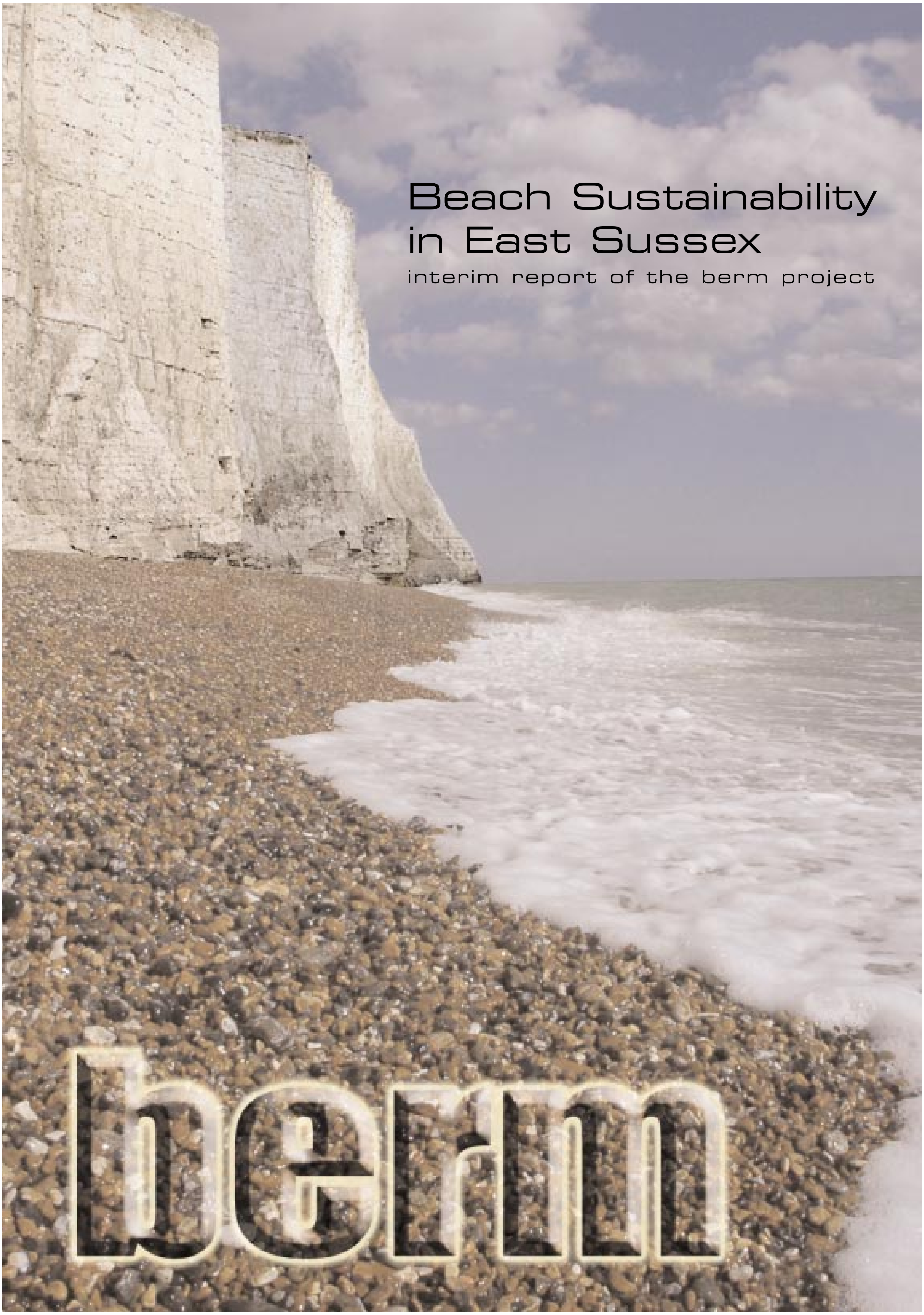
Beach Sustainability in East Sussex

interim report of the berm project



BERM:

Beach Erosion in the Rives-Manche

An Interreg II programme funded by the European Union (Priority E: Environmental Conservation and Enhancement. Measure 9: Information, Prevention and Awareness)

UNIVERSITY OF SUSSEX AT BRIGHTON

UNIVERSITE DE ROUEN

Interim Report of the English Partner
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Beach Sustainability in East Sussex

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FOREWORD

One of the pleasures of summer is visiting the beach for a picnic, swim or a gentle laze in the sun. Even in winter we enjoy the dramatic sights and sounds of waves crashing against the shingle. Yet for some reason we tend to take the existence of our beaches for granted and imagine them to be a free gift provided by the sea. We forget that the same sea can destroy beaches as quickly as it creates them. In the last twenty years, increasing amounts of money have been spent on artificial beach replenishment in East Sussex, reminding us that beach maintenance and conservation has real costs.

Beach depletion is an equally important issue on the French side of the Channel. BERM is an Anglo-French project investigating the "health" of shingle beaches in the Rives-Manche Region of East Sussex, Seine-Maritime and Somme. It brings together researchers from both sides of the Channel to work in partnership, sharing expertise to develop a better understanding of beach dynamics and shingle sustainability. It is funded under the INTERREG II programme of the European Commission, and is supported by a wide range of partners.

It is a great pleasure to introduce this Interim Report, outlining our progress in studying East Sussex beaches up to the end of June 2001. Drs Daniel Delahay and Stéphane Costa, who direct the French research programme, are also preparing an Interim Report for the Seine-Maritime and Somme beaches. The Final Report to be issued at the end of the project will present combined results from both the French and English researchers, and compare the sustainability of the beaches on both sides of the Channel.

I would like to thank all those participating in the BERM project for their enthusiasm and hard work. The transnational dialogue facilitated by BERM is helping greatly to improve awareness of the need to conserve shingle beaches. The ongoing exchanges of expertise and information are proving very useful in furthering understanding of shingle beach sustainability and are greatly enhancing our ability to monitor beach changes.

Cherith Moses
Project Co-ordinator (East Sussex)

Executive Summary

The BERM project is yielding valuable new insights into shingle beach sustainability within the Rives-Manche region of East Sussex, Seine-Maritime and Somme. Detailed investigations into the balance of supply and loss of shingle are well underway. Preliminary work to establish transnational methodologies and work programmes has been successfully completed, and the two national teams are presently concerned with data collection and analysis. Historic maps of the coastline have been digitised and compared with modern digital-format maps. Computer-generated maps of cliff line retreat have been produced. The varying flint content of the cliffs is being assessed using an image analysis technique. Once this work is completed, it will be possible to estimate annual volumes of flint shingle provision with much greater assurance than previously, and for the first time the contribution of the shore platform to the shingle budget will be assessed. The construction of sea walls has significantly reduced the supply of flints from the cliffs, and this has important implications for beach sustainability. The beach survey data collected by the Environment Agency have undergone initial analysis, but will not be fully utilised until the problems of height control identified by BERM are solved.

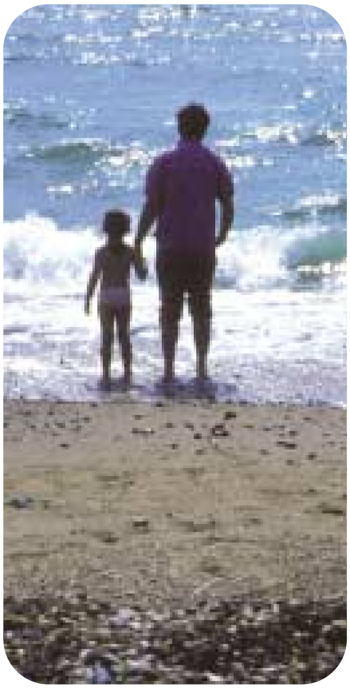
BERM has implemented pioneering laboratory experiments and field measurements designed to measure the in situ wear of beach shingle under the influence of wave action. Initial results suggest that although flint shingle is resistant to wear, it is not as durable as has previously been thought. Once sufficient data have been collected, an estimate will be made of the annual volume of shingle lost through in situ wear. This work is likely to have important implications for coastal management.

The final outcome of the project will be to provide a clearer understanding of the past, present and probable future of flint shingle beaches within the Rives-Manche region, based on a detailed examination of observable inputs and outputs. Preliminary results indicate that the shingle beaches of the East Sussex coast may not be a sustainable resource under present day conditions of increasing storminess and sea level rise.

Dr Alex Tait ESCC

Aims and Objectives

The aim of the BERM project is to investigate the sustainability of shingle beaches in East Sussex, Seine-Maritime and Somme (the Rives-Manche region). The beaches play a major role in absorbing wave energy and thus provide a vital natural defensive barrier for the land next to the coast, helping to reduce the severity of wave attack. In low-lying coastal areas they are the principal natural defence against erosion and flooding. They are also a major visual and recreational amenity of great importance to the tourist industry. In addition, they speedily become colonised above the high tide mark by specialised, salt-tolerant plants, developing into habitats of major nature conservation importance. The sustainability of shingle beaches is therefore a crucial factor for coastal defence, tourism and nature conservation.



Dr Alex Tait ESCC

BERM is concerned to examine the recent evolution of the coastline in so far as this helps explain contemporary sediment dynamics, particularly the supply and loss of shingle to the beaches. It is also concerned to make predictions about the future of the beaches under conditions of increasing storminess and rising sea level.

Project Rationale

The shingle on Rives-Manche beaches is composed almost entirely of flint pebbles and cobbles that derive ultimately from the flint nodules and sheet flints that developed within the chalk while it was being deposited some 70 -100 million years ago. Weathering and erosion of the chalk beds releases the flints, which are composed of silica and much more durable than the chalk itself.

Significant numbers of flint nodules and sheet flints are deposited on the Rives-Manche beaches each year as a result of erosion of the chalk cliffs. Each cliff fall helps to replenish the beaches. The flints grind against each other as they are moved by the waves, becoming more and more rounded.

It has long been assumed that the eroding chalk cliffs supply flints to the beaches in sufficient quantities to compensate for the annual losses caused by wave abrasion and wave transport, either along the shore or out to sea. The shingle beaches, in other words, are thought to be a self-sustaining resource.

This assumption is more and more being called into question on both the Sussex and French coasts. Long stretches of the chalk cliffs on the East Sussex coast are now defended by sea walls, which significantly restricts the supply of flint to the beaches. The dredging of harbour mouths, for example at Newhaven, interferes with the natural movement of shingle, and may further deplete shingle resources where the dredged material is used by the construction industry and is lost to the beaches.

On both sides of the Channel the shingle tends naturally to move along the beaches in an easterly direction under the influence of the waves and the prevailing southwesterly winds. Groyning of many beaches and the construction of jetties at harbour mouths have seriously interrupted the natural movement and distribution of shingle. As a consequence, the supply of shingle to some beaches is no longer sufficient to offset the annual losses, increasing the risk of erosion of land next to the beaches. Artificial beach recharging has had to be undertaken along the more vulnerable stretches of coastline, at considerable expense.

Costs of Protection Works on the Chalk Coast

Sea wall and undercliff walkway	£7.5 million per km
Rock breakwaters at mid or low tide	£5.0 million per km
Rock barrier at or in front of cliff toe	up to £6 million per km
Beach recharge and new groynes	up to £5.0 million per km

Yet another concern has been voiced by Simon Jennings and Christine Smyth at North London University, who have made detailed studies of the evolution of the East Sussex coastline.[1] They suggest that much of the flint that now forms shingle on the beaches was eroded from the chalk outcrop during the glacial periods when world sea-levels were much lower than at present. Rivers and streams running off the frozen Downs deposited flint gravel on the floor of what is now the English Channel, which was then a vast lowland, some distance from the sea. Rising sea levels after the last glacial period flooded the Channel (not for the first time), and drove much of the flint gravel landwards, thereby creating the shingle beaches. Even though the sea reached its present level around 5000 years ago, Jennings and Smyth believe that transfer of shingle to the beaches continued for as long as supplies of shingle remained available just off shore. By about 300 years ago, however, all available shingle had been transferred to the beaches. According to this theory, the shingle that protects the present-day East Sussex shoreline is essentially a relict deposit that is ever diminishing under the attack of the waves. The supply of flints from the eroding chalk cliffs has always been insufficient to prevent beach depletion, even before the construction of sea walls.

If the flint shingle beaches are indeed mostly "fossil", the implications for long-term sustainable coastal management are extremely serious. Even if the beaches are naturally sustainable, the increasing scale of human intervention is seriously affecting the volume and distribution of shingle along the Sussex and French coasts with impacts on the rates of coastal retreat and the risk of flooding.

It is crucial for coastal zone management in the Rives-Manche region to ascertain whether or not the current shingle beaches are self-sustainable. The region faces a projected sea level rise of approximately 0.5 m in the next 50 years.[2] When combined with predicted increased storminess and high tide levels there is a substantial risk that current sea defences will be destroyed by the sea before they can attain their intended life-spans. This makes the investigation of the sustainability of the shingle beaches all the more urgent, given their key role in reducing wave energy.

The Shingle Supply: Continuing or Fossil?

The very fact that shingle beaches exist proves that the supply of shingle at some time in the past has outweighed any losses. The crucial question with regard to beach sustainability relates to the permanency of this supply. Is the supply continuing at an adequate rate to maintain beach volumes or is the Rives-Manche region witnessing a progressive reduction of a shingle resource that was much greater in the past? If the beaches are mainly fossil, the question arises as to how long they will last under present conditions. Even if the beaches are receiving adequate supplies of shingle at present, there is still the question of how they will fare under conditions of rising sea level and increased storminess.

The theory that the shingle on the beaches is largely fossil is difficult to prove or disprove since the supposed initiating conditions have long gone. Flint gravel carpets the floor of the English Channel in many places. For some reason this gravel has not been transferred onshore. Nevertheless, its existence does not effectively disprove the theory that much gravel reached the coast to form the present beach shingle. The Channel has rather an irregular bottom topography, and shingle movement may have been facilitated in one area and not another. More perplexing is the fact that there are submerged cliffs off the Sussex coast, which may have formed during the period of rising sea level after the last glacial period or perhaps during some earlier period of sea level rise.[3] These cliffs would certainly have obstructed the onshore movement of shingle. It is also worth noting that the prevailing southwesterly winds would have facilitated shingle movement onto the Sussex coast, but would have tended to hinder movement onto the more sheltered French coast.

Doubts can also be raised concerning the theory that erosion of the chalk cliffs has supplied most of the shingle to East Sussex beaches. There are about 22 km of flint-bearing chalk cliffs between Brighton and Beachy Head. Between Beachy Head and Eastbourne there are another 2 km of chalk cliffs but the chalk contains almost no flints. Yet flint shingle is present on East Sussex beaches all the way from Beachy Head past Eastbourne and Hastings to beyond Rye Harbour, 45 km from Beachy Head. The large shingle foreland of Dungeness is composed almost entirely of flints. Is it realistic to suppose that all this shingle is derived from erosion of the chalk sea cliffs? Has it really travelled so far along the coast? As Simon Jennings and Christine Smyth have shown, the coast was more embayed in the recent past when much of the migration of shingle supposedly took place. The shingle would have had even more difficulty making its way along the coast than now. To add to the problems, there are suggestions that very little shingle passes round Beachy Head at the present time.[4] If it cannot easily reach Eastbourne, then how can it have got to Dungeness?

The situation in France is very different from that in Sussex. The chalk cliffs extend over a very much greater distance, and appear more capable of supplying flint shingle to beaches to their east.

Flint provision from chalk cliff erosion

Some of the flint shingle on Sussex beaches is derived from marine erosion of gravel deposits overlying the chalk, but amounts seem to be quite small. Present-day rivers do not have the discharge capacity to transport particles coarser than pea-sized gravel, and therefore can be discounted as a significant source of beach shingle. Most of the shingle currently reaching the Sussex beaches derives from erosion of the chalk coast.

Simon Jennings and Christine Smyth have made a rough and ready calculation of the volume of flints eroded annually from the Sussex chalk cliffs. Taking the total cliff length to be 22 km, the average height of cliff to be 45 m, the average rate of cliff retreat to be 0.5 m per year, and the average flint content to be 5%, the volume of flints released to the beaches is 22,000 x 45 x 0.5 x 5/100 or approximately 25,000 cubic metres per year.

The Engineering Consultants, Posford Duvivier, have estimated the volume of flints eroded from the cliffs between Seaford Head and Beachy Head to be about 5000 cubic metres per year, assuming an average rate of cliff retreat of 0.3 - 0.7 m per year, and an average flint content of 2%.[5]

These calculations are necessarily somewhat tentative given the inadequacy of existing data for cliff retreat rates and the average flint content of the chalk. A large number of researchers have used past and present Ordnance Survey maps to estimate the retreat rate of the Sussex chalk cliffs for different periods and different places, but with strangely conflicting results. The flint content of the various chalk beds has been little studied and it is unclear whether the overall average is 2%, 5% or some other value.

One of BERM's main tasks is to obtain better estimates of flint supply to the Rives-Manche beaches. The Sussex researchers have prepared a map of retreat rates for the entire length of unprotected chalk cliffs between Brighton and Beachy Head. This map improves upon currently available estimates of cliff retreat by calculating rates of retreat for small 50m cliff sections. It was prepared by scanning the earliest detailed Ordnance Survey maps (scale: 6 inches to the mile) published in the 1870s, geo-referencing the data to the National Grid, and comparing the position of the cliff top with that shown on the latest OS Land Line maps. This has allowed the area of cliff top lost over the last 120 years to be calculated.

A second map is currently being prepared that estimates the volume of cliff lost in each 50m section by multiplying the average height of the cliff and the area of cliff top lost to erosion. The next step will be to prepare detailed estimates of the flint content of the chalk cliffs. The estimate of 5% flint content used by Jennings and Smyth is likely to be very approximate. The different litho-stratigraphic units present in the chalk cliffs are known to differ quite markedly in flint content,[6] and the Sussex BERM researchers will attempt to quantify this using an image analysis technique, which has been successfully tested by both the English and French BERM research teams and accurate to within a few percent. The image analysis work will be completed in the coming months and will result in the calculation of flint volume inputs from the cliff erosion.

The construction of sea walls to protect some stretches of chalk cliff has undoubtedly reduced shingle supplies to the beaches. The total length of flint-bearing chalk cliffs now protected by sea walls and by Newhaven breakwater is about 8.1 km, while about 14.2 km of cliff remain unprotected. Taken at face value these figures suggest that shingle supplies from the cliffs have been reduced by 36%. However, the protected cliffs are developed mostly in chalk belonging to the Newhaven and Culver Formation, which has a lower flint content than the chalk of the Seaford Formation, which forms the greater part of the unprotected cliffs. These differences will need to be quantified before the implications of the sea wall construction can be properly assessed. Nevertheless, the reduction in shingle supply is clearly quite serious.

Flint provision from shore platform erosion

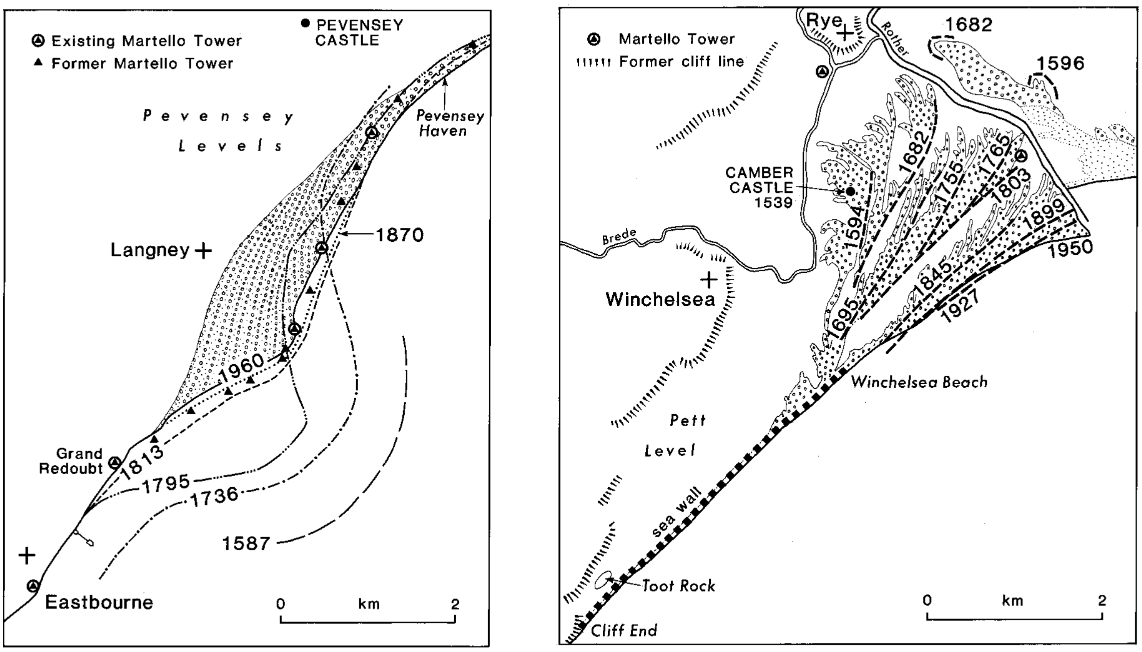
In order to obtain an accurate estimate of flint supply to the Sussex beaches it is necessary to estimate the volume of flints contributed by not only cliff erosion but also erosion of the shore platform in front of the cliffs. This has not been previously attempted.

The shore platform, like the cliffs, is composed of chalk with included bands of flint nodules and sheet flints. As the cliffs retreat, the shore platform is worn down and worn back, releasing flints to the beaches.

Judging from old maps and photographs, the platform seems to maintain more or less the same width and gradient over time. If this is true, then geometrical considerations suggest that the volume of chalk lost, and hence the volume of flint released to the beaches, is about 10% of the contribution made by the adjacent cliffs. Estimates of flint provision based solely on the rate of erosion of the cliffs need to be increased by 10%. Caution is needed, however, because published measurements of the rate of surface lowering of the platforms indicate that it averages only about 2.32 mm per year.[7] This very modest rate of lowering could be expected to release only 3 - 400 cubic metres of flints per year, even assuming a 5% flint content. This is a mere 1 - 2% of the estimated contribution of the cliffs. Clearly, there is a major conflict of evidence relating to flint supplies from the platform that urgently needs to be resolved.

Beach Volume Studies

The shingle foreland near Eastbourne known variously as the Crumbles or Langney Point suffered severe erosion since it first developed many centuries ago.[8] The Armada Survey of 1587 depicts it as a vast shingle foreland, projecting perhaps as much as 3 km into the Channel. Subsequent maps show it steadily shrinking in size. By 1778 it projected only about 2 km seaward, and by 1844 only 1.4 km. Sea defences have had to be built to try to stem the continuing erosion. It is tempting to regard the loss to the sea of 50% or more of the Crumbles as evidence that Sussex shingle resources are diminishing. What may have happened, however, is that the shingle has simply migrated eastwards, possibly accumulating at Camber and Rye Harbour. Camber Castle was built close to the shore in 1539, but due to subsequent shingle accumulation is now 1.5 km from the sea. If this shingle has indeed come from the Crumbles, this would prove that shingle on the Sussex coast is capable of very rapid lateral movement in massive quantity.



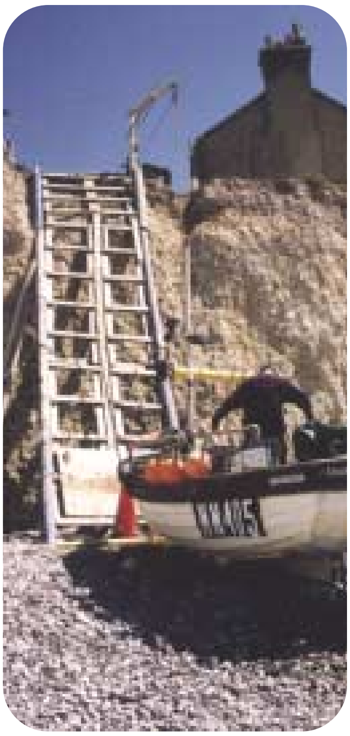
Historic redistribution of flint shingle. Significant losses of shingle deposits at the Crumbles near Eastbourne between the 16th and 20th centuries was accompanied by growth of shingle ridges at Rye Harbour and Winchelsea Beach[9].

In recent decades, the shingle beaches at Rottingdean, Saltdean and Seaford have become seriously depleted and have been artificially replenished. Whether this depletion has been due to natural processes is debatable. The widespread construction of groynes along the Sussex coast has undoubtedly interfered with natural shingle movement, causing shingle to accumulate in the vicinity of the groynes but creating shingle shortages elsewhere. The construction of the breakwater at Newhaven undoubtedly helped starve Seaford beach.

Old maps unfortunately do not provide reliable evidence of shingle volumes on Sussex beaches. The shingle is shown diagrammatically, if at all, because it was not surveyed as part of the mapping process. It was for this very reason that the Environment Agency began an annual air photograph survey of East Sussex beaches in 1973. Using the photographs, contractors have prepared a regularly spaced series of beach profiles at right angles to the coast. This work is ongoing and the data have kindly been made available to the BERM research team for analysis.

Preliminary study suggests that the contractors have not always succeeded in measuring heights with sufficient accuracy. For example, if the profiles are to be believed, the rocky shore platform in front of Belle Tout lighthouse has increased in elevation over time. As this cannot be the case there must be errors in the heights recorded for the sequential profiles at this location. A.P. Bradbury in his report for New Forest District Council also concludes that there are difficulties with the beach profile heights, so the issue is not confined to Sussex[10].

Analysis of the beach profile data has been halted pending additional information from the Environment Agency regarding data collection methodologies and survey datum points. Provided the problems with this valuable resource can be overcome, the BERM team will resume analysis of the profile data with the aim of determining how much beach volumes have changed since 1973, and whether the profiles can be used to quantify longshore and offshore transport of shingle. Changes in beach volume will also reflect variations in input to the system from cliff and shore platform erosion, and possibly also losses due to in situ shingle wear.



Seaford beach around 1900 and in the 1950s, as recorded on old picture postcards. Diminishing beach volumes mean that waves are more effective in causing erosion and therefore represent a more significant threat to coastal properties.

The beach today, following replenishment in 1987.

Dr Alex Tait ESCC

The replenished beach still requires careful management as this photo from winter 2000 - 2001 shows.

Durability of Flint Shingle

There is a general presumption amongst scientists that flint shingle is very durable. In coastal management planning no allowance is normally made for shingle wear. Observed reductions in beach shingle volumes are almost invariably attributed to shingle movement either along the shore or out to sea. Pebbles and cobbles of flint (and its paler relative, chert) are assumed to last more or less indefinitely, unless flung by storm waves against a massive and unyielding sea wall or harbour breakwater. The Dutch geologist, Philip Kuenen, for example, suggested in 1964 that it takes the sea a thousand years to fashion an irregularly-shaped chert nodule that has been eroded from cliffs into an ellipsoid-shaped beach pebble.[11] More recently, John-Paul Latham and his colleagues at Imperial College London, have measured the rate of wear of flint in a tumbling mill and found it to be virtually indestructible compared with granite, basalt and other rock types that were tested.[12]

In the opinion of BERM, this faith in the durability of flint is unwarranted. Contrary to Philip Kuenen's assertion, flint nodules released onto beaches when masses of chalk fall from the cliffs are often fractured during the falls or else speedily develop fractures. The angular fragments usually become worn into rounded pebbles and cobbles within a year or so, sometimes in the space of just a few months. Of course, one would expect sharp edges to wear relatively quickly, but how durable is rounded shingle? Malcolm Bray of Portsmouth University suggested in 1997 that angular flint and chert loses 10 percent of its weight within a year, but once rounded wears very slowly.[13] However, BERM has obtained evidence that even rounded flints wear at a significant rate. Attempts have been made to keep rounded flint pebbles with distinctive markings under observation on Sussex beaches during several hours of wave agitation. Many of the pebbles were lost, which was not surprising. Nevertheless, those that were recovered showed very small but measurable losses of weight during the period of observation. Shingle wear is thus a very real phenomenon, whether the shingle is angular or rounded. The challenge is to obtain sufficient measurements to estimate the rate of wear throughout the year in storms as well as in calmer conditions.

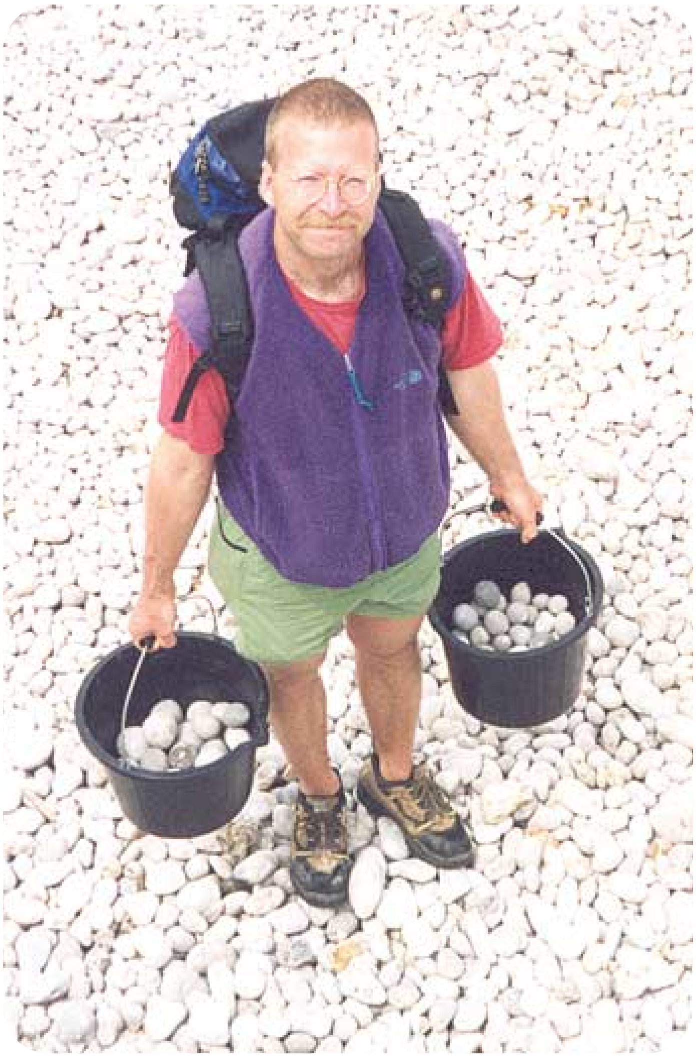
Measuring Shingle Wear

Measuring the rate of movement of flint shingle along beaches is quite simple. All one has to do is paint some of the stones a distinctive colour, set them out on the beach in known positions, and after one or more tides re-find as many as possible and measure how far they have moved.

It is considerably more difficult to measure the rate of wear of flint shingle, which is doubtless one reason why almost no research has been previously attempted. Another reason would seem to be that the shingle has been thought to be so very durable as to doom any attempt to measure its rate of wear over a period of a few months or even years.

Measuring the rate of wear of flint shingle on a beach ought in theory to entail weighing a sample of stones, retrieving them from the beach after an appropriate interval of time, and then re-weighing them to determine their weight loss. However, the problem of re-finding the stones is similar to that of retrieving the proverbial needle in a haystack. The stones cannot be brightly painted to facilitate re-finding as the coating would obviously affect their rate of wear. Drilling a hole in the stones and inserting a radioactive plug would make them easy to relocate with a geiger counter, but this would not be allowable for reasons of public health. Metal inserts, locatable with a metal detector, might tend to corrode or alter the weight of the stones and their propensity for wear.

BERM has tackled the needle-in-a-haystack problem using what is believed to be a wholly novel technique combining beach measurements with laboratory studies. The beaches at Saltdean and Telscombe have been “seeded” with pebbles and cobbles of a hard quartzite from a Devon beach and a somewhat softer limestone from a beach in South Wales. These “exotics” differ somewhat in colour from the native flints and so can be fairly easily re-found on the beaches. Each stone has an identifying number engraved on its surface.



BERM researcher Uwe Dornbusch collecting flint pebbles for laboratory testing.

A beach cobble of Liassic limestone from South Wales prior to exposure on Telscombe beach. The cobble carries an identifying code, engraved 2 mm into its surface and additionally marked with a water resistant marker pen. The cobble is 12 cm long and 7.5 cm wide.

The same cobble recovered after almost three weeks on Telscombe beach recorded a weight loss of 4.4%. If this rate of wear continued, the cobble would diminish by over 50% in 9 months and would be totally destroyed in just under a year and half of exposure on the beach.

At the time of writing, there have been over 400 retrievals of the exotic stones. The losses of weight have been recorded, and analysis commenced to determine the extent to which these losses reflect the beach location (Saltdean or Telscombe), the type of stone (limestone or quartzite), size of stone, time before recapture, antecedent wave and tide conditions, and other factors.

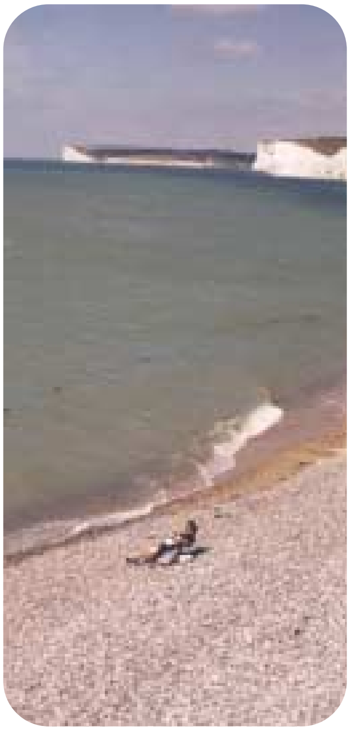
BERM will combine these beach measurements with the results of the laboratory tests that it is conducting using tumbling mills. Samples of flint shingle from the two beaches and from other locations are rotated in hexagonal barrels with sea water so as to simulate beach wear. The stones are weighed before and after each test to determine weight loss. Further tests will be made mixing individual quartzite or limestone pebbles with the flints in order to determine the resistance to wear of the two exotic rock types relative to flint. Armed with this information, and the direct measurements of the wear of the exotic stones on the beaches, it will be possible to estimate the rate of wear of the flint shingle on the Sussex beaches.

How does it all add up?

The rate of wear of the quartzite pebbles and cobbles released on Saltdean and Telscombe beaches has so far averaged 0.0078% per tide. The maximum observed rate is 0.233% per tide averaged over four tides. The stones have been exposed to tidal action since January 2001 and have therefore experienced winter storm conditions as well as calmer weather in summer. With around 700 tidal cycles per year, the quartzite pebbles could be expected to lose about 5.5% of their weight per year. In other words, with continuous exposure they would be likely to disappear in less than 20 years.

BERM has yet to test the speed of wear of the quartzite relative to flint in its tumbling mills, but the flint is likely to be significantly more durable. Philip Kuenen, working in Holland, reported in 1964 that the rounded chert that he tested was ten times as resistant as rounded quartzite. If a similar relationship holds for the Sussex flint and Devon quartzite (a big IF), the life expectancy of flint shingle in the surf zone on the Sussex beaches may be less than 200 years. Within the 50-year lifetime of most coastal protection schemes perhaps as much as a quarter of the volume of beach shingle could disappear, unless replenished naturally or artificially. This is a major consideration, previously neglected in coastal planning.

It is hardly necessary to emphasise that these estimates are highly speculative. It is the intention of the BERM project to continue to collect data so that the estimates can be refined and made more reliable. Nevertheless the evidence collected so far suggests that the beaches of East Sussex may be much less sustainable by natural processes than previously assumed.



Conclusion

BERM will yield valuable and previously unavailable information on the sediment dynamics of the Rives-Manche coastline. For the East Sussex coast maps showing chalk cliff line retreat rates are already available and maps showing volumes of sediment provision by the cliffs to the beach system will shortly be made available. In the summer field season detailed measurements of percentage flint content of the chalk exposed on the coast will allow an accurate estimate of annual flint volume provision to the beaches from this source. Analysis of the Environment Agency beach survey data, if it proves possible, may allow an assessment of annual losses by movement along and offshore. Testing of flint shingle wear will continue into the autumn field season to allow an assessment of seasonal variations in rates of wear. The final stage of the project will be to combine results from map and survey analysis and field and laboratory experimentation to provide a sediment budget for the East Sussex beaches. The final outcome of the project will be to provide a much clearer understanding of the sediment dynamics of the region that will allow an assessment of beach sustainability. Preliminary results indicate that the shingle beaches of the East Sussex coast may not be a sustainable resource under present day and predicted environmental conditions.

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