East Sussex County Council

Report of the problems of coastal erosion

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P/130

Coastal Erosion Report

FOREWARD

This report was prepared for the Planning and Recreation and Countryside Committees.

The Planning Committee considered the report on 18th January 1977 and resolved to endorse recommendations (5) and (7) — (10) inclusive in the report and to ask the Recreation and Countryside Committee particularly to support recommendation (1).

The Recreation and Countryside Committee, on the 19th January 1977, adopted the remaining recommendations (1) — (4) inclusive and (6) in the report and decided to invite the Borough and District Councils and those Parish Councils with a coastline to comment *further*.

N.B. Items referred to in this report as being displayed at Committee have now been redrawn and are incorporated in this edition.

LIST OF ILLUSTRATIONS

COASTAL EROSION — EAST SUSSEX COAST

Introduction

This report is an appraisal of coastal erosion in East Sussex from the planning point of view. It has been prepared with the help of various authorities which is gratefully acknowledged. Amongst those consulted were the Institute of Geological Sciences, the District Councils, the Southern Water Authority, the Nature Conservancy Council, the Ministry of Agriculture, and the County Engineer's department. However, the opinions expressed and the recommendations made are entirely personal and do not necessarily coincide with the viewpoint of the authorities concerned.

It deals briefly with the history of the coastline and the forms and causes of erosion and aggradation along it. The problem areas are pinpointed and a short description of current protection works is given.

Recommendations are made with respect to the aerial survey and further areas of study which are thought to be desirable. Rates of erosion and changes in the volume of beach material are assessed and their effect upon the urban, agricultural and amenity areas of the coast and upon Rye Harbour and the adjacent gravel producing industry are forecast. Planning Authorities will need to take these forecasts into account within the next 5 - 10 years.

History of the Coastline

When the Romans established their forts of the Saxon shore, they recognised the strategic importance of the Sussex coast. Perhaps they also had time to appreciate its varied nature: the shingle beaches, the tidal inlets now Pevensey and Pett Levels, the shining white chalk cliffs and the golden yellow sandstones of Hastings and the ferruginous clays and sandstones of Fairlight.

Habitation sites had existed on the chalk near the coast 2,000 years previously. These Neolithic people, who crossed the channel from France were pastoralists. They reared cattle, sheep, goats and pigs and cultivated fields high on the Downs. They also mined flints for the making of tools. The climate was rather wet and it is likely that the water table was higher than it is now so that they may have used water from springs which no longer exist. The evidence for their sites is now likely to be found near the cliff edge but assuming a constant rate of erosion, the cliff edge was then 1 mile further out in the channel and the cliffs, which dip towards the sea, might have been much lower.

Later, during the Bronze Age river valleys were drowned and extensive1 tidal flats were created as a result of both isostatic and eustatic changes[1] ; the former causing a sinking land surface and the latter a rising sea level. The
coastal outline would have looked rather different. The chalk areas would have extended more to the south and the west and there would have been wider rivers and inland basins giving an indented appearance to the coastline.Today, some idea of what the eastern part would have looked like can be gained by standing on Pett Level and looking inland towards Winchelsea. The line of old sea cliffs, intersected by the Rivers Brede, Tillingham and Rother, can be seen on a clear day as far as Appledore.

After Bronze Age Limes, some land was recovered from the marshes. This process, creek ridge development, enabled the Belgae in about 50 B.C. to occupy parts of Romney Marsh. The Belgae were followed by the Romans, who began with an army of conquest and occupation and later settled permanently. Anderida (Pevensey) was one of their forts on the Saxon shore. At this Lime, Pett Level, Walland and Romney marshes and Pevensey Levels were shallow bays interspersed with marshes and creek ridges.

However, by the 9th Century, there had been some silting up of the tidal flats and artificial drainage may have been started. Probably at this time, there was considerable erosion of the Hastings cliffs which originally protected old Winchelsea from the full force of the waves. In the 13th Century there

[1] For explanation see Glossary

was a period of violent storms, which ruined a great deal of the agricultural land in the coastal plains and finally in 1297 old Winchelsea was overwhelmed forever. After that, the sea returned slowly to its former level and reclamation of the marsh lands began again.
Winchelsea was rebuilt inland and both it and the port of Rye declined from their former importance as Cinque Ports. Shingle continued to build up along the coast from Fairlight and complex changes in the shape of the coastline, which have resulted in the present formation of Dungeness, were still going on.

The marsh lands were almost completely reclaimed by the 17th Century, but the fate of old Winchelsea was about to overtake old Brighton or Brighthelmstone. The earliest settlement had been built below the low cliffs by fisherfolk. An “upper” town was added in the Middle Ages and this was sited on the cliffs; it was largely an agricultural settlement. It is believed that the landsmen dwelt in the area of the present day North Street, whilst East and West Street were extensions to the “lower” town used by the mariners. There was a High Street on the cliff edge dividing the “upper" from the “lower” town and a South Street, which was probably the main street of the fishing community, on the land below the cliff.

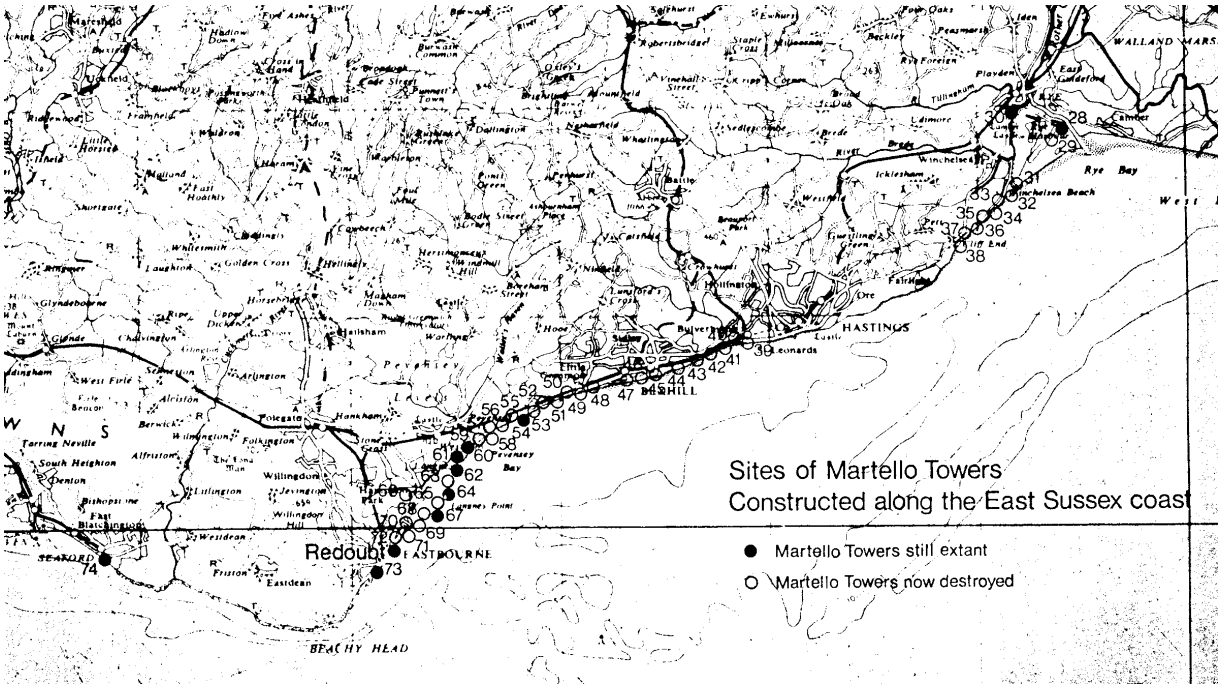
The “lower” town must have been unprotected from the sea, and its destruction was inevitable. The record shows that, between 1292 and 1340, 50 acres of land at Brighton, 150 acres of land at Hove and 50 acres at Rottingdean were engulfed by the sea. By 1665 only 113 tenements in the “lower” town remained and many of these were lost in the great storm of 1703. The “lower” town survived only another 2 years. In 1705, another great storm completely washed away the remaining dwellings and also did enormous damage to the “upper” town. The cliffs upon which the “upper” town stood were eroding at alarming speed and a collection was held throughout the country to raise £1,700 for the construction of two groynes in 1723. It now seems likely that, if it had not been for Brighton’s rapid change of fortune from a poor fishing town to a well favoured health, resort, it would have been left to fall into the sea.

In 1803, during the war with Napoleon, there was public concern over the threat of invasion on the South Coast. Plans were drawn up to defend those parts of the coast which were thought to be vulnerable to attack by the enemy. New batteries were built and existing ones strengthened and more troops were moved into defend strongholds such as Dover and Newhaven. The low—lying coastal plains were to be evacuated, anything of use to the enemy would be destroyed and then the sluice gates were to be opened and the sea wall at Dymchurch breached to let in the sea and flood the land.
The latter idea was, naturally, very unpopular and in 1804 two new ideas were put *forward.* The first was the Royal Military Canal which was intended to isolate Romney Marsh; it was later extended to Cliff End to cut off Pett Level as well. The second idea was to build a chain of “towers as *sea—fortresses”* along the coast at short int4vals so that their fire crossed almost at point—black range. These towers became known as Martello Towers after a similar fortification at Mortella Point on Corsica.

Between 1805 and 1810, 47 Martello towers were built on the Sussex Coast from Rye Harbour to Seaford. Only 10 of them are left. Of the 37 which have gone, no fewer than 28 are known to have been destroyed by the sea, which indicates the steady erosion of the coast, 3 were used as targets for gun testing, 1 was destroyed by enemy action in World War II, 1 was demolished to make way for a housing estate and the fate of the other 4 is unknown.

The ten survivors are in varying states of repair and use. Fortunately, the Wish Tower at Eastbourne has been completely restored and is now protected as an Ancient Monument, so that at least one example of these interesting historical defences of Sussex will be preserved for future generations to see. Seven others are also scheduled as Ancient Monuments and the other two are listed as being of historical and architectural interest.

(A plan showing the location of the East Sussex towers will be on display in the Committee room. The numbers assigned to the towers are those by which they are officially known, Numbers 1 - 27 were built on the Kent coast.)



In the first World War the plan to evacuate and flood the Levels was resurrected. Fortunately, it was not necessary.

The Second World War saw the erection of the most long lasting and systematic set of defences against invasion by the enemy which have ever been seen. Unfortunately, that other enemy, the sea, had to be left to do its worst. Beaches were mined, barbed wire and anti-tank devices were deployed and gun emplacements guarded every access point. Pett Level was flooded from 1940 to 1945 and maintenance of the sea defences was impossible. When the situation returned to normal, it was found that some losses had occurred, but the Coast Protection Act of 1949 and the statutory powers of Water Authorities have ensured that coast protection and sea defence works and their maintenance have not been neglected since the War.

Forms of Erosion and Aggregation

Having seen that great changes have taken place in the East Sussex coastline over the centuries it is useful to take a quick look at the ways in which erosion and, deposition occur. To start with it is desirable to have a few definitions, as follows:-
the shore is the zone extending from the base of the cliffs (or sea wall if there are no cliffs) down to low water mark. It is sub-divided into foreshore, which is the part lying between high and low water marks, and backshore, which is the area between high water mark and the foot of the cliffs (or sea wall). If high water mark coincides with the foot of the cliffs, there is no back shore.

Cliff Erosion

Where the coastline consists of some kind of rock and there is a narrow foreshore,
erosion is the result of the action of gravity upon rock masses which have been loosened along joints by rain or natural springs or weakened by the pressure of waves dissipating their energy against the cliff face. The movement of the rock mass may be one of three types: (a) a slide occurs when a bed of rock slides downward, usually over a layer of saturated clay, (b) a drop happens when the action of waves has undercut the rock below and Cc) a flow occurs when movement takes place by continuous deformation.

Movement of Shingle

In areas where there is a substantial foreshore of shingle, there is an overall movement of material known as longshore drifting. This occurs because waves generally strike a coast obliquely and in doing so carry beach material up the shore in the direction of their strike. As they recede, the material they have carried falls back under gravity nearly at right angles to the shore line. In this way, individual pebbles and sand grains proceed along the South Coast, in an easterly direction under the influence of the prevailing winds. Of course, this is the general pattern of events: under local conditions, coastal currents the interference effect of harbour works can result in beaches being taken away by the sea, leaving the land behind open to attack by wave action.

Deposition of Eroded Material

Material which is carried along by longshore drift eventually comes to the end of its journey$_0$ At a bend in the coast, such as the mouth of a river or a bay, or on the leeward side of a headland, a spit of sand or shingle may grow. Sometimes, a spit will deflect the mouth of a river: this originally happened with the Ouse,' which flowed into the sea at Seaford.

Compound spits may also develop and are known as cuspate forelands. Dungeness is an excellent example. It is thought to have been formed by storm waves which run in mainly from two directions, south and east; the nearness of the French coast prevents large waves arriving head on from the south east. Seas approaching the coast from the two main directions have apparently built up successive storm beaches, which can be seen as parallel shingle ridges.

Deposition also occurs on the windward side of breakwaters and other artificial works which interrupt the wave flow.

Tidal Movement

In the English Channel, which is a shallow sea running in what is effectively a narrow channel, the rise and the fall of the tide generates tidal currents which flow eastwards at about 2 miles per hour as the tide rises and westwards as it ebbs. Generally speaking, tidal currents are only strong enough to move small particles of sand or silt in the shore zone but when a high tide coincides with a severe storm, the coarser deposits of the back shore are lifted up into storm ridges.

From time to time, there is an exceptional build—up of water which sets off a tidal surge. Fortunately for the Sussex Coast disastrous tidal surges are more likely to occur in the North Sea, where a surge of 6 metres above sea level can be expected once in 70 to 80 years. The last occurrence of such magnitude was on the night of January 31, 1953 when extensive flooding affected the East Coast of England. Canvey Island and 80 square miles of North Kent were inundated and many lives were lost. Since another major disaster in the Greater London area can occur anytime within the next 50 — 60 years, the situation is constantly monitored by the G.L.C. flood—warning unit and the proposed Thames barrier seems to be a vital precaution.

However, a tidal wave, set off by movement along a fault in the channel, was observed at Brighton in 1927 and further tidal waves, generated in the same way, though unpredictable, are not impossible.

The Effects of erosion and Aggradation

Cliffs

Chalk cliffs tend to lose ground in two ways; either long narrow strips or very small lens-shaped areas. Figure 1, which shows a length of cliff top near Birling Gap, illustrates the falls which occurred between Winter 1950 and Summer 1962.

Where cliffs have strata of sandstone and clay, dipping seawards as they do at Fairlight, there is a tendancy for slipping to occur. Rain percolating through the sandstone lubricates the clay causing it to become a surface upon which sliding easily takes place. Even when the clay surface is curved, the weight of the over-lying rocks will send them sliding down it to fall in a tumbled heap. This kind of erosion results in rather hummocky ground, difficult for walking.

Beaches

Waves which shape beaches are createdby the wind blowing on the surface of the sea. If the wind is strong it blows over long distances and raises large waves which throw up a ridge or berm of shingle high upon the foreshore but, on receding, carry back great quantities of previously deposited material into the sea. In calmer weather, waves are smaller and have the opposite effect of depositing more material than they can carry away. The gradient of a beach depends upon the size of beach material as well as the length and steepness of waves. Shingle beaches are considerably steeper than sand beaches; this is because more of the advancing wave percolates through the shingle which reduces the effect of the backwash. A fine sandy beach, on the other hand, is far less permeable so a flatter profile is formed. Figures 2, 3 and 4 show beach profiles as they were in the summers, of 1973 and 1974 at three sections sited between Newhaven and Seaford. Figure 2, which relates to a section at Newhaven end, shows the storm ridges where material has accumulated above the high water mark. In contrast, Figures 3 and 4 show profiles with steep gradients and such material lost in the Winter 1973/74. (Figures 2, 3 and 4 will be on display in the Committee room).

Protective Works

Two forms of protective works are commonly used; sea walls and groynes. Sea walls s protect the coast from wave action by taking the impact of the waves, which, on average, varies from a pressure of 600 lbs per square foot up to 2,000 lbs per square foot However, it must be remembered that the effect of a sea wall is like that of an exposure of hard rock; where it ends erosion proceeds rapidly and may cut back behind the end of the wall. Careful design of the ends of sea walls is therefore necessary and the whole defence works must be planned comprehensively to avoid causing greater erosion to the unprotected coast at the leeward end.

Sea walls are normally constructed as a bank with a gently sloping seaward face covered with a pitching of stone blocks or other resistant material. A shingle, bank is equally effective. Some massive sea walls have been constructed with vertical faces, but they suffer from the disadvantage that waves breaking against them are reflected up and down leading to scouring at the toe of the wall.

However vertical walls are sometimes unavoidable and are not necessarily unacceptable.
The groynes are used to retain or accumulate beach deposits, because a substantial beach protects the land behind from erosion. Generally, groynes are positioned at right angles to the coastline or to the prevailing longshore move Deposits accumulate on the Windward' site of the groyne. The spacing and height of groynes are important factors which must be carefully designed to produce a uniform beach; that is, so that there is not too large a drop on the leeward sid of the groynes nor is there virtually total arrest of longshore drift, which / would deprive beaches further along the coast.

The East Sussex Coast Present Situation

Hove

There are no major problems along the length of the coast for which the Borough is responsible but there has been some concern about losses of beach near Brighton B Power Station where the Central Electricity Generating Board are the responsible authority. Elsewhere in the Borough beach levels are fairly constant and defence works are confined to the maintenance of groynes.

Brighton

Apart from an occasional loss ofbeach, there are no major problems. Indeed, from 1973 to 1975, there has been an overall gain of material at the western end, with balancing gains and losses at the eastern end. From Black Rock to Saltdean, the coast is protected by a sea wall. Groyne maintenance is on a regular basis.

The Marina at Black Rock has breakwaters of a new design from Denmark featuring jointed caissons. Although the designers were satisfied with the results of their investigations; which included three hydraulic model studies, hydrographic and seismic surveys and an eleven months record of long and short waves; there has been criticism of the choice of site for the Marina on the grounds that it is not well protected from waves, the foundation chalk contains cavities and gullies and there are the possibilities of surging due to trapping of wave energy by the breakwaters and the accumulation of sand and silt which could deplete local beaches.

Peacehaven

There is serious erosion of the chalk cliffs at Peacehaven and Telscombe Cliffs. The average rate of erosion is 0.45 metres per annum. The protection works which are under construction take the form of a 4.8 metre high concrete wall built on a rock ledge at the foot of the cliffs at about 3 metres below spring tide level The construction, which is similar to that at Brighton, is of mass concrete with facing courses of pre—cast concrete blocks faced With flints. The space between the' sea wall and the base of the cliffs 'is infilled with chalk and surfaced with reinforced concrete. To stabilise the cliffs, they have been, cut back to a slope of 75°. A new access road and under-cliff walk plus provision for a swimming pool later on is included in the works, which cover 'two' stretches of the coast totalling approximately 1km in length.

There has also been some loss of beach material (mainly chalk, pebbles and flint) in the vicinity of east Peacehaven between 1974 and 1975.

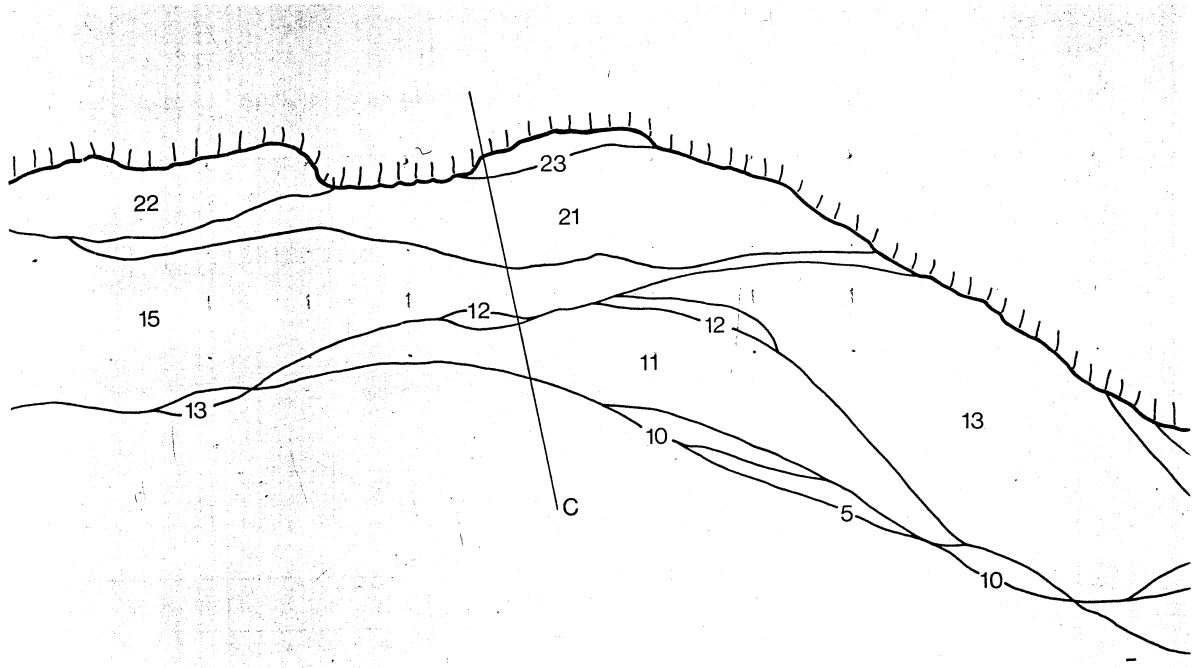
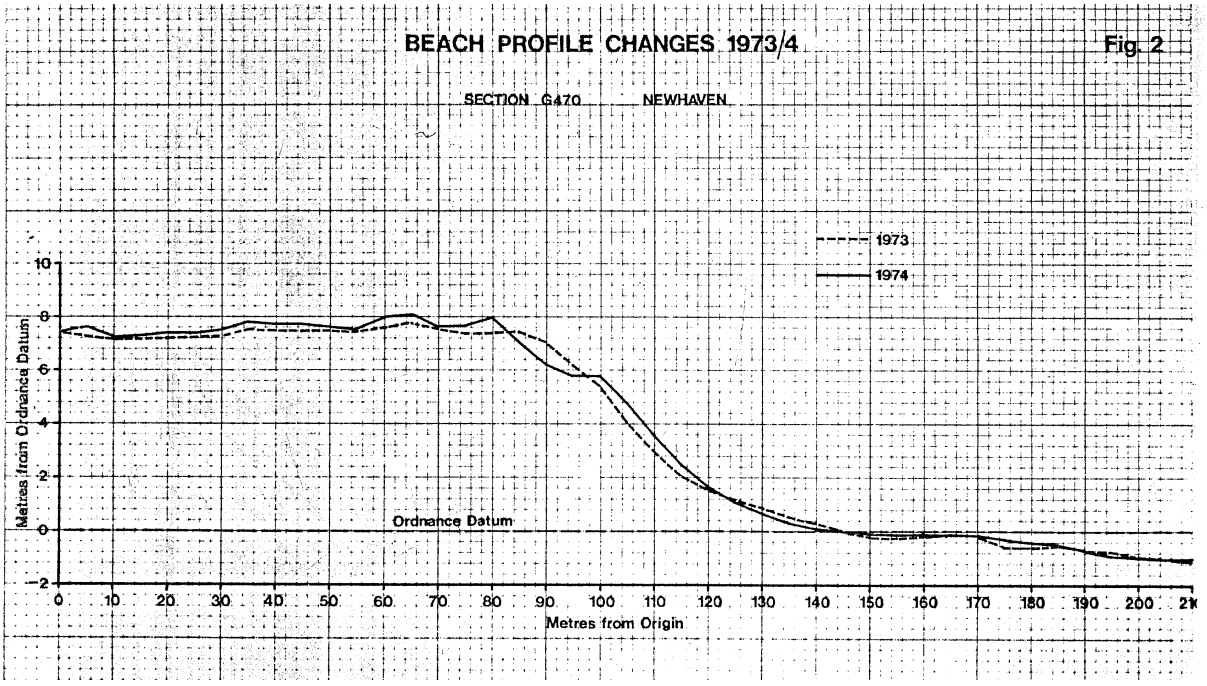


Fig. 1 Sample areas of cliff-top at Birling Gap, Numbers 1-23 refer to winter and summer periods from 1950 to 1962 (Total cliff retreat at Section C. was 6·7 metres)



BEACH PROFILE CHANGES 1973/4

Fig. 3

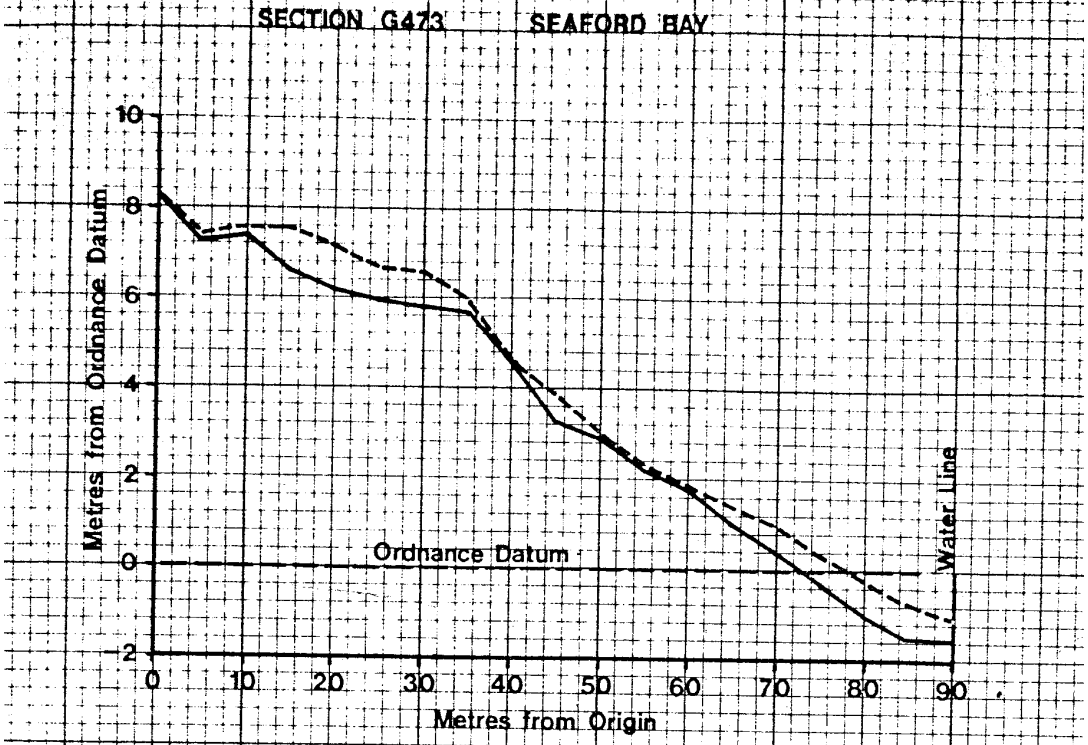
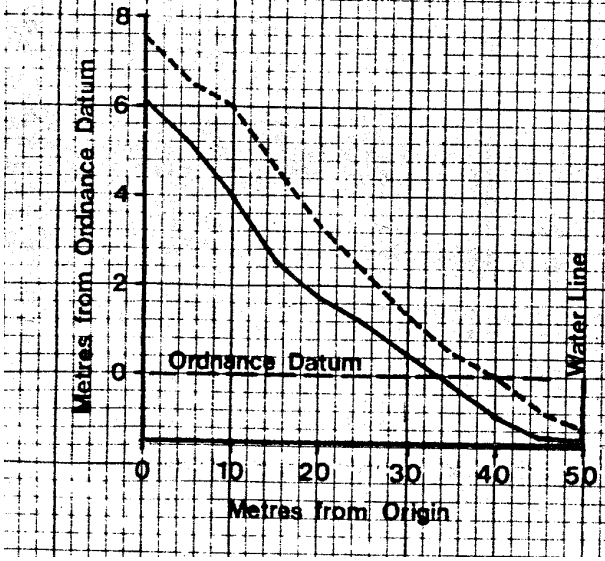


Fig. 4



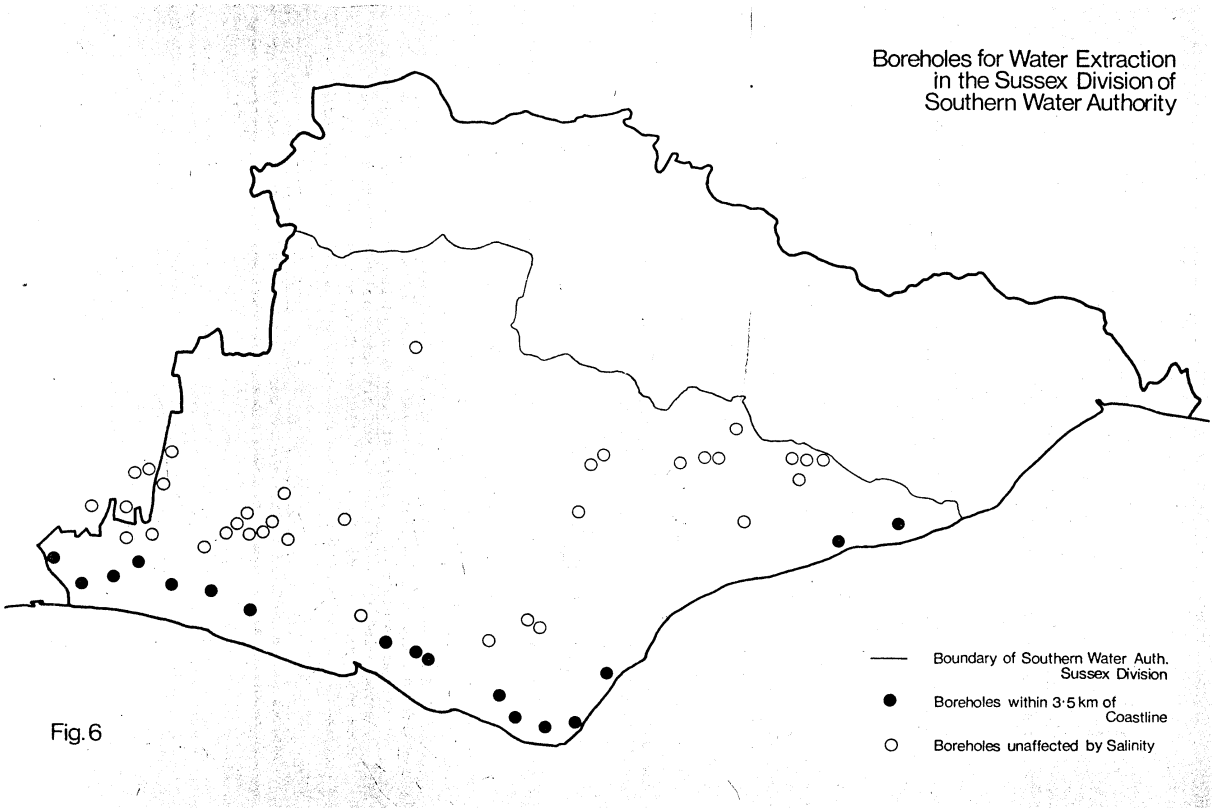


Fig. 6

Newhaven and Seaford

Newhaven and Seaford come under the responsibility of the Newhaven and Seaford Sea Defence Conmissioners.
This part of the coast is constantly under heavy attack by the sea and the town of Seaford, which is at sea level needs constant protection. However, the present state of the sea defences is generally satisfactory and the Commissioners Reports indicate that beach levels have remained fairly steady in the last year. The Monitoring Survey confirms this. However, temporary damage to the beach can occur rapidly. In October this year, for example, a south-easterly wind at gale force 10 destroyed the beach opposite the sailing club. It is slowly recovering.

There is, of course, some hold up of the supply of beach material due to the Newhaven breakwater and over the past 30- years a reduction in the size of pebbles on the beach east of the harbour has been observed. The breakwater itself, which dates from 1880, is in need of constant maintenance and it is quite a common occurrence for waves to break right over it.

Seaford Head and Cuckmere Haven

Cliff erosion is rapid between Seaford and the Cuckmere, about 0.3 metres per annum. Apart from the former Coastguard cottages, dwellings are not threatened but the Nature Reserve of Seaford Head and the amenity value of this part of the coast, which is very popular as a public recreational area, will be affected.

The Seaford Head Nature Reserve contains some interesting flora. One of the rare plants which grows there is the Moon Carrot, *Seseli libanotis*, so called because it glows at night. A variety of orchids are also to be found in the area and, with the creation of the bird lagoon behind the shingle bank in the Country Park, there has been an increase in the number of birds visiting that part of the coast. Ringed Plovers have even started to breed there and Sandwich Terns have been seen investigating possible nesting sites.

Cuckmere to Birling Gap

Beach levels have been steady in the period 1973 to 1975. Cliff erosion of the Seven Sisters from Cuckmere to Birling Gap is, however, of some concern. At several places the rate of erosion actually averages 1.25 metres per year. This stretch of the coast is one of the most famous in the south of England and part of the Heritage Coast. Its value is not measurable in money terms and, for that reason, it may never qualify for grant under the Coast Protection Act. Except at Birling Gap no other buildings will be affected for hundreds of years, but grazing land, recreational and ecological resources will suffer quite serious' losses within a much shorter period.

Birling Gap is particularly interesting. It has been suggested that a cove may eventually form here. This is because the Gap crosses a dry valley, in which the chalk beneath the valley floor and the lower valley slopes is very much broken p and contains softer periglacial deposits which are consequently prone to more rapid erosion than the sound chalk on either side of the Gap.

Belle Tout and Beachy Head

The cliffs from Belle Tout to Beachy Head have suffered serious losses in the last two years. The recent drought is likely to have made matters worse by drying out the chalk and encouraging the expansion of joints. At the present rate of erosion part of the coast road may disappear in five years time. Unfortunately, the land which will disappear, apart from the road, is of no commercial value and there is no chance of obtaining Government funds to help preserve it. The —beauty of this cliff section is unique and its eventual loss is much regretted. To save it, without ruining its beauty with a facing sea wall, would be difficult and probably costly but it is felt that the feasibility of doing so might be further examined.
The ecological value of this area is also considerable. Downland species of plants and insects are well represented and in areas of gorse and scrub the Dartford Warbler may be seen. The latter badly needs protection here because the disastrous fires during the summer drought nearly wiped it out in the New Forest.

Eastbourne

Apart from locally heavy erosion east of Langney Point, beach levels have been steady from 1973 to 1975. Groyne maintenance is on a regular basis.

The Crumbles

The Crumbles, which in past centuries has been built up by aggradation, seems now to be in a stable state, with the losses of one year balanced by the gains of another. It is an area from which a significant amount of gravel is extracted, though not, of course, from the beach, but the future of the gravel industry is in doubt here with the uncertainty about the development of the Eastbourne Marina.

Pevensey Bay

The Southern Water Authority are responsible for this part of the coast The beach levels have been satisfactory in recent years. The Pevensey Levels behind the coast are a valuable wildlife habitat and there is much good agricultural land.

Four of the ten surviving Martello Towers are along this stretch of coast which suggest that it has suffered comparatively little erosion in the last one hundred and fifty years.

Normans Bay, Bexhill, Bulverhythe

Beach levels are suffering considerable erosion at several points along this coastline. The Beach Monitoring Survey shows losses of 30,000 to 35,000 cubic metres from 200 metre long sections at

Normans Bay and Bexhill. These are the highest losses recorded by the survey for the East Sussex coast.

Storm damage and the associated losses of beach material have, of course, brought about the need for the expensive remedial operation at Beaulieu Road, Bexhill. The defence works needed are to be supplemented by the importation of granular material to artificially nourish the beach and this is a clear indication that the natural supply from longshore drifting is gravely diminished along this section of the Sussex Coast.

As well as the repairs at Beaulieu Road, similar major works are also proposed for Southcliffe, Bexhill and a continuous programme of groyne renewal and beach nourishment appears to be essential throughout the area.

Hastings

At Hastings and Fairlight there has been a substantial gain of beach material, presumably derived from the Bexhill beaches. As the beach monitoring survey shows, nearly 50,000 cubic metres was gained at Fairlight over a 480 metre long length of coast between 1974 and 1975.

Repairs to the sea wall and maintenance of groynes are carried out when necessary. The concrete breakwater of the harbour, which was built by a private company between 1895 and 1899 but never finished was breached and in a bad state of repair for a long time. The repair works consist of a bank of pre-cast concrete wave breakers, known as stabits, placed on the seaward side of the gap.
Erosion is also taking place at Hastings Castle, though the sea is not responsible. The cliffs upon which the Castle stands are crumbling away. and the masonry of the castle itself is in poor condition. The Department of the Environment has recommended a comprehensive survey of the cliff face and a programme of repairs to the castle and its foundations. The Borough Council, who own the Castle, are currently considering the D.O.E. recommendations.
The Hastings Country Park is an area of rugged cliffs and glens. The cliff sections are geologically interesting and show the Fairlight Clays, Ashdown Sand and Wadhurst Clay. In places there are good examples of erosion by movement down curved slip planes in the Fairlight Clays, which leaves a mass of slipped material in front of the new cliff line and for a time protects it from further erosion. There are also minor examples of mudflows, which occur when clays and weathered shales become plastic through saturation by water.

Pett Level

The length of coast along Pett Level is protected by a sea wall and the beach is regularly recharged with material from the Rye Harbour end.

Winchelsea Beach and Rye Harbour

The sea wall which protects Pett Level finished 400 yards east of Dogs Hill Road. At this point the shingle belt is rather narrow and there is local concern that it might be breached in storm conditions. The land behind the shingle bank is generally. lower than high tide level and if a breach were to occur much of the land as far inland as the River Brede might be flooded.

Immediately behind the shingle bank is a further area of shingle where gravel extraction is taking place. This will be referred to later. The whole of this area is a site of Special Scientific Interest and the foreshore is also a Local Nature Reserve.

Camber

Despite the diminution in supply of beach material along the rest of the coast, there remains a problem at Camber, where the sand dunes are still being added to. Although badly damaged in the past by intensive recreational use, the main dunes have now been stabilised by regrading, grass seeding and the erection of dune building and anti—trampling fencing, although continual maintenance is necessary.

An interesting change has been reported recently at Camber. Apparently pebbles brought to Broomhill for sea defence purposes have migrated in a westerly direction and ended up on Camber sands. This may be only a temporary phenomenon.

SUGGESTED ACTION

The Beach Monitoring Survey

The Beach Monitoring Survey was originally set up by the coastal authorities because of concern about the effect of a proposal to dredge 2.2 million tons of sand and gravel from an area of 150 sq.miles of seabed stretching from Brighton to Littlehampton It is organised by the Southern Water Authority and the results are shared with the Local Authorities and the County Council who contribute their proportions of the cost.
The survey is an aerial one; the flight covers a stretch of the West and East Sussex coast from West Wittering to Fairlight. Beach levels are calculated by photogrammetric measurements from the aerial photographs at 697 cross sections along the frontage. The same origin points are used for each year's survey and volumes of material are calculated by the Southern Water Authority's computer using a datum base of —2.0 metres O.D. and a vertical axis through each cross section origin. The survey is an annual one, made in the summer months and the first results were for 1973. Figure 5 shows the changes in beach volumes between 1973 and 1974 and between 1974 and 1975 for sections along the East Sussex coast. References have been made to some of the significant changes in the preceding text, although it must not be forgotton that the survey only shows the cumulative effects of each year's sea and weather conditions and may, therefore, minimise short term dangers. However, the survey is valuable and it is essential that it should continue to be made, especially as the present series of anti-cyclonic summers may come to an end and bring about a variation in the pattern of erosion along the coast.

The results from the survey are currently of greatest use to the Southern Water Authority themselves although all District Councils also make use of them. However, it is considered that the same survey could also yield data about cliff erosion rates. It has been ascertained that the same photogrammetric techniques could be used and the cost is of the order of 30p per selected cross section. To cover the coast at, say, 50 metre intervals would cost less than £200. The data would be of most use to the District Councils as coast protection authorities but, since the charge is minimal, it could appropriately be funded as an extension of the existing survey by upping current contributions accordingly. In addition to this, the survey should be extended to cover the remainder of the East Sussex coast from Fairlight to the County boundary at Jury's Gap.

Infiltration of Saline Water into the Public Water Supply

Research by Monkhouse and Fleet of the Central Water Planning Unit and the Water Research Centre has shown cloride ion concentrations from sea water far above normal can occur at pumping stations up to 3.5 kilometers from the shore line. At Balsdean some control of pumping has been necessary to limit the amount of contamination to the public supply.

The chalk, which is a good aquifer, has been extensively used for bore hole extraction as can be seen from figure 6, which shows the location of bore holes -in the Southern Water Authority's Sussex Division. Infiltration of sea water will occur through fissures in the chalk when there is a reduction in the flow of ground water as a result of increased abstraction. Another way to overcome the problem,

apart from reducing the quantity of ground water abstracted, is to keep the sea from contact with the chalk. It is, therefore, suggested that the future of the public water supply should be another criterion for consideration in coast protection schemes.

The Gravel Industry

Extraction of gravel takes place at the Crumbles and Rye Harbour. These are the only proven viable sources of supply in the County. It has taken many centuries to create both areas of deposit, and the Crumbles now seems to have reached a stable position with little or no addition taking place. Extraction at the Crumbles can safely be allowed to continue for some time but at Rye Harbour it will be necessary to maintain a substantial shingle bank on the foreshore. The present workings at Nook beach, south west of Rye Harbour, are wet pits but these make good wild life habitats in after use.

The River Rother is contained by banks from its mouth to the town, but the surrounding land is low lying and liable to flood. Near Rye the land is classified as Grade I agricultural land: it was originally won from the sea and obviously it should continue to be protected from the danger of flooding. Some limitation must be placed on gravel extraction for environmental reasons, nevertheless, permissions should be considered in the areas adjacent to the present workings and some of the land which is the subject of an agreement between the operators and the Southern Water Authority not to be worked , might ght also be reconsidered to see if any alternative sea defences, for example a sea wall, could be built.

The Verney Report (on aggregates) recommends that "existing studies of the Hydraulics Research Station should be expanded with a view to establishing in the light of growing knowledge whether the large areas sterilised for coast protection reasons particularly inshore areas — may now be dredged without the risk of unacceptable damage to the coast." This recommendation is endorsed because there is already a deficit of land won gravel to meet the demand for concreting aggregates in East Sussex. This deficit is presently made up by imported crushed rock, coming in by road or rail, and any substantial increase in these imports leads to environmental problems. Marine dredging also leads to environmental problems but the means to overcome them are more readily available.

Nature Conservation

The 1969 Special Study Report of the Countryside Commission on Nature Conservation at the Coast lists three sections of the East Sussex coast as being areas of Outstanding Scientific Importance. These were Winchelsea/Rye Harbour, Cliff End to Hastings, and Beachy Head to Cuckmere. In addition two other areas were
mentioned as being of Special Scientific Importance; namely Rye Golf Course / Northpoint Beach and Peacehaven / Castle Hill (Newhaven) together with Black Rock. The latter two are notified as a geological SSSI (Site of Special Scientific Interest).

In this decade, eight miles of the coast from Seaford to Eastbourne were defined as Heritage Coast and the Seven Sisters and Hastings Country Parks have been created.
From the current ecological view point, a great deal of the interesting coastline has been altered in the last .50 years. About 53% is built up and most beaches are protected by groynes. The changes brought about by erosion only result in a total loss, if the natural cycle of erosion and deposition is interfered with. Unfortunately, there is some evidence that this is happening along part of the Sussex coast; west of Castle Hill, Newhaven, for example, where the overlying Tertiary deposits, which form the geological interest, will eventually disappear entirely. The type of coast protection works used at Black Rock and Peacehaven would not be suitable in such a case as it would destroy the very qualities which ought to be protected. Therefore, it is considered that research into alternatives might be undertaken. The possibilities to be explored would include the use of grouting (an injection compound) to fill the joints and fissures in the chalk, together with techniques to reduce wave energy and the under—cutting effect.

The Coast Protection Act

The Coast Protection Act allows Exchequer grants towards the cost of capital works. Generally speaking, schemes are approved for grant where the value of property protected is greater than the cost of the scheme. The District Valuer usually gives advice to Coast Protection--Authorities upon the current market value of affected properties. However, it may be desirable to give more consideration to replacing properties, providing this can be done without taking up valuable agricultural etc., land.

It is interesting to note that, in 1948, an agreement existed between the then Local Planning Authority and the Saltdean Estate Company that no building should be erected within 300 ft of the cliff edge. The rate of erosion at the time was an average of 10" per year. What has happened since confirms the need for the present Structure Plan Policy, which is against development of the remaining undeveloped coast.

Rates of Erosion

The study of changes in low and high water marks and cliff edge has been made using the Ordnance Survey maps, where possible for the 30 year period 1925 to 1953. The changes per annum in the three variables mentioned were plotted at
100 metre intervals along the Sussex coast. (This item will be on display in the Committee room) Table 1 shows the areas where the most significant changes occurred. Table 2 shows the 'life' of certain landmarks at current and accelerated rates of erosion. The study should be updated when the latest revised maps are available.

Beach Volumes

Figure 5* shows the changes in beach volumes between 1973 and 1974 and between 1974 and 1975. In some areas gains and losses cancel out; in other areas there is a continuing loss or a continuing gain. Table 3 shows gains or losses of 20,000 cubic metres or more. It should be noted that because the survey does not continue beyond Fairlight, no results are available for Pett Level, Winchelsea, Rye Harbour or Camber. However, this is only the first three years of a long term project and .t is hoped that the remaining sections of the coastline will be added to the survey n the near future.

Conclusion

This report has looked at coast erosion somewhat cursorily. It is an immense subject and there are many areas which are not fully developed in scientific and technological research. For example, the effects upon beaches of wage refraction over rectangular dredged holes offshore has been examined by the Hydraulics Research Station. The results of this study suggest that dredging inshore of the 18 metre depth contour, the present inner limit, would lead to beach erosion. However, further work is necessary to establish the effects of sloping sides to the hole and holes of different shape.

The history of the East Sussex coastline shows that the results of man-made alterations in the form of reclaimed land, breakwaters, jetties, marinas, etc. may not become apparent for centuries. However, what the sea takes away from one place it returns elsewhere, but in a different form. This may be beneficial in the long run.

The lesson is to remember that nature only tolerates a certain amount of opposition, so it is best not to interfere too much or for too long with the natural process, but instead to make use of it. If this were done, we should not always think of repelling waves with a concrete wall but we should think instead of using their energy to generate power.

Summary of Recommendations

* Figure 5 will be on display in the Committee Room

It is recommended that:-

(1) Subject to the views of the Southern Water, Authority and constituent Local Authorities, the beach monitoring survey should be extended to include the remainder of the East Sussex coast from Fairlight to Jury's Gap and the rates of cliff top retreat should be included in the calculations. The cost, which is minimal, to be paid for by increased contributions by the participating authorities.

(2) Saline contamination of the public water supply should be considered a factor in decisions to protect the coast in areas where there is exposed chalk.

(5) Measures should continue to be supported to protect low lying areas from inundation

(4) Alternative forms of sea defence should be evaluated to see if, some part of the gravel deposit south of Nook Beach, currently embargoed, can be released for working.

(5) The recommendation of the Verney Committee on Aggregates for the expansion of existing studies of the Hydraulics Research Station into the dredging of inshore areas should be supported.

(6) Further research should be encouraged into ways of protecting cliffs without detriment to their visual appearance.

(7) Replacement of properties affected by coastal erosion should be considered, when rebuilding can be carried out without serious loss of valuable undeveloped land.

(8) It should be noted that the effects of coastal erosion are an additional reason reason why Structure Plan policy to preserve undeveloped coast should be upheld.

(9) The long term effects of proposed changes to the coastline should always be taken into account when considering applications for development.

(10) Ways of harnessing the energy of the sea should not be ignored.

TABLE I

AVERAGE ANNUAL CHANGE IN LOW-WATER, HIGH-WATER MARKS AND CLIFF LINE

AREAS OF SIGNIFICANT CLIFF RETREAT

(Changes OF 1 M OR MORE IN CLIFF LINE)

LOCATION	GRID LINE	LWM	IIWM	CLIFF LINE
Seaford Head	494970	-0.96	-0.94	-1.26
Birling Gap	548960	-0.45	-1.05	-1.18
	549960	-0.62	-1.12	-1.24
	550960	-0.69	-1.29	-1.26
	552960	-0.41	-0.94	-1.21
Beachy Head	596950	-0.56	-0.29	-1.06
Hastings East Cliff	832090	0	+0.08	-1.08

Ecclesbourne Glen	842100	-2.11	+0.19	-1.19
Fairlight Glen	845100	-0.96	+0.62	-1.00
	858100	-0.15	+0.21	-1.86
Fairlight Cove	885120	-0.26	+0.16	-1.20
Cliff End	888130	+0.16	-1.08	-1.08

Note: + denotes advance

\- denotes retreat

TABLE 2

EROSION RATES AT SELECTED SITES

LOCATION	LANDMARK	MAP REFERENCE	AVERAGE RATE OF EROSION (METRES)	EQUIV. LIFE (YEARS)	HIGHEST RATE OF EROSION (METRES)	EQUIV LIFE (YEARS)
Peacehaven	Houses	TQ4000	0.46	29-33	0.68	12-16
		TQ41OO	0.46	18-22	0.88	0-2
		TQ42O0	0.39	27-51	0.64	8-10
Seaford Head	Footpath	TV4997	0.55	2-4	1.26	0-2
Birling Gap	Cottages	TV5595	0.62	7-9	1.21	
	Hotel		0.62	47-51	1.21	15-19
Bexhill	Houses	TQ7206	0.20	25-29	0.26	13-17
Hastings	Reservoir	TQ8410	0.58	500-550	1.19	230-250

Note: Rates of erosion have been calculated for a thirty year period (1925 — 1955) in most cases.

TABLE :3

BEACH MONITORING SURVEY
CHANGE OF 20,000 CUBIC METRES OR MORE

LOCATION	SECTION REF	VOLUME CHANGE ('000 cu.m) 1973 to 1974	1974 to 1975
West Brighton	396	+3.9	+24.5
East Peacehaven	459	+2.9	-21.3
Eastbourne East	551	+40.0	+4.1
Normans Bay East	609	+8.0	-22.5
Bexhill East	642	-21.1	-8.2
	643	-5.6	-31.6
Bulverhythe	659	-24.9	-17.4
Hastings	684	+10.6	+27.1
Hastings East	692	+2.8	+20.2
Fairlight	696	-0.4	+49.0
	697	-0.4	+24.4

Note: + Denotes Gain

—Denotes Loss

APPENDIX

Responsible Authorities for Cost Protection and Sea Defence

Coast Protection

Under the Coast Protection Act 1949 the responsible authorities for coast protection are the maritime District Councils.

Coast Protection authorities are empowered to carry out any coast protection work, including maintenance and repair, both within and outside their area, which appears to them to be necessary or expedient for the protection of any land in their area. They may also enter into agreement with any other person to carry out the work or acquire land for protection purposes.

Sea Defence

The Land Drainage Acts of 1930 and 1961, the Water Act 1973 and the Land Drainage (Amendment) Act 1976 relate to Sea Defence. Local land drainage functions, which under the first two acts were the responsibility of the River Boards, are now carried out by the Regional and Local Drainage Committees, which have to be set up by the Water Authority for the area.

The sea defence functions include the maintenance, improvement or construction of drainage works for the purpose of defence against sea water or tidal water anywhere in the area of the Water Authority and the provision of flood warning systems.

Newhaven and Seaford Sea Defence

Newhaven and Seaford are exceptional cases because of two Acts of 1898 and 1947, which set up and gave powers to the Commissioners for the Newhaven and Seaford Defence Works. This body is therefore responsible of the construction, repair and protection of sea defence works in their area. The costs are met by precepts from the constituent authorities, i.e. the County Council, Lewes District Council and the Southern Water Authority.

GLOSSARY

Isostatic changes refer to the depression and uplift of land relative to a static sea level, which can result from the added load of ice during glaciation and the subsequent relief of pressure when the ice melts.

Eustatic changes affect sea level and are caused by changes in the volume of ocean water or in the capacity of ocean basins. During a period of glaciation, for example, a larger proportion of ocean water is in the form of ice and the oceans are therefore at a lower level. When the continents are free from ice the sea level is higher because there is more water, and because erosion of the land is now more active, the ocean basins receive more sediment and are reduced in capacity thus raising the sea level even more.

The two processes often act together and produce a complex result.

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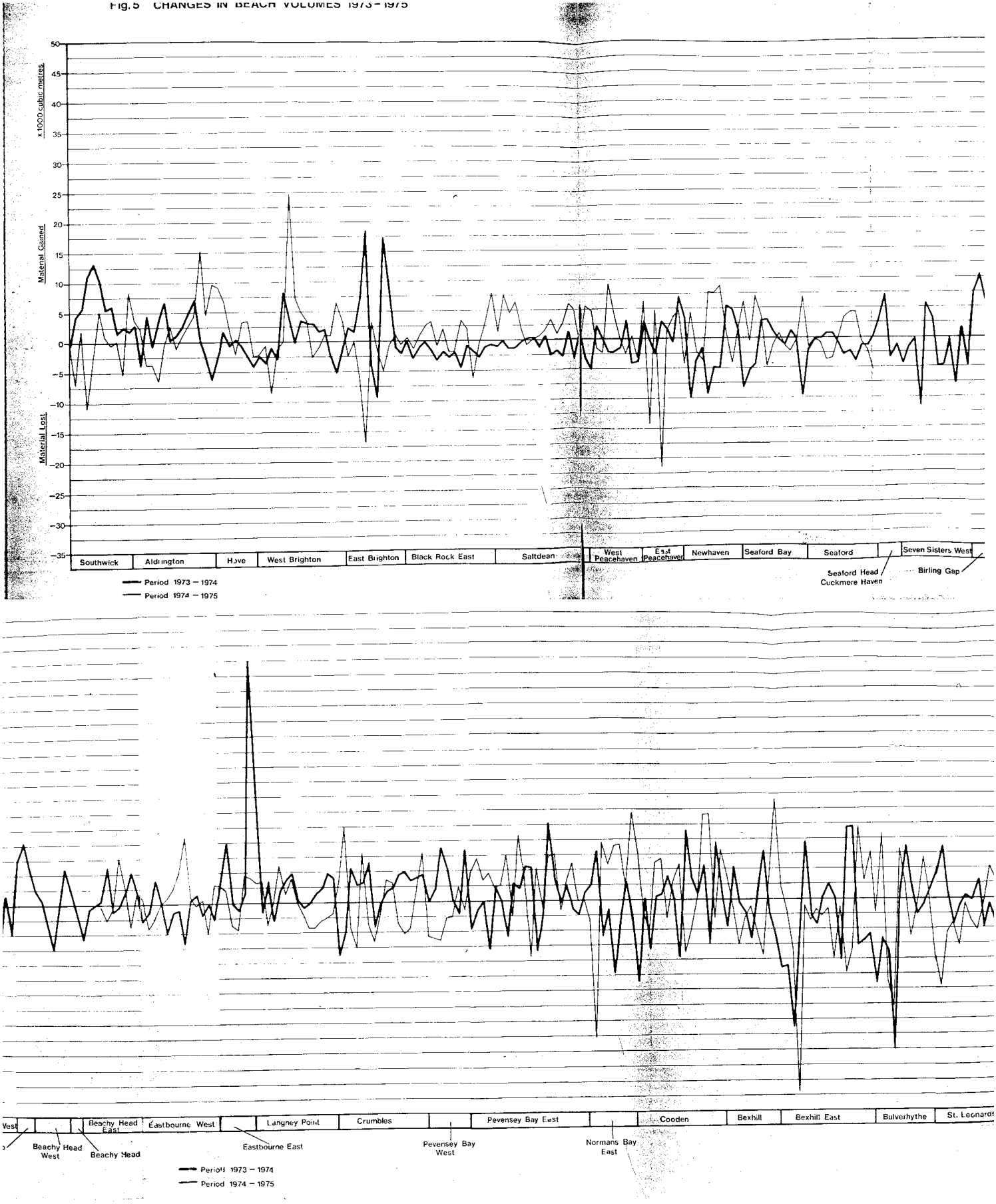
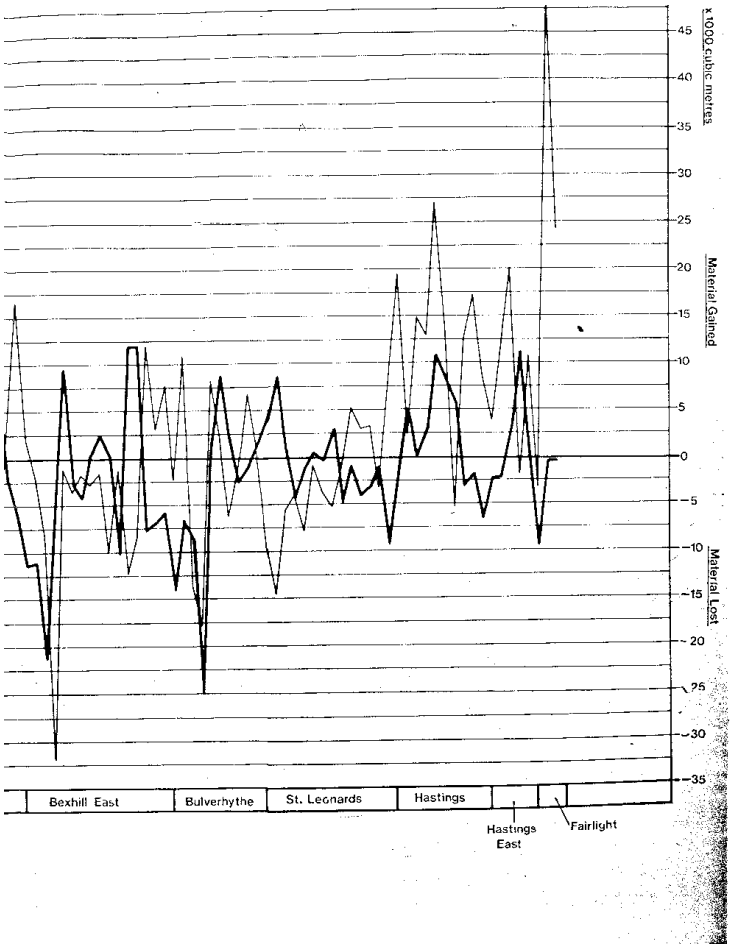
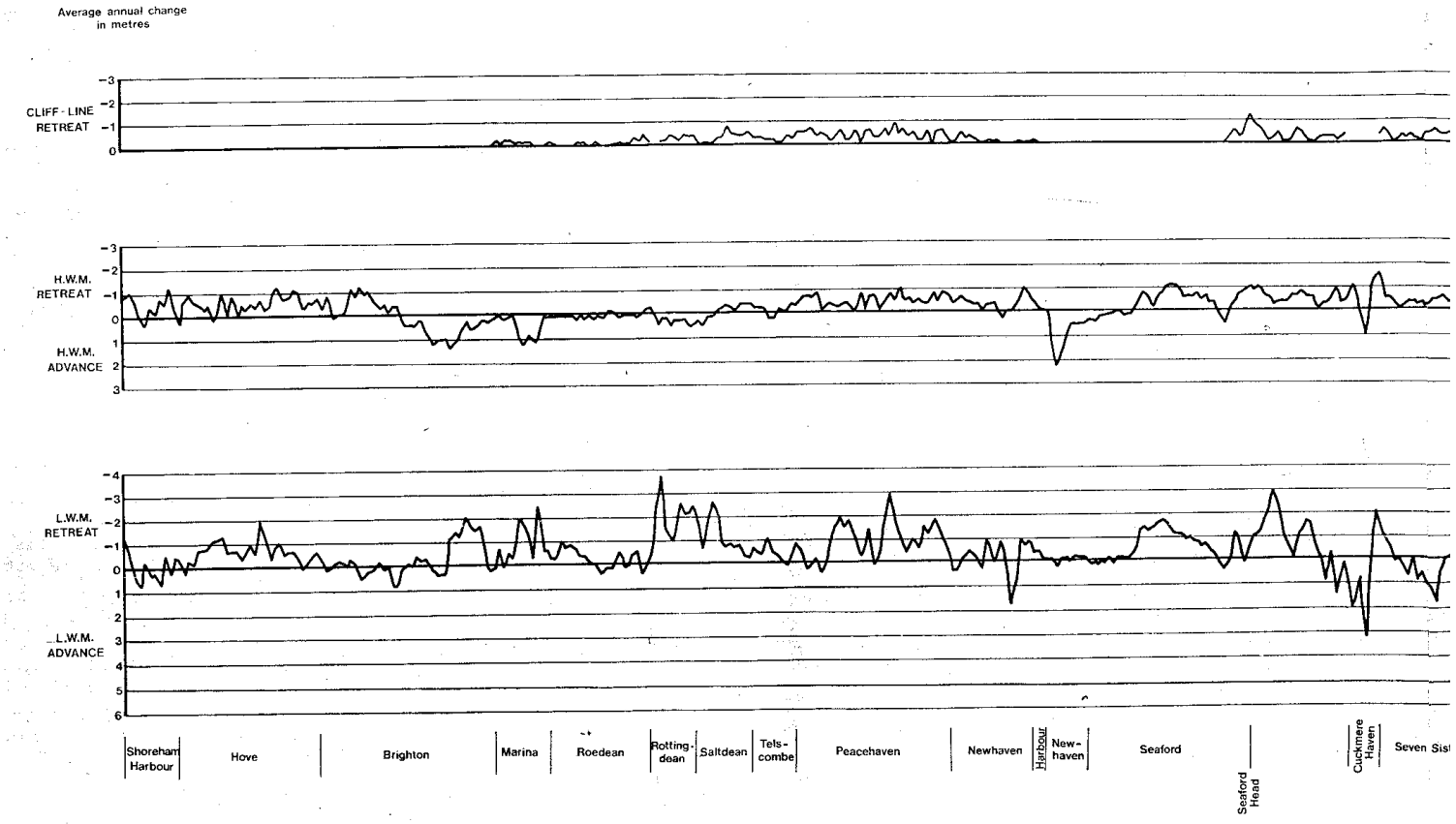
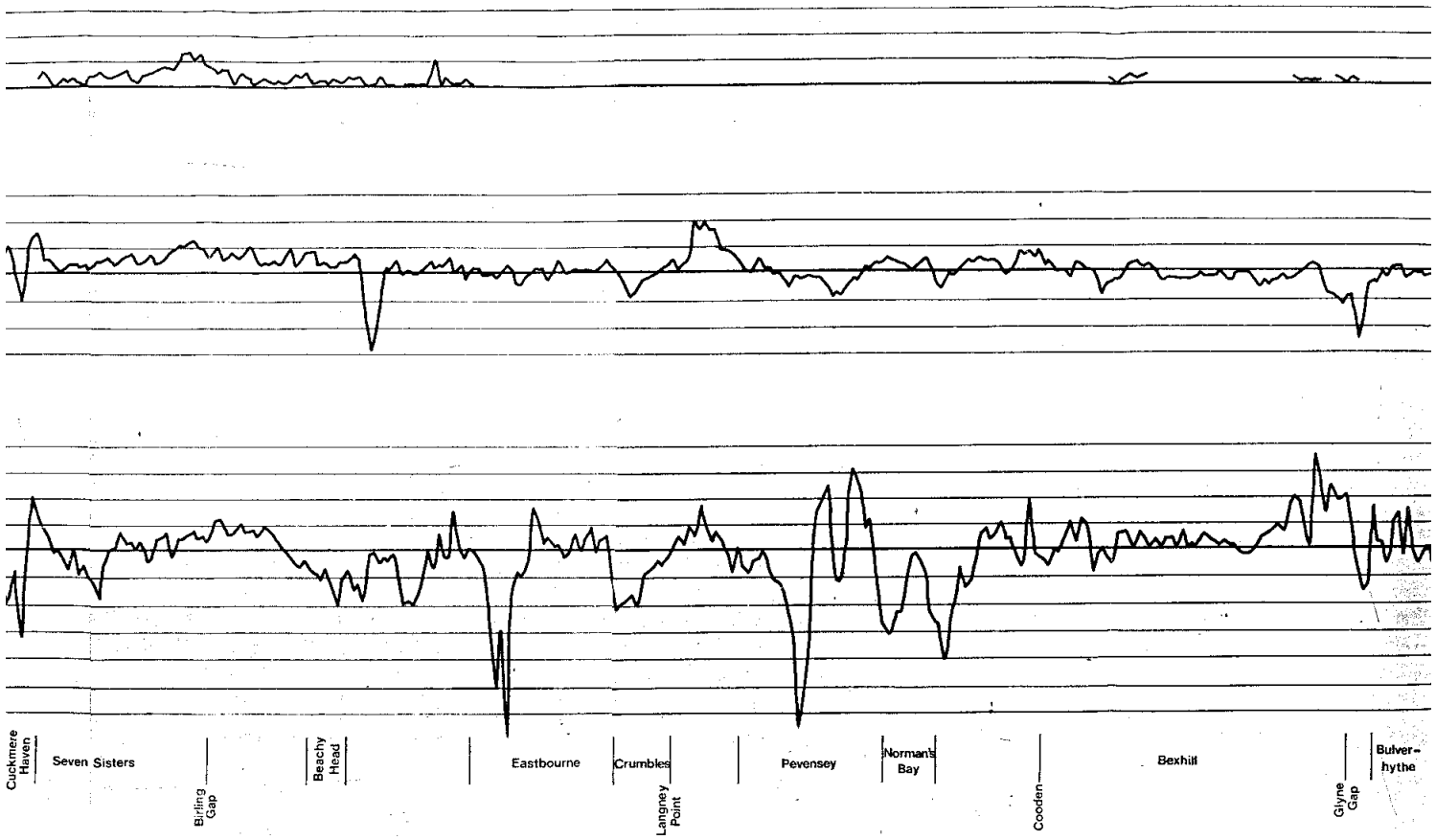
Changes in Beach Volumes 1973 to 1975

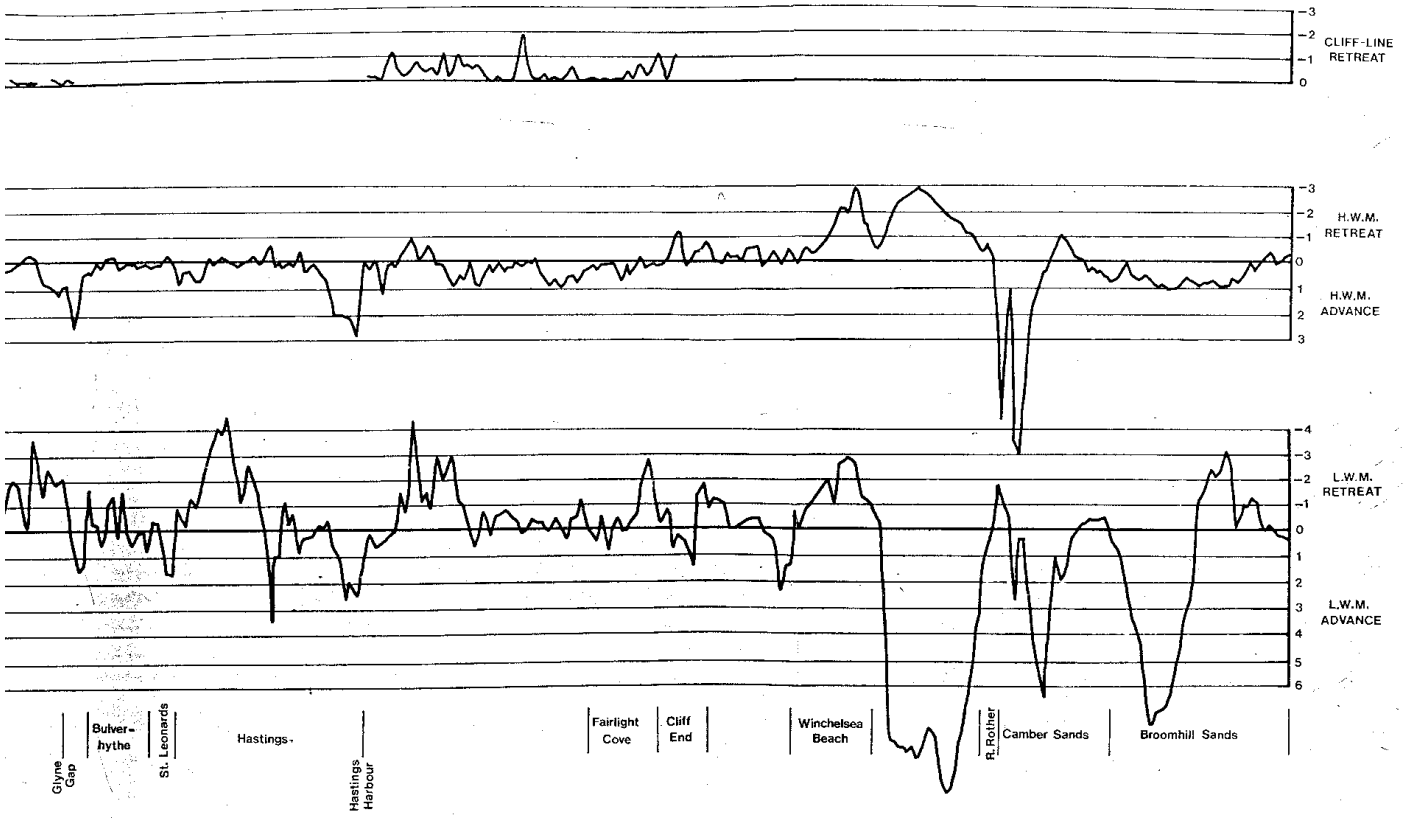




Average annual coastal changes in East Sussex for the approximate period 1925 to 1955




Cuckmere Haven
Seven Sisters
Birling Gap
Beachy Head
Eastbourne
Crumbles
Langney Point
Pevensey
Norman's Bay
Cooden
Bexhill
Glyne Gap
Bulver-hythe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CLIFF-LINE RETREAT
H.W.M. RETREAT
H.W.M. ADVANCE
L.W.M. RETREAT
L.W.M. ADVANCE
Glyne Gap
Bulver-hythe
St. Leonards
Hastings
Hastings Harbour
Fairlight Cove
Cliff End
Winchelsea Beach
R. Rother
Camber Sands
Broomhill Sands