most rapid shoreline erosion on the entire Côte d'Opale, and is causing serious concern. Erosion occurs mainly during winter storms. In November 1984, for example, a major storm combined with a spring tide caused the shore to retreat by 17 m. In stark contrast, to the north of Wissant, the shoreline has advanced seawards by about 0.8 m a year since 1949. New foredunes are developing in front of the Dune d'Amont.
BAR researchers from the Université du Littoral-Côte d'Opale at Dunkerque have discovered that a strong gyre, or circulatory current, develops in Wissant Bay at certain stages of the tide, and are working to determine whether this explains the shoreline evolution. Already, they have established that the beach changes reflect the amount of erosion of the seafloor in the nearshore zone. Comparison of marine charts of 1911, 1977 and 2002 shows that the seafloor south of Wissant has experienced significant erosion, implying a persistent sediment deficit, which correlates with the rapid beach retreat. North of Wissant, the advancing shoreline corresponds to a stable or even aggrading seafloor in the nearshore zone.

Beggar my neighbour: Problems caused by interrupting natural shingle movement.

Breakwaters provide valuable storm protection at harbour entrances and, by intercepting sand and shingle drifting along the coast, reduce the risk of the entrances becoming blocked by dangerous shoals. The sand and shingle trapped on the western sides of breakwaters helps to preserve the structures from wave attack. Unfortunately, by interfering with longshore drift, the breakwaters tend to create serious beach depletion "down coast".

BAR researchers are studying the adverse effects of breakwaters on both sides of the Channel. At Dieppe, for example, the harbour breakwaters and jetties trap shingle arriving from the west and deprive the beaches further east of their natural shingle supply. Criel Sur Mer, west of Le Tréport, has suffered serious beach erosion, which started some seventy years after the Dieppe harbour works first intercepted the drift. As a result of the erosion, the rate of retreat of the chalk cliffs has increased, threatening cliff-top housing. Since 1999 the authorities at Criel have ordered 14 families to evacuate their homes because the cliff edge has approached dangerously close. As is normal in France, the home owners receive compensation reflecting the value of their houses prior to expropriation. In Britain the authorities can spend public money on sea defences and coastal protection schemes, yet are not empowered to compensate the owners of properties lost to the sea.

The massive breakwater at Le Tréport acts as another shingle trap, starving beaches to the north-east. Between Ault-Onival and Cayeux, 55 groynes were built along a 4.5 kilometre stretch of depleted beach in an attempt to slow the longshore drift and reduce erosion. However, in February 1990 the sea overtopped the beach and flooded 300 homes at Hâble d'Ault, causing considerable damage. Shingle drifting still further north, to La Mollière, is now taken away in lorries to nourish the beaches nearer Le Tréport. Every year 20,000 cubic metres are transported, at the cost of about €10 per cubic metre. It might well be cheaper to excavate the ever-growing accumulation at Le Tréport breakwater and dump it on the beach just beyond the harbour!

Picture: Rendel Williams

Old postcard, ca. 1900.

Longshore drift problems can be difficult to resolve for legal and administrative reasons. In England, land ownership by private individuals and companies normally extends to the high water mark. The intertidal zone beyond, with certain exceptions, belongs to the Crown. Where shingle accumulates and the high water mark migrates seawards, the new land normally becomes the property of the individual owning the former frontage. The owner is then under no obligation to transfer the shingle to beaches down coast, even if he or she is the beneficiary of shingle trapped by a publicly funded coast defence scheme. There are many who argue that this "beggar my neighbour" situation needs to be resolved by a change in the law.

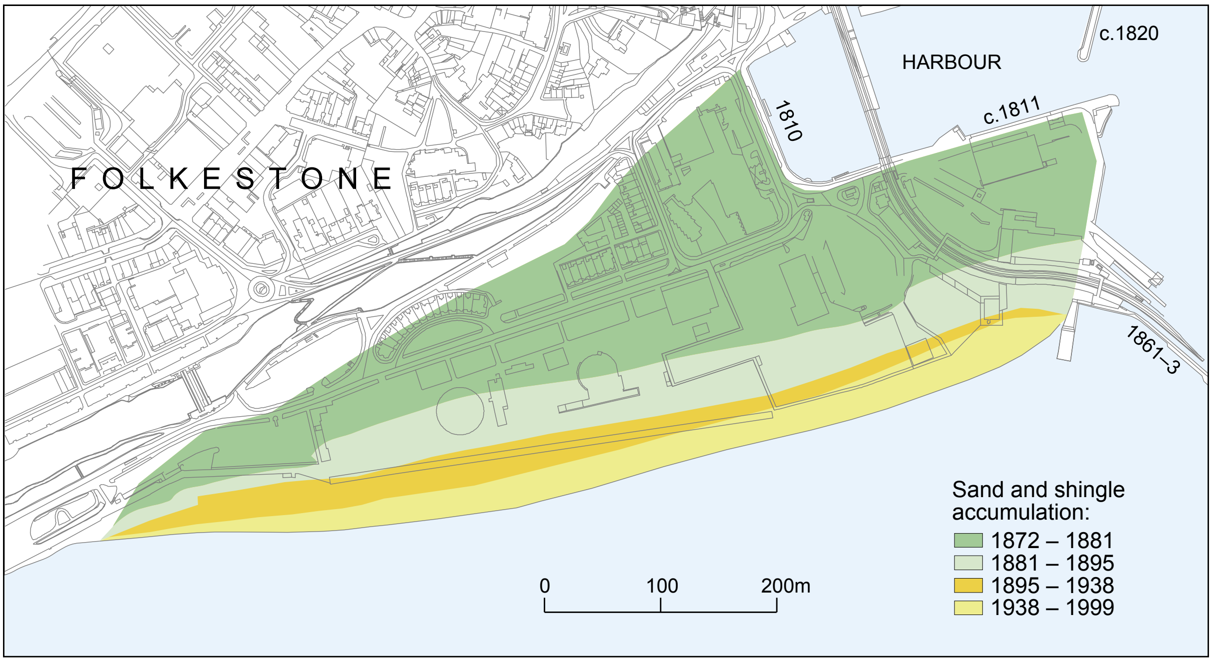
Folkestone, an example

Picture: Rendel Williams

Folkestone Harbour, photographed from an Airco biplane, ca. 1919.

Before the harbour was built, Folkestone fishermen had to haul their boats onto the shingle beach when they returned from the sea. Storm waves often swept across the beach, damaging the boats, and in 1807 Folkestone obtained Parliamentary consent for the construction of a tidal harbour. The west side of the harbour was completed in 1810, the south side in about 1811, and the eastern breakwater in about 1820. The new harbour trapped large quantities of drifting sand and shingle on its western side, and some drift got past into the harbour, which soon required regular dredging.

In 1861-63 a pier was built out into deep water, extending the harbour in a south-east direction. This pier allowed large steam ships to tie up even at very low tide. It originally had an openwork structure, but by 1883 it was clad in stone and started trapping longshore drift. The pier was rebuilt and extended between 1897 and 1905.



Shingle accumulation at Folkestone harbour has starved beaches downdrift.

The map shows how rapidly sand and shingle has been trapped against the west side of Folkestone Harbour. By 1872 the beach had built seawards to the start of the pier, and between 1872 and 1895 the area of sand and shingle increased by an average of about 2270 square metres every year. As the beach built out into deeper water, the annual increase in surface area declined, as greater volumes of shingle were needed to create the same increase in width. In addition, improved coastal defences west of Folkestone are believed to have reduced amounts of longshore drift. Between 1895 and 1938 the surface area of sand and shingle increased annually by an average of about 360 square metres, and after 1938 this fell to about 330 square metres. BAR is using digital terrain modelling of the nearshore sea floor to turn these areal estimates into sand and shingle volumes so that annual rates of longshore drift can be calculated.

Picture: Rendel Williams

Old postcard, ca. 1905.

Measuring Beach Volume Loss Due To Longshore Drift

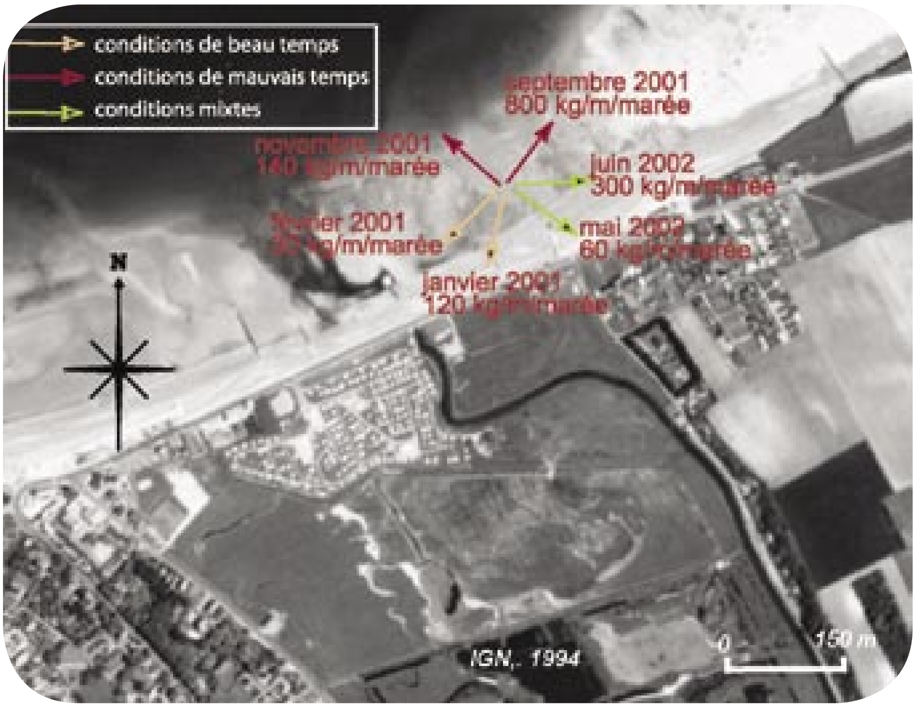
A major concern of the BAR project is to measure rates of longshore drift of sand and shingle. These rates can be predicted theoretically, but reality on the eastern Channel coasts may well be very different from theory. BAR researchers are establishing a database of measured beach transport rates in order to test the available theoretical models that are available, and to refine them as necessary.

Pictures: Franck Levoy

Deployment of flourescent sand tracer (A) and current meter (B) on the Sainte-Marguerite-sur-Mer Beach.

Researchers at the Université de Caen, Rouen and du Littoral at Dunkerque are measuring sand movement at various sites on the French coast, including Quiberville, Sainte-Marguerite-sur-Mer, Wissant, Malo-les-Bains and Leffrinckoucke. A combination of beach profile surveys and fluorescent sand tracing experiments allows the direction and rate of movement of beach material to be derived. The deployment of wave recorders means that the influence of the degree of beach exposure to wave action can be assessed. Nearshore bathymetric surveys are also being conducted to assess the role of nearshore morphology on wave energy and direction and consequently on sand transport directions and rates.

Picture: Franck Levoy



Sand transport directions on the sandy beach at Sainte-Marguerite-sur-Mer during different weather conditions.

Pictures: Uwe Dornbusch

Deployment of painted and synthetic tracer pebbles at Pevensey Bay beach.

At the University of Sussex research has focussed on measuring directions and rates of shingle movement. Methodologies are not as well established as those for measuring sand movement. Experiments have been made using painted flint pebbles as tracers and also non-native pebbles, such as quartzite. In addition, BAR researchers have designed synthetic pebbles made of hardened resin with a copper core, which have the advantage that they can be located with a metal detector. The tracers have been put out in clusters on Pevensey beach and their positions measured using a differential GPS (Global Positioning System) with centimetre accuracy. Wave recorders have also been installed. After two or more days, the beaches have been searched by eye and with a powerful metal detector tuned to respond to copper. Recovery rates for the painted pebbles and quartzites have been low, typically less than 5% per search after quite weak wave activity. Results with the resin pebbles have been much more encouraging with recovery rates approaching 20% when wave activity is weak. Few resin pebbles have been found on the surface; most have been recovered with the metal detector at depths of up to 10 cm.

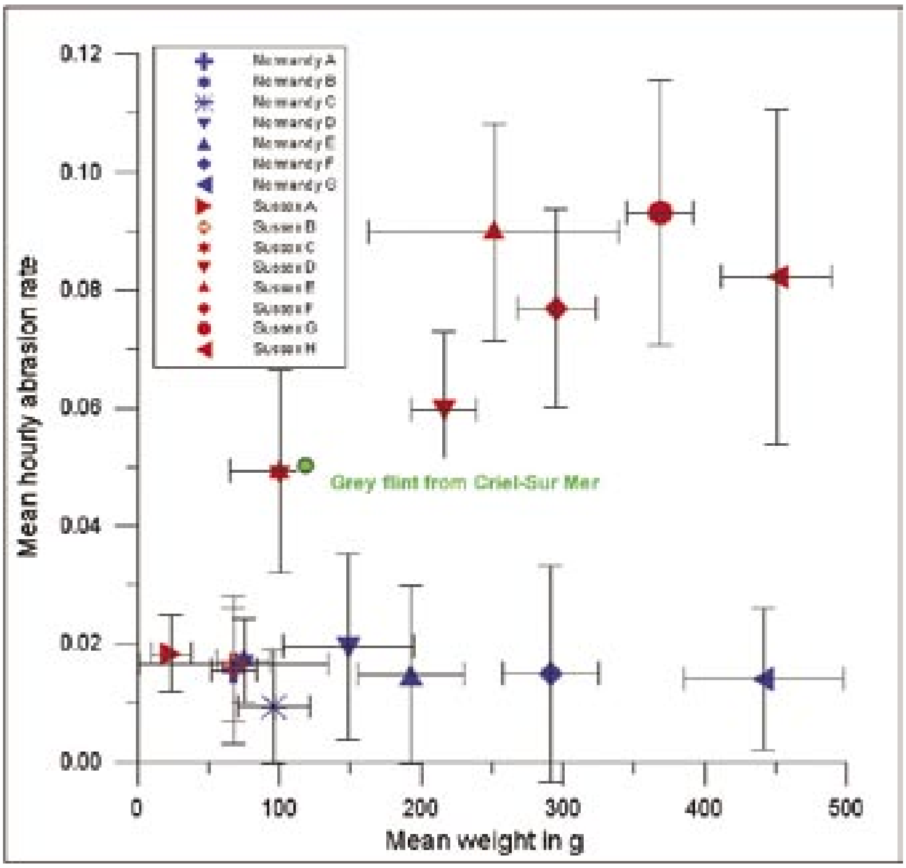
The distances that the tracers move are being analysed to assess the roles of wave direction, wave height and other factors. Already, it is clear that under favourable conditions pebbles can move long distances even in just a few tidal cycles. One pebble at Pevensey moved 217 m in two days even though wave activity was generally weak.

During Phase 2 of the BAR project longshore transport rates will be studied at a series of sites on both sides of the Channel, which are planned to include Pevensey Bay and Seaford in East Sussex, Samphire Hoe and Sandwich Bay in Kent, and the Cayeux Spit in France. French researchers will help to monitor sand movement on the English coast, and English researchers will reciprocate by assisting with the monitoring of flint shingle movement on the French coast.

Loss Of Beach Due To Shingle Wear

The rounded flint pebbles on Channel beaches are much less durable than is commonly supposed. The waves batter the pebbles against each other, slowly but steadily grinding them down. University of Sussex researchers have established that the pebbles undergo measurable wear even during a single tidal cycle. To estimate the long-term attrition rate, flint shingle beaches at Saltdean and Telscombe in Sussex were "seeded" with non-local quartzite and limestone pebbles of known weight. Over a 10-month period, the beaches were regularly searched and all the quartzite and limestone pebbles that could be found were reweighed. The quartzite pebbles fared better than the limestone pebbles, losing an estimated 5.8% of their weight per year, whereas the limestone pebbles lost 18.6%. When the quartzites and limestones were tumbled with beach flints in revolving barrels in the laboratory, it was found that the quartzite abraded 2.1 times faster and the limestone 9.8 times faster than flint. The quartzite results suggest that flint pebbles exposed to wave action lose about 2.8% (=5.8/2.1) of their weight per year, while the limestone data indicate that the loss is about 1.9% (=18.6/9.8). Taking 2.3% as an average, the life expectancy of flint pebbles on Sussex beaches would appear to be a mere 43 years!

It is important to realise that under natural conditions beach pebbles often become buried and are not continuously exposed to wave action. The measured rates of wear of the quartzite and limestone pebbles on the two Sussex beaches include possible periods of burial and zero wear, and are therefore not maximal. A flint pebble remaining on the surface of a beach and subject to wave action on every tide could be expected to have a life expectancy of much less than 43 years.



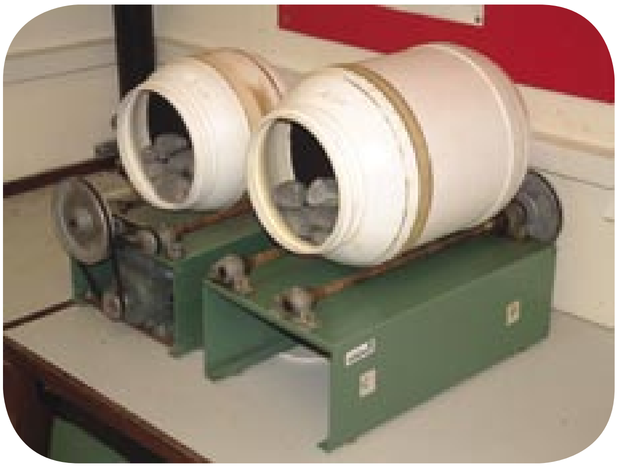
Experimental abrasion rates of rounded flint
(red = Sussex black flints; blue = black flints from Haute-Normandie).

When planning coastal protection schemes, no allowance is usually made for flint shingle wear. The BAR investigations, however, demonstrate that wear can be an important issue. Most schemes aim to give 50 years of protection, and during this time the beach shingle could possibly be reduced in volume by 25% or more because of wear.

More research work is being undertaken to gain a better understanding of the controls on rates of shingle wear. A key issue is how often beach pebbles get buried and escape wear. It is also important to discover how rates of wear relate to wave energy. Flints on sheltered beaches presumably wear down quite slowly compared with those on beaches like Saltdean and Telscombe that are exposed to the full force of the prevailing winds. Another major issue is whether pebble size and origin affects rates of wear.

Because many shingle beaches on the Channel coasts contain sand, research is needed to determine whether the sand increases or decreases rates of shingle wear. The issue is particularly important for coastal managers because sand is often introduced with shingle in beach replenishment schemes. Detailed experiments are under way to investigate the role of sand in controlling rates of wear of flint shingle. Preliminary results indicate that the presence of sand reduces the rate of shingle wear, and that the rate varies with the amount and grain size of the sand. More research is needed, but on present evidence it seems that beaches replenished with a sand-shingle mix are likely to last longer than beaches replenished solely with shingle.

Does pebble size and origin control the rate of wear of flint shingle?



Picture: Cherith Moses

Tumbling apparatus for simulating shingle abrasion.

BAR's laboratory tests show that dark grey flint pebbles collected from beaches at Newhaven and Telscombe in Sussex abrade more rapidly if they are large than if they are small. Preliminary experiments suggest that dark grey flint pebbles from the beach at Criel sur Mer, between Dieppe and Le Tréport, wear at about the same rate as those of similar size from the Sussex beaches. However, pale grey and banded flint pebbles collected from beaches further west at Fécamp and Étretat in Normandie have proved to be significantly more durable than the dark grey pebbles. Puzzlingly, the amount of wear of the Normandie does not increase with pebble size. The pale and banded flints are derived from younger Chalk than the dark grey flints, but whether this difference in age causes the difference in rates of wear is uncertain. Further experiments are planned to test the durability of pebbles of different size and origin.

The surfaces of many beach flint pebbles are covered with minute crescentic scars known as chatter marks. BAR researchers want to know whether these chatter marks control the rate of wear of flint shingle. Evidence suggests that the scars are constantly renewed as the pebbles are battered and worn down by waves. Laboratory tests are being conducted to measure the density of the scars to assess whether it varies from beach to beach according to amounts of wave impact.

Cliff Erosion and the Supply of Beach Shingle

The BAR project aims to identify the scale and causes of existing beach deficits and to advise on beach management policy. A key question is whether the eroding chalk cliffs are supplying the beaches with sufficient flints to compensate for losses caused by longshore drift, abrasion and other processes. There is concern that the beaches may be living on borrowed time because current cliff erosion may not be enough to sustain them.

BAR researchers are estimating chalk cliff erosion and flint provision in Kent using the same technique that was employed in Sussex by the BERM (Beach Erosion in the Rives Manche) project, funded by INTERREG II and completed in 2002. Cliff edge positions on the latest Ordnance Survey Land Line maps are compared with those on the first 1:10,560 Ordnance maps of 1872-1875 in order to calculate the average rate of retreat of successive 50 m stretches of undefended cliff. The rates are then combined with elevation data in a Geographic Information System (GIS) to determine the average volume of chalk that each stretch of cliff and shore platform has lost per year since the early 1870s. Different beds of chalk can have very different flint contents, and so field surveys are made to estimate how much flint is present in the cliffs and platforms along each stretch of coast. The data on chalk volumes and flint content are combined to estimate the annual supply of flint to the beaches.

The accompanying photo-maps show erosion rates for the Dover and St Margaret's Bay area calculated by BAR. Other maps have been prepared by BAR showing the Thanet coast. The chalk cliffs of Kent are mostly retreating quite slowly, and this combined with inaccuracies in the 1870s maps has resulted in the apparent advance of some short stretches of cliff! Nevertheless, the photo-maps give a quite reliable overall picture. For instance, the cliffs immediately east of Samphire Hoe, including Shakespeare's Cliff, are eroding at an average of about 6 cm a year. The still more famous White Cliffs of Dover, between Dover Harbour and South Foreland, are retreating on average at around 7 cm a year. These averages hide major spatial variations, with some stretches of cliff retreating much faster than others over the period of survey. In addition, cliff retreat in some places is noticeably episodic, with major cliff falls preceding many years of almost no retreat.

BAR researchers have found that the chalk cliffs of Normandie are retreating more quickly than their Kentish counterparts, at an average rate of around 21 cm a year. Erosion is least in the west, near Etretat and Cap d'Antifer (only 8-13 cm per year) and highest in the east, reaching 28 cm a year near Dieppe. The Sussex chalk cliffs are eroding even more quickly than the Normandie cliffs, perhaps because they are more exposed to the full force of Atlantic gales. The Seven Sisters, for example, are retreating at an average rate of about 46 cm a year, around six and a half times faster that the White Cliffs of Dover.

At the time of writing, BAR researchers are still engaged in measuring the flint content of the Kent chalk cliffs and platforms. Preliminary results, however, indicate that the supply of flints to the beaches is even more modest than in Sussex. The cliffs are perhaps providing enough flint to replenish adjacent beaches, but almost certainly not enough to sustain Kent shingle beaches generally. The results suggest that much of the shingle on Kent beaches derives from pre-existing flint gravels, and is a "fossil resource", which will not be replaced by natural processes. Coastal protection schemes that reduce erosion of the chalk cliffs increase shingle deficits on the beaches, making an already difficult situation worse. BAR researchers working on the Normandie coast have reached similarly worrying conclusions.

Erosion of the chalk cliffs around Dover

Beach Behaviour in Response to Storm Activity

BAR researchers are studying the response of Channel coast beaches to storm activity. The beaches, as one would expect, respond quickly, whether they are composed of sand, shingle or a mixture of the two materials. Shingle pebbles normally move by sliding or rolling, whereas sand can be more readily picked up by waves and carried in suspension. Steep, closely spaced storm waves erode the beaches, dragging the material into the offshore zone. The beaches become noticeably flatter. Low, well-separated swell waves during calm weather return material from offshore and steepen the beaches. At the upper limit of wave action, there is often a step-like feature called a berm.

Beach gradients are closely dependent on sediment size. Normally, flint shingle beaches slope quite steeply, whereas sand beaches tend to be relatively flat. One reason for this is that water drains more quickly through shingle than through sand. Waves breaking on shingle produce a relatively weak backwash because the beach absorbs so much water. In contrast, sand beaches have much lower porosity and the backwash is correspondingly more powerful.

BAR researchers from the Université du Littoral are making detailed surveys of the profiles of pure sand beaches near Dunkerque in order to correlate sand movement with wave directions and velocity. Researchers from the University of Sussex are conducting similar surveys in Sussex to determine how storm conditions of differing intensity affect shingle beach profiles.

Pictures: Stéphane Costa

Etretat beach, before (above) and after (below) a storm. Storms lower the beach and remove shingle, exposing sand.

Picture: Environment Agency

Picture: Ian Thomas

Pevensey Beach, East Sussex in January 1965 (above) and after beach recharge works in April 2004 (below).

Beaches containing a mixture of sand and shingle respond to wave activity in a more complex way than pure sand or pure shingle beaches, depending on the relative mix of the two materials. On some beaches the sand is more or less evenly distributed, filling the pore space between the shingle pebbles. On others the sand is present as a series of separate layers within a shingle mass. A further type of mixed beach is commonly found, in which the sand forms a platform beneath a mass of shingle and is exposed only at low tide. Research conducted by the Université de Rouen shows that shingle overlying a sand platform is particularly mobile and can be removed in a single storm event.

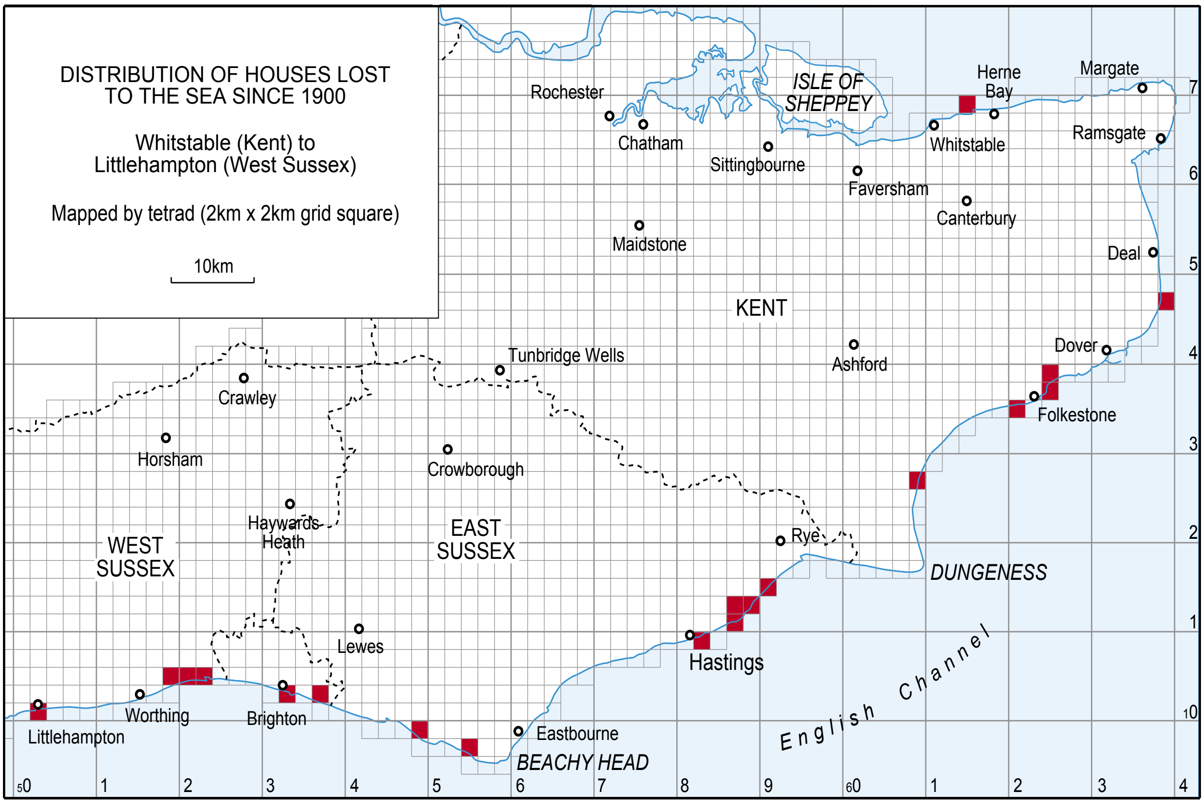
In the BAR area, modern management practices are altering the character of many beaches. Beach material is often recycled by lorry or bulldozer to raise beach crests and repair storm breaches. In addition, many replenishment schemes have been implemented, using sand and shingle from offshore deposits to augment depleted beaches. These interventions are creating more and more mixed beaches. BAR researchers are investigating whether certain mixtures resist storm conditions better than others, with the aim of making beach replenishment more sustainable.

The BAR project is giving particular attention to assessing the response of beaches to gale-enhanced high tides, or storm surges. Surges occur when low atmospheric pressure coincides at high tide with strong, storm driven onshore winds. Surge heights increase eastwards in the Channel because it narrows and gales advancing from the west tend to heap the water up. The Dover Straits are exposed also to North Sea surges. BAR researchers are determining the frequency of storm surges of different heights on both sides of the Channel, with the aim of deriving models of beach response. The response is complicated because storm surges can be extremely destructive, overtopping beaches and removing quantities of sand and shingle, but they can sometimes be constructive, throwing shingle over the top of the beaches, raising the level of the land behind.

Future Changes: Increased Storminess and Sea Level Rise

Global warming poses a serious threat to coastal communities. Accelerated melting of the Greenland and Antarctic ice caps is releasing more and more water into the oceans, and the ocean water itself is expanding as its temperature rises. For both these reasons, world sea level is rising. Along the coasts of the eastern Channel the problem is made worse by crustal subsidence. Opinions differ as to why the land is slowly sinking. One possibility is that the crust is slowly re-adjusting after the last glaciation. The huge ice sheet that once covered northern Britain depressed the underlying crust, and may have moved crustal material sideways, so that areas around the margin, such as South East England and northern France, became raised up as a "forebulge". With the melting of the ice sheet, the forebulge may be slowly disappearing, causing the Channel coastlands to subside.

Local crustal downwarping and world sea level rise combine to increase the apparent or relative sea level (RSL). Shoreline management plans need to give careful consideration to likely future increases in RSL. BAR researchers are reviewing evidence for RSL rise in the eastern Channel area in order to predict what will happen to the beaches. When geological data for the last 4000 years are compared with recent historic data from tide-gauges it is clear that RSL rise is accelerating. Although there is much unexplained variation in the tide-gauge data, it seems that RSL in south-east England has risen annually in the last 50 or so years about three times faster than in the past 4000 years. What is harder to resolve is how much further RSL will rise in the future.



The map shows grid squares where one or more houses have been removed by the sea or demolished because of imminent destruction by the sea. Many more properties are threatened by sea level rise despite current coastal protection measures.

Pictures: Rendel Williams

GOING, GOING, GONE
The sad fate of a terrace of houses at Hampton-on-Sea, near Herne Bay. The first two postcards show the houses in 1910; the last photograph the cleared site in 1911.

The UK Climate Impacts Programme has developed regional climate change scenarios for the present century. There are four different scenarios of how the climate may change, each based on different emission scenarios (Low; Medium Low; Medium High; High) from the IPCC (Intergovernmental Panel on Climate Change). Which scenario is the most likely depends on the future choices regarding emissions made by governments and society around the world. All scenarios produce generally similar geographical patterns of change, it is the severity of the change that differs between scenarios.

Under the High Emissions scenario, parts of south-east England may be 0.5°C warmer in summer in the 2080s. Relative sea level will rise by 0.86 m. Under the Low Emission scenario the rise in RSL will be 0.26 m. The British Government, in its Planning Policy Guidance (PPG 25), anticipates that relative sea level in southern England will increase by 6 mm per year later in the century. Of this, 3 mm is attributed to rising world sea levels and 3 mm to regional subsidence. BAR researchers are working to refine this estimate.

Under global warming, the frequency of stormy conditions is set to rise, especially in winter when rainfall may increase by up to 30% according to some pessimistic predictions. If storms and wind-enhanced high tides or surges become more frequent, the risk of beaches being overtopped or breached will be significantly increased. Beach erosion will become even more of a problem than it is at present because of enhanced wave activity and more rapid abrasion of beach materials. Rates of cliff erosion are also likely to increase.

BAR researchers are seeking to develop better models of storm surge activity on the eastern Channel coasts in order to assess the sustainability of sea defence and coastal protection options.

Biodiversity of The Eastern Channel Coasts

Although some sections of coast at the eastern end of the Channel have become highly urbanised, others remain in a more natural state and provide a haven for a great variety of plants and animals. Many species are highly specialised and live only on the coast.

A wide range of habitats exists along the coasts covered by the BAR project, including shingle and sand beaches, sand dunes, salt marshes, saline lagoons and sea cliffs. Although very important for wildlife, many of these habitats are threatened by land reclamation, urban development, and schemes for coastal protection and new sea defences. They are also a focus for tourism and recreational activities. Clearly, they need careful management if their wildlife interest is to be maintained.

Some key wildlife sites on the coast are preserved as nature reserves or as protected natural areas. In France, the Conservatoire de l' Espace Littoral et des Rivages Lacustres was created in 1975 to safeguard vulnerable coastal and lacustrine sites from the Mediterranean to the North Sea, and its holdings, like those of Britain's National Trust, are inalienable. The Conservatoire du Littoral, to use its common abbreviation, has acquired an impressive portfolio of sites on the French Channel coast in Nord, Pas de Calais, Picardie and Normandie. On the English side of the Channel, statutory bodies, such as the County Councils, and voluntary bodies, such as the National Trust and the Kent and Sussex Wildlife Trusts, have been active in setting up nature reserves and protected areas. Nevertheless, the total area of the Channel coast that has been safeguarded in this way remains quite small.

At the majority of English sites wildlife objectives are promoted through a long established system of statutory and non-statutory designations. For example, the government agency, English Nature, designates the areas of greatest wildlife value as Sites of Special Scientific Interest (SSSI), which receive statutory protection.

France, also, has a national system of designating sites. A Site Classé (SC), for example, is officially recognised as having significant landscape, artistic, historical, scientific or picturesque value, and can be modified only after Départmental authorisation. Likewise, Départment Prefects can set up an Arrêté Préfectoral de Protection de Biope (APPB) to preserve habitats to ensure the survival of protected species.

As members of the EU, France and Britain are engaged in designating Special Protection Areas (SPAs) under the 1979 Birds Directive and Special Areas of Conservation (SACs) under the 1992 Habitats Directive as a contribution to the Natura 2000 network of protected sites. These internationally recognised designations are making an increasingly important contribution to nature conservation in the Channel coastlands as well as elsewhere in the EU.

Plants and animals that live on coasts are well adapted to the ever-changing natural conditions. Indeed, change is fundamental to the maintenance of coastal habitats. All too often, unsympathetic sea defence strategies and development pressures prevent the wildlife from responding to change. Under such conditions, beach erosion can have serious negative effects on coastal habitats. BAR ecologists are investigating habitat gains and losses due to beach sediment processes, comparing stretches of coast that remain unmanaged with stretches where defences have been built and beaches replenished to reduce erosion and flooding.

Vegetation surveys in progress

Picture: Kate Cole

Picture: Tracey Younghusband

Information on the distribution of the various plant species and communities along eastern Channel coasts is fragmentary and by no means up-to-date. BAR ecologists are assembling a regional inventory of coastal habitats and coastal biodiversity to enable an informed assessment to be made of the impacts of increased beach erosion. The work is being incorporated into a wider project to assess the state of coastal habitat mapping along the whole of England's south coast, currently being undertaken by the Channel Coastal Observatory in Southampton.

Existing techniques for surveying and classifying plant communities are recognised as being inadequate for vegetated shingle. BAR ecologists are working to establish a protocol for the accurate identification and description of shingle communities. They are also studying the regional distribution of the different communities. Fieldwork is being undertaken with the aid a small group of dedicated volunteers, whose help is gratefully acknowledged. To date, more than 4 km of the East Sussex coastline have been surveyed, covering the main accumulations of shingle where there is known to be at least some vegetation. Sites include: the locally important shingle accumulation west of Newhaven harbour arm; Seaford beach, which was artificially recharged in the 1980s; the beaches at Cuckmere Haven, which have SSSI status and are nationally important; Holywell beach under the chalk cliffs south of Eastbourne; remnants of vegetated shingle at the Crumbles north of Eastbourne; and several sites along Pevensey Bay where artificial recharge and beach reprofiling occur but where there are still some semi-natural areas. These surveys are being augmented by more detailed studies at Rye Harbour Nature Reserve.

Shingle Habitats

Annual plants often colonise shingle beaches just above the strandline. Waves wash their floating seeds up onto the shingle in winter; the plants then germinate and complete their development during the summer, only to be carried away by the next autumn's storms. More varied communities of both annual and perennial plants develop further inland on shingle that is less frequently inundated or wholly beyond the reach of the waves. The richest communities are found at sites, such as Rye Harbour, where large masses of shingle have accumulated because the beach has built outwards into the Channel.

Plants that colonise coastal shingle have to be well adapted to cope with the inhospitable environment. They need to endure copious amounts of salt spray, particularly in winter, as well as frequent high winds. Many species, such as sea pea, hug the surface of the shingle, forming mats, to avoid being desiccated or uprooted. Newly deposited shingle can be very unstable and difficult to colonise. However, sea campion and stonecrops develop extensive root systems that very effectively bind loose shingle. The comparative sterility of beach shingle presents plants with a further problem. Except where rotting seaweed and other organic materials have accumulated, essential nutrients tend to be in short supply. In addition, plants growing close to high water mark risk temporary submergence if an onshore gale happens to combine with a very high tide. It is not unknown for entire plant communities to be washed away during severe storm events.

Pictures: Barry Yates

Babington's orache. This annual is a strandline species It tends to grow just above high water mark where flotsam such as detached seaweed accumulates, providing essential nutrients. A dense colony of young orache can appear as a green haze when viewed from a distance.

Many plants are unable to establish themselves on shingle because it is very free draining and soon dries out at the surface after rains. Deep within the shingle, however, there is often a layer of fresh water resting on seawater. Plants such as sea kale and yellow horned poppy develop very long roots that reach down to tap the fresh water. To reduce water losses, kale leaves have a waxy coating, while poppy leaves have a thick covering of hairs. Even in very dry summers kale and poppy plants rarely suffer from drought.

Picture: Barry Yates

Sea Kale. Once established, this long-lived perennial can cope with being covered by moving shingle, pushing up new stems to reach the light.

Picture: Rendel Williams

Viper's bugloss. Many shingle plants are insect pollinated and to attract insects have colourful, nectar-rich flowers.

Picture: Barry Yates

Little terns. The little tern's preference for nesting on shingle makes it particularly vulnerable to human disturbance, and, in an attempt to ensure breeding success, they are protected at many sites through voluntary wardening schemes. Foxes were a serious problem at Rye Harbour until electric fences were installed to exclude the predators.

Picture: Robert Edgar

Dungeness. Dungeness has more vegetated shingle than any other site in the United Kingdom. English Nature estimates that at Dungeness the shingle habitat covers 1600 ha, around 31% of the UK total. Much of the shingle is "fossil" – it is no longer accumulating as rapidly as in the past because of a reduction in natural shingle movement.

These highly adapted plant communities are important not only in their own right but also because they support animal communities of great ecological value. Dungeness, for example, boasts 11 species of invertebrate that are known nowhere else. Vegetated shingle also attracts many interesting birds. Little terns and ringed plovers, for instance, nest on shingle, laying camouflaged eggs that much resemble the pebbles.

Vegetated shingle is a rare habitat, not only in Britain and France, but also globally. It is therefore of significant international conservation importance. The shingle accumulation at Rye Harbour and Dungeness comprises more than half of England's total resource, and is one of the largest in the world. Its importance is demonstrated by the fact that it has SPA and candidate SAC status.

Vegetated Shingle at Risk

Vegetated shingle plant and animal communities are easy to destroy and difficult to re-create. BAR researchers are investigating the many threats to their existence:

Beach recession. Erosion of beaches and their landward recession reduces the area available for shingle plants and animals, and if long continued can eliminate them. BAR is concerned to assist coastal managers to maintain, restore, and where possible expand shingle habitats.

Picture: Tracey Younghusband

Sea defence schemes can seriously interfere with shingle wildlife.

Coastal protection works. Shingle vegetation is fragile and often damaged when sea defences are built or maintained. In addition, many sea defences obstruct the movement of shingle, reducing the natural replenishment of beaches further along the coast, often causing them to erode. Where beaches are in surplus, as at Rye Harbour, shingle is often extracted to rebuild other beaches that are in deficit, which reduces the area above high water mark that is available for colonisation by shingle vegetation.

Tourism and recreational pressures. Off road vehicles and motorbikes can severely damage shingle vegetation. People walking over the shingle often tread on the plants, crushing the flowers or foliage. If the trampling is too severe, the plants may be killed. BAR researchers are conducting field experiments to assess the impact of trampling and to examine regeneration of trampled areas. Shingle areas that are breeding grounds for birds need special protection. The birds may forsake their nests if visitors or their dogs come too near and create disturbance.

Picture: Barry Yates

Dogs off leads and marauding foxes attack ground nesting birds.

Picture: Rendel Williams

Seaside bungalows have encroached on to beach shingle at Dungeness, Pevensey and other places. Escaping garden plants, such as valerian, are invading the natural shingle communities.

Alternative land use. Large areas of vegetated shingle have been reclaimed for agriculture with the consequent loss of their unique flora and fauna. Other areas have been sacrificed for housing developments. Near Eastbourne, for example, almost all the shingle foreland known as the Crumbles, which was once a major wildlife site, has been developed as a housing area and marina. At Dungeness, two nuclear power stations have been built on vegetated shingle, and their maintenance requires constant recycling. The nearby Lydd Ranges, which cover 1150 ha, are used intensively for military training, despite their ecological importance. While some species may have benefited others appear to have suffered from the disturbance caused by the military activities.

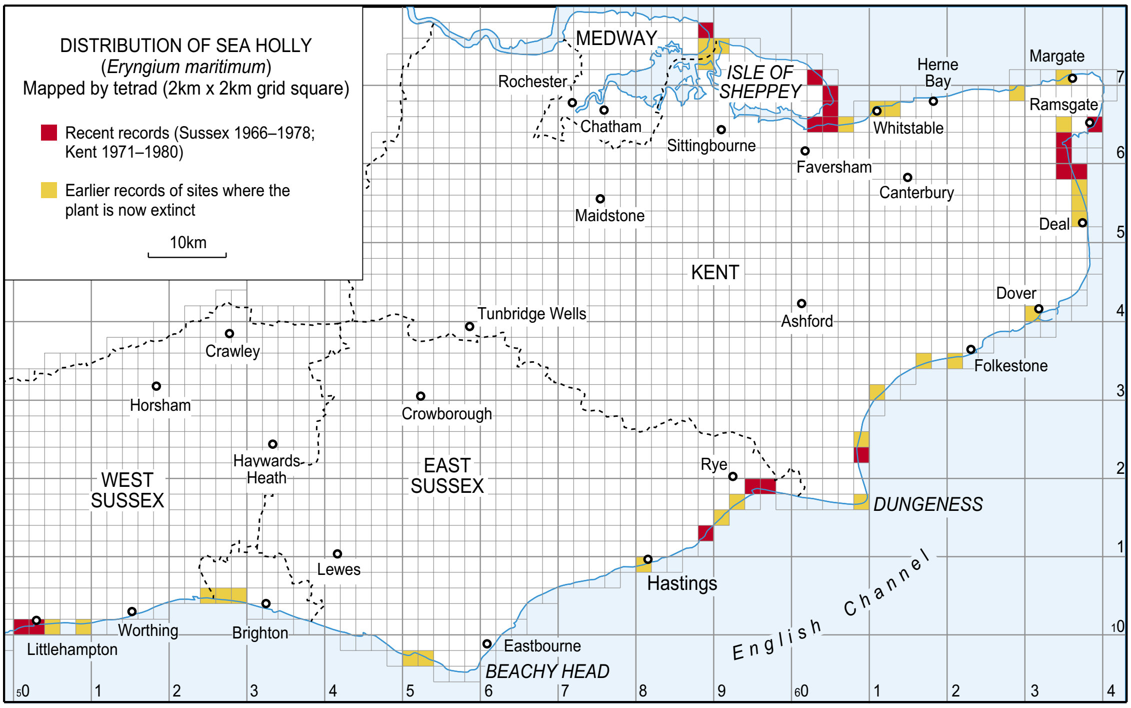
Water and gravel abstraction. Gravel extraction is now much more closely controlled than in the past, but continues to threaten vegetated shingle communities. At Dungeness, the excavation of gravel pits has significantly lowered the water table by increasing evaporation rates; increased public water supply abstraction has also lowered water levels. There are concerns that various plant communities on the shingle, such as the unique holly wood at Holmstone, are in danger of drying out.

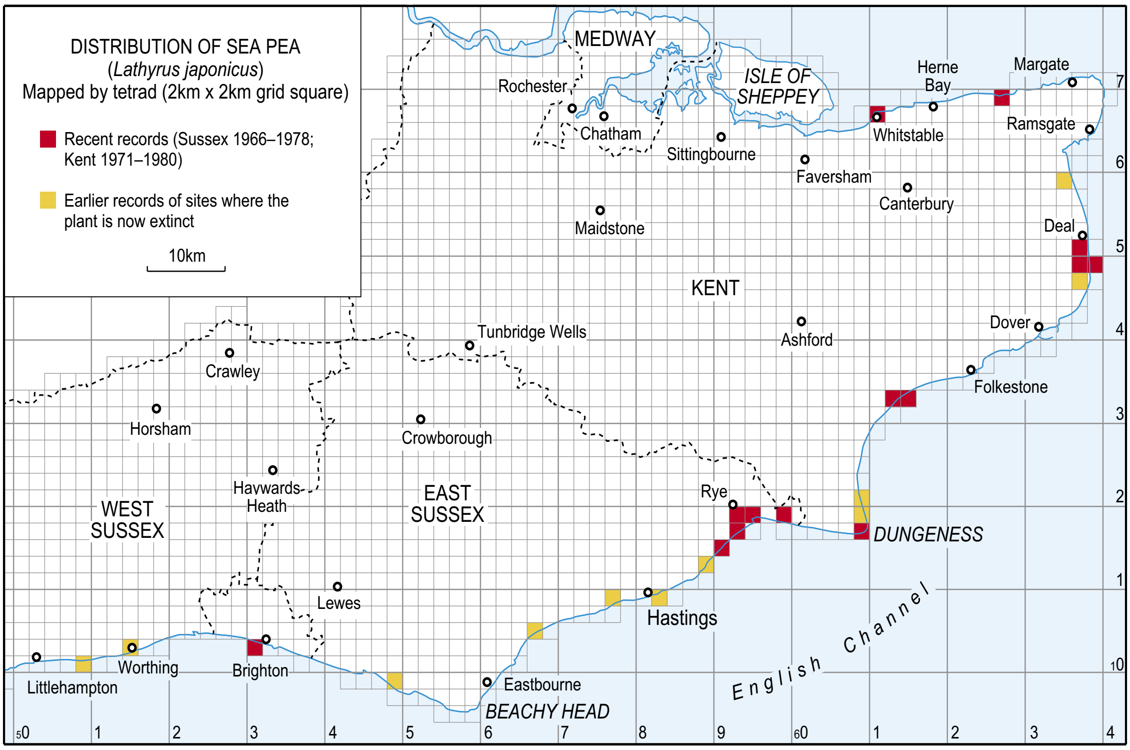
Garden encroachments. Houses have been built along the landward edge of shingle beaches at Shoreham, Pevensey and other sites. Owners sometimes clear the vegetation in front of their boundary fences or dispose of garden waste by dumping it on the beach, raising fertility levels within the shingle. Garden plants all too often escape onto the beach, or are deliberately planted. Some non-natives, such as red valerian, are becoming highly invasive. BAR is investigating whether these newcomers are putting stress on native species, and is actively encouraging the owners of beach-side properties to plant native shingle species in their gardens.

"Coastal squeeze". Many areas of vegetated shingle are trapped between the sea and immovable, man-made structures, such as sea walls, roads or housing estates. They are in danger of being squeezed out of existence as sea levels rise.

Changing Fortunes of Shingle Plants

Many of the plant species that grow on beaches within the BAR area have become much less common because of beach erosion and damaging human activities. The problem is long-standing and most acute on the English side of the Channel. Many sites in Sussex and Kent were lost before the end of the nineteenth century, but the majority of losses occurred in the last century. Many species are still declining despite strenuous conservation efforts. The distribution maps for sea holly and sea pea illustrate how serious the situation is becoming for some species.





Sea holly is an attractive shingle species, which is sometimes grown in gardens and used in flower arrangements. It was once quite widely distributed on the Sussex and Kent coasts, but in recent years it has been recorded at only a few sites. Much of the decline is thought to be due to coastal development and habitat loss, but picking and trampling may have contributed. In some places where people walk barefoot, sea holly has been cleared because it is so prickly.

Pictures: Rendel Williams

Sea Holly at Pett Level, East Sussex.

Sea pea is another species that is sadly declining. It grew on the Cayeux spit at the mouth of the Somme estuary, but disappeared, probably in the mid 1940s, and is no longer present in France. Its distribution in Sussex and Kent is decreasing in part because of sea defence works and coastal development pressures. It fixes nitrogen, making the shingle less sterile, which allows other plants to invade and replace it. Various insects relish its palatable foliage, and, as BAR researchers have discovered, its seeds are subject to weevil attack. It is a northern species, at its southern limit on Channel coasts, and so may also be suffering from global warming.

Pictures: Rendel Williams

Sea Pea, Rye Harbour.

Sand Dune Habitats

Sand dunes develop behind wide sandy beaches that dry out at low tide. Strong winds blowing onshore pick up the sand and carry it away, depositing it in small mounds at the back of the shore. These embryonic dunes are liable to be washed away by storm waves and also remodelled with every change in wind direction, but, if they survive long enough, they start to become colonised by plants that are specially adapted to the difficult growing conditions. These plants help to stabilise the sand with their extensive root systems and also trap further supplies of sand amongst their leaves and stems. In this way the original mounds of sand grow progressively higher and develop into full-scale dunes.

Marram grass is an early colonist of dunes within the BAR area. It dislikes being covered by seawater, but is very efficient at trapping sand. It responds vigorously to burial, quickly putting up new shoots from its extensive system of creeping roots and buried stems. However, it is sensitive to trampling, and does not thrive at sites where people are attracted in large numbers.

Pictures: Marie-Hélène Ruz

The north French coast is characterised by on-shore winds. These create blowouts that evolve into parabolic dunes and elliptical pannes or slacks where the water table is reached. The dunes migrate inland under the influence of the on-shore winds.

Recently formed dunes typically have crest lines that parallel the shore and also an incomplete cover of vegetation, particularly on their seaward side. The wind erodes the sand on this side, carrying it over the dune crests and depositing it on the far side. As a result the dunes slowly migrate downwind, away from the beach. At the same time, the wind often scours out deep hollows, called "blowouts", that may completely breach the dunes. These frequently start along sags in the dune crests where paths cross and trampling destroys the vegetation. As the blowouts deepen, they channel the wind, and erode ever more quickly. New dunes often form at the downwind end of the blowouts. By this stage, the dune crests trend both parallel to the shore and at right angles to it.

As the dunes migrate away from the beach, a new line of embryonic dunes may develop in front. These "foredunes" reduce the supply of sand to the older dunes, which become more stabilised as their vegetation gains a better foothold. Eventually the older dunes may become so covered in vegetation that they stop moving downwind and become "fixed". By this stage, the surface sand has usually lost its original yellowish colour and turned grey because of increasing acidification and the accumulation of organic matter. Marram thrives best in freshly deposited sand, and starts to become moribund as dunes become fixed. Dune scrub often takes over, dominated by species such as privet, blackthorn and sea buckthorn. Where grazing prevents shrub invasion, species-rich dune grasslands or even heaths may develop.


Picture: Rendel Williams

Lizard orchids at Camber.

Damp hollows between dunes, which may be original features or the sites of blowouts, are known as "slacks" in Britain and "pannes" in France. They are often marshy, and at some sites so wet that they contain temporary or permanent freshwater or brackish pools. Many of the more interesting species of dune plants and animals are found in the slacks.

Sand dunes occur at only a few sites on the Sussex and Kent coasts because the dominant beach material is shingle, rather than sand. The biggest dune areas are at Camber and Sandwich Bay, where particularly wide sandy beaches are uncovered at low water. At both sites dune formation began 2-5 centuries ago, and both mobile and fixed dunes are present. However, even the tallest dunes are less than 20 m high, and the slacks are shallow and well drained.

The French Channel coast presents a striking contrast. Wide sandy beaches are common, and shingle scarce. Where the beaches are backed by low ground and not chalk cliffs, extensive dune systems have developed. From the Somme estuary north to the Belgian border 53% of the coastline is fringed by sand dunes. Some of these dune areas started forming a thousand or more years ago, and the dunes reach heights of 35 m or more. The pannes between the dunes are equally impressive.

The dunes of Marquenterre between the rivers Somme and the Authie are particularly extensive and attract more than 100,000 visitors a year. The older dunes are well wooded, unlike those of Sussex and Kent. Growing in the dune slacks are a great variety of rare and interesting plants, such as Grass of Parnassus in one of its few coastal locations. Other major dune areas on the Côte d'Opale include the thousand hectare Garennes de Lornel, which harbours the seriously endangered fen orchid, and the great sand spreads of Mont Saint-Frieux, which are the home of 531 species of flowering plants, including the rare monkey orchid and round-leaved wintergreen. The entire British Isles, by comparison, have only just over 1500 native and long established alien species.

East of Dunkerque, near the Belgian border, are the majestic Dunes Flamandes, which started forming in the Middle Ages. Many of the older dunes are parabolic, surrounding ellipsoid shaped pannes. The pannes have become much drier in recent years, and the dunes more stabilised. Three kilometres inland, and separated by a polder, are the fossil dunes of Ghyvelde, which seem to have formed at the landward edge of a wide sand flat, in response to a storm surge around 5000 years ago. Much later, the sea laid down sediments that now underlie the polder and bury the base of the dunes.

Dunes at risk

Sand dunes on the BAR coast are important as natural sea defences, and as recreational areas and wildlife habitats, but they face serious threats:

Sea defences. Sea defence schemes can seriously disrupt natural sediment transport on beaches. This in turn may reduce the supply of sand to dune systems, putting them at risk.

Dune stabilisation measures. Artificial stabilisation, including fencing, marram planting and afforestation, is often undertaken to counteract dune erosion, and in particular to stop dunes migrating inland and encroaching on agricultural land or housing developments. Whilst carefully managed stabilisation is sometimes necessary, stabilisation measures all too often reduce the biodiversity value of dune areas. Dunes are naturally dynamic systems and should not be over-managed. Some sand movement, including blowouts, is essential to re-start the plant succession process and maintain the unique flora and fauna. As far as possible dune systems need to be allowed to evolve naturally.

Tourism and recreational pressures. Dune systems have a high amenity value and are popular with holiday-makers. Public enjoyment and understanding of sand dune environments is to be encouraged, but excessive numbers of visitors can damage the vegetation and cause severe erosion. At some sites, dune managers have felt compelled to fence off large areas, confining visitors to footpath corridors leading to the beach.

Alternative land use. Large areas of dune have been lost to agriculture or planted with trees, particularly on the French Channel coast. In addition, dunes are favoured sites for golf courses because the sand dries out quickly after rains, and supports low growing turf, which needs minimal maintenance. With sympathetic management, golf courses can play a major role in preserving animal and plant species, especially in the rough where the original vegetation can be retained. In Kent and Sussex, for example, the nationally rare lizard orchid is normally only to found in the rough of the golf courses on the dunes at Sandwich Bay and Camber, where it is carefully preserved. In contrast, plant communities on mown tees, greens and fairways become severely modified. Also, golf courses compartmentalise dune systems, which makes wildlife management more difficult.


Picture: Rendel Williams


Picture: Rye Bay Countryside Office

Camber dunes and beach in East Sussex were a magnet for holiday-makers in the 1930s and today attract as many as 20,000 visitors a day in the summer.

Falling water tables. Dune slacks often support valuable communities of marsh and aquatic species. In some dune areas, especially on the French side of the Channel, important species have been lost, and others seriously threatened, because of falling water tables. The species are affected not only by the drying out of their habitats, but also by subsequent scrub invasion.

Dune water tables have been lowered at some sites because of over-pumping of groundwater to supply housing developments. Sand extraction may also have contributed to the problem. In addition, improved drainage of surrounding agricultural land often lowers the water table within dunes.

An example of the problem

Camber dunes are suffering from invasion by sea buckthorn and by holiday makers who arrive by the thousand on hot summer weekends, attracted less by the dunes than by the sandy beach, which at low tide is as much as 750 m wide. Fences have been erected along the main paths through the dunes to channel the holiday-makers onto the beach and reduce trampling of the vegetation.

Pictures: Roy Metcalfe

Camber dunes in 1960: a desert of struggling marram grass and bare sand.

Picture: Alex Tait

Picture: Cherith Moses

Camber dunes today.

Scrub encroachment. Sea buckthorn can be highly invasive in dune areas, forming dense, very thorny scrub. It is a native of France and eastern England, but on the Channel coasts it has been so widely planted that its present distribution is far from natural.

Thrushes, starlings and other birds relish the orange berries of sea buckthorn. The seeds that pass through their crops have a much higher germination rate than uneaten seeds. Although much buckthorn is bird dispersed, it also reproduces vegetatively. The roots, which can extend laterally for several metres, sucker freely, creating thickets that appear to consist of many separate bushes, but are actually giant clones arising from single germinations.

Sea buckthorns have nodules on their roots containing nitrogen-fixing bacteria. Once established, buckthorns quickly increase nitrogen levels in dune sand and also add humus with their annual leaf fall. The dune flora generally becomes less varied. As nutrient levels rise, the more vigorous herbaceous plant species out-compete and replace the other species that are present. The increasing shade cast by the buckthorns causes further extinctions.

Buckthorn invasions are difficult to control. The bushes are armed with viciously long spines and need to be approached with caution. It is not sufficient just to cut down or bulldoze the bushes; the roots must be grubbed up or poisoned, otherwise they sucker vigorously, making the buckthorn infestation worse. The leaf litter and surface sand may need to be removed to reduce nutrient levels. Unless the normal dune flora can be quickly re-established, erosion may set in, destabilising the dunes.

Phase II of BAR will examine the dynamics of sand dunes on the eastern Channel coasts, seeking to identify best management practice.

Cliff and Cliff Top Habitats

Chalk forms bold sea cliffs on both sides of the Channel. These cliffs are an important landscape element and major tourist attraction, and are also of great geological interest. Many details of chalk stratigraphy and sedimentation can be studied only in the cliff exposures because of the absence of suitable sites inland. In addition, at Black Rock, Brighton, and at Sangatte near Calais, the modern cliffs provide a cross section through an interglacial beach and sea cliff, formed at an earlier stage in the Channel's evolution. Both sites have long been a focus of scientific research.

Chalk cliffs are important not only for their geology but also as a wildlife habitat. Fulmars, kittiwakes and other sea birds nest on the ledges, as well as various land birds, notably peregrines. A number of species ceased breeding on the Kent and Sussex cliffs in the late nineteenth and early twentieth centuries as a result of cliff falls and human disturbance, in particular persistent egg collecting. In recent years there have been heartening signs of recovery. Guillemots, for example, have returned to breed on the Sussex cliffs after an absence of over a century.

Picture: Kate Cole

Fulmars, distant relatives of albatrosses, have colonised chalk cliffs on both sides of the Channel.

Picture: hastings.net

A kestrel patrolling the sandstone cliffs at Hastings.

Chalk cliffs are also a key habitat for plants. To the east of Brighton, for example, the rare hoary stock is well naturalised on cliff ledges. At Seaford Head and the Seven Sisters other rare plant species are found close to the edge of the cliffs, notably moon carrot, wall germander (in possibly its only native British station) and small hare's ear. The wild cabbage that is well established on the White Cliffs of Dover may have escaped from cultivation in Roman or Saxon times. It is grows at only two sites on the Sussex coast.

At the foot of the cliffs, chalk shore platforms extend far beyond the low water mark, and are of major environmental importance, being rich in inter- and sub-tidal wildlife. In the splash zone at the base of the chalk cliffs between Seaford and Beachy Head, a unique algal and lichen assemblage has been found, including some species new to science.

Picture: Rendel Williams

Picture: Sussex Wildlife Trust

Above: Hoary Stock on the Sussex coast.
Left: Field Fleawort - locally abundant on the Normandie chalk cliffs but rare on English chalk.

The sandstone and clay cliffs that are found on both the French and English coasts tend to be less precipitous than the chalk cliffs. They too are a major geological attraction, especially for their dinosaur remains and other fossils. Their ecological importance is perhaps less obvious, because they support fewer breeding sea birds. Nevertheless, they provide valuable breeding sites for sand martins and black redstarts as well as specialised invertebrates, including rare ground beetles, and burrowing bees and wasps. They offer a great range of micro-habitats from spreads of loose sand and expanses of low-growing herbaceous plants to pools and seepages in jumbled landslip terrain.

BAR is joining with other organisations in developing better management strategies for the maritime cliff habitats in its area. Because of their relative inaccessibility, cliff-face habitats have been subject to less human modification than the majority of maritime habitats. However, cliff tops have fared less well. Many areas of valuable cliff top vegetation have been ploughed out, and yet others badly damaged by fertiliser and pesticide applications. Coastal urbanisation is also creating increasing problems, particularly on the English side of the Channel. Considerable stretches of cliff east of Brighton and on the Isle of Thanet are protected by sea walls at their base while housing developments on the cliff tops reach in some cases very close to the eroding edges. Cats prey on nesting birds, which are further disturbed by recreational activities such as abseiling and dog walking. Several local authorities have felt compelled to undertake cliff trimming in order to reduce the risk of cliff falls, even though this severely reduces the number of ledges available for plants and nesting birds.

The BAR Project: Informing Management

BAR is a multi-sectoral partnership project in which coastal managers and scientists from both France and England meet to share information and expertise about the beaches at the eastern end of the Channel. It is also a trans-national programme of scientific research driven by the needs of the region's managers. Other projects, such as Eurosion (funded by the European Union) or Futurecoast (funded by the British Government), provide valuable European or national overviews, but are not regionally specific. The BAR project builds on research and management networks established during the INTERREG II programme by projects such as BERM (Beach Erosion in the Rives Manche), Two Bays One Environment (biodiversity management of the Baie de Somme and Rye Harbour) and Geosynthe (Channel floor sediment pathways). It also complements the current INTERREG III project, RIMEW (Rives Manche Estuary Watch), which studies the region's main river estuaries. In addition, expertise is drawn from nationally funded programmes such as the Channel Coastal Observatory in England and the French Discobele project.

Phase I of the project has investigated threats to the region's beaches and coastal biodiversity, and has identified key issues requiring further research in order to inform management practice. Collaborative Study Groups have been established that regularly review the research direction of the project. In particular, the Geomorphology, Biodiversity and Management Study Groups draw on expertise of the project research teams, match funding partners and other participating organisations. This ensures that ongoing work continues to be related to the needs of the region's coastal managers and is in line with national, European and global initiatives.

Pictures: Cherith Moses

Ian Thomas of Pevensey Coastal Defence Ltd. addresses an Anglo-French BAR study group.

East Sussex County Council Ranger, Daryl Major, discusses management practices at the Camber dunes with a BAR study group.

Phase I of BAR will produce preliminary Scientific and Management reports outlining progress to date and will set the context for Phases II and III. Already, specific requirements and objectives have been identified for the next phase of the project. For example, the vegetation survey methodology pioneered in the current phase will be extended in collaboration with French ecologists who will join the project for Phase II. Joint fieldwork by the French and English geomorphology researchers will extend the work on beach morphodynamics. Researchers from the Université du Littoral will conduct nearshore bathymetric surveys for the English team, whilst the English team will conduct longshore transport studies for their French colleagues. It is also planned to further the modelling of storm surge generation and in particular to examine the influence of southern North Sea surges on the eastern Channel coast.

The BAR Project: Informing the Wider Community

Communication is a key element of the BAR project. The results of much of the scientific research are appearing in specialist publications, accessible to the world's scientific community. This is crucially important to ensure that the project research, designed to inform the region's coastal managers, is of the highest quality and reaches a world-wide scientific audience. However, the BAR project places equal emphasis on communicating with the general public, explaining the principles that underlie its work and reporting on its findings. This is being achieved through participation events and the production of leaflets and educational materials. An Education and Information Collaborative Study Group has been established that regularly reviews and directs the communication of information to the public.

In May 2003, the Chairman of East Sussex County Council officially launched the BAR project at the Bentley Bird and Wildlife Festival. Visitors to the Festival viewed information boards and participated in interactive exhibits on the biodiversity and geomorphology of eastern Channel coasts. Since the launch, many more public participation events have been organised, including guided walks and talks. These have proved invaluable for informing the public about the BAR project and the work it is doing.

In August 2003 the BAR project participated in Marine Mania organised by East Sussex County Council, which was a series of family events designed to raise awareness of the importance of coastal habitats. Following the success of Marine Mania, ESCC has organised a fuller Maritime Season programme for summer 2004, which includes a number of trans-national events.

BAR's Education and Information Collaborative Study Group is designing a series of bilingual leaflets and poster displays that can be used in public participation events on both sides of the Channel. Work is also progressing on bilingual education materials to suit the needs of the French schools' Second and Third Cycles and English schools' Key Stage 2.

The bilingual project web site, established at the start of Phase I, is regularly updated (www.geog.sussex.ac.uk/BAR).

Picture: Tracey Younghusband

The BAR project helps to ensure a continued interest in coastal issues by bringing the beach to the next generation of managers.

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The photographs on the front cover show:

Cuckmere Haven beach and the Seven Sisters between Brighton and Eastbourne on the Sussex coastline (copyright: www.lastrefuge.co.uk)

Porte d'Aval and La Manne Porte near Etretat, between Le Havre and Cap d'Antifer on the Haute Normandie coastline (copyright: www.leuropevueduciel.com).

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