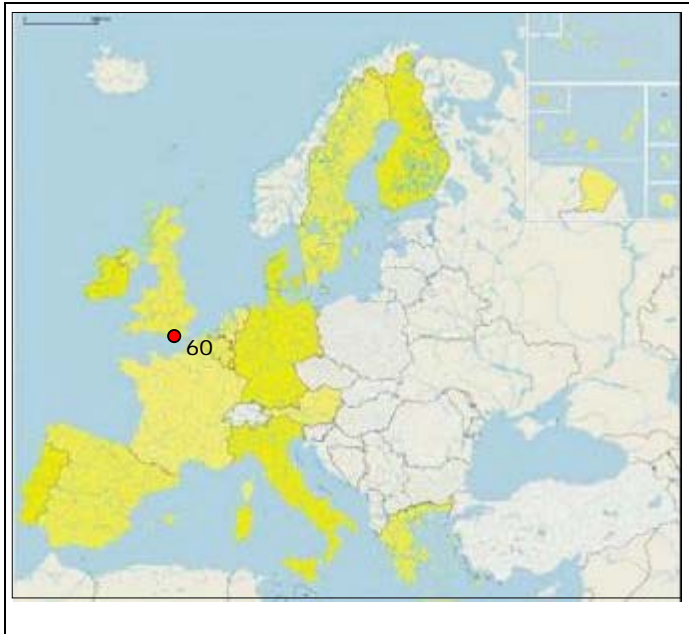

SOUTH DOWNS SUSSEX COUNTY (UNITED KINGDOM)



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1. GENERAL DESCRIPTION OF THE AREA

1.1 Physical process level

1.1.1 Classification

The Sussex coastline stretches some 150 kilometres from Chichester in the west to beyond Hastings in the east (see Figure 2). Sussex is split in east and west Sussex. Generally southerly facing throughout its length, individual sections of the coast vary in aspect from south-southwest to east-southeast. The coast comprises cliffs of chalk and sandstone separated by alluvial lowlands. At the base of the cliffs gently sloping shore platforms extend seawards for up to 200m to below low water mark. The upper parts of the platforms are often covered with a pebble or shingle beach, but the lower part is bare except for a covering of seaweed. The platform surface is often dissected by a system of runnels along which flint pebbles are rolled during each tidal cycle, especially during storms.

In this case study only the South Downs area of the Sussex coast is taken into account because this area forms one coastal cell. The shoreline covered by the South Downs coast spans some 84km of East and West Sussex, from Selsey in the west to Beachy Head in the east (see Figure 2).

The coastal geomorphology of the Sussex coast is best described as a macro-tidal eroding cliff-beach-shore platform system developed on chalk. According to the typology in the scoping study, the coast can be characterized as:

2. Soft rock coast.
- Barrier shingle coast.



Fig. 1: Location of case area.

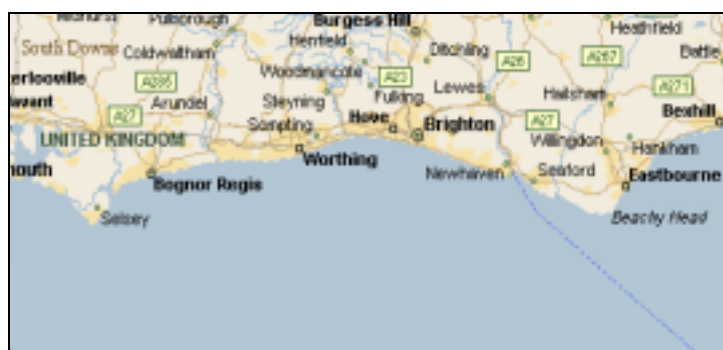


Fig. 2: Topography South Downs.

1.1.2 Geology

The South Downs case study area mainly consists of shingle beaches and white chalk cliffs. The Sussex shingle beaches are composed mainly of flint obtained primarily by erosion and retreat of the chalk and sandstone cliffs and the shore platforms at their base. Secondary, iron-stained, pre-worn flints, are added to the beaches from the erosion of Tertiary and Quaternary deposits that locally overlie the chalk. Most of this flint was probably eroded during the glacial periods.

Rising sea levels after the last glacial period drove much of the flint gravel landwards, thereby creating the shingle beaches. When the sea reached its present level, 5000 or more years ago, the supply of shingle from offshore largely ceased. According to this view, the shingle that protects the present-day shoreline is essentially a fossil deposit that is ever diminishing under the attack of the waves. The sealing off of cliffs through the construction of sea walls, such as those along the stretch from Brighton to Peacehaven, reduces the natural flint input.

The Chalk of the Sussex cliffs is a soft, white limestone, formed during the Cretaceous Period, around 70 to 100 million years ago. Younger Tertiary and Quaternary deposits often mantle the uplifted, eroded upper surface of the chalk, or fill solution hollows and caves within it.



Fig. 3: White cliffs at Birling Gap.

1.1.3 Morphology

From Beachy Head, with high chalk cliffs (up to 160 m above the sea), in the east, to Selsey in the west, the shoreline forms a long sweeping bay (as can be seen in Figure 2).

The coastal plain west of Brighton rarely rises more than 10 m above High Water near the shoreline. The inter-tidal area and the seabed beyond slope very gently, producing a wide (up to 500m) foreshore, much of which is covered with a veneer of sand over the chalk bedrock. West of Bognor Regis this chalk gives way to London Clay, interspersed with Reading Beds (shingle) and harder sandstone outcrops. East of Brighton, the land is relatively high and continues to be so through to Newhaven - a distance of approximately 13km. Further east of Newhaven, the land is low-lying.

Along the low-lying stretches of coast, a sand beach frequently underlies the pebble beach and is often exposed at low tide. At Newhaven, clays mantle the cliff top immediately west of the harbour. The weak clays, in particular, are prone to land sliding, occasionally spilling over the cliff edge.

In past centuries, eastbound longshore transport of sand and shingle has led to the growth of shingle spits and bars across local bays and estuaries. The mouths of rivers such as the Cuckmere were deflected eastwards and often partially blocked by drifting shoals of sand and shingle. The natural harbour at the mouth of Ouse, settled by Stone Age Man and then rediscovered by the Romans, was sealed up during an extreme storm in 1579 when a shingle bank 'redirected' the mouth of the river Ouse four miles up the coast.

1.1.4 Physical processes

Tide

The Sussex coast has a mean tidal range of 4.7m (macro-tidal environment), increasing from west to east along the coast. This induces a tide-driven littoral drift also increasing west to east.

Waves

The prevailing wind direction is from the southwest/west and waves generally approach the Sussex shore from this direction. A frequency analysis for wave height and direction at Shoreham, 25 km to the west of Telscombe beach (East Sussex), indicates that 1.6% of the significant wave heights exceed 3 m (Posford Duvivier, 1993). Based on measured data in the period 1971 to 1998 at Dungeness (Kent), extreme nearshore wave heights exceed 3.5 m once every year and 5.0 m once every 200 years.

Currents

Sediment transport in the nearshore is dominated by wave-induced currents; further offshore both wave- and tide-driven currents are important. The sand and shingle move eastward along the Sussex coast. This has been evidenced by volume fluctuations at specific places such as The Crumbles (east of Eastbourne). However, manmade constructions inhibit natural transport patterns causing currents to only transport a certain sediment size around obstructions such as harbour arms. For example, at Newhaven it is evident that shingle is trapped to the west of the harbour whilst sand can move around and is deposited on the east side.

Sea level rise

In Table 1, the relative sea level rise for the English Channel is shown. The medium predicted sea level rise in fifty years is about 0,3 m (6 mm/year). This can have a significant impact on the Sussex coast.

Table 1: Relative sea level rise around UK areas (in cm) by 2050; including land subsidence/rise.

	Low	Medium-low	Medium-high	High
West Scotland	2	9	17	63
East Scotland	8	15	23	69
Wales	18	25	33	79
English Channel	19	26	34	80
East Anglia	22	29	37	83

River discharge

Sussex is drained by a series of large fast-flowing rivers, which rise on the weald and cut through the Downs on their way to the sea (Arun, Adur, Ouse and Cuckmere) and smaller rivers, which drain the coastal plain.

1.1.5 Erosion

The net long shore sediment transport along the Sussex coastline is directed eastward, for sand as well as shingle. The Sussex coastline has been subject to erosion by the sea over the past 10,000 years, since the English Channel was flooded at the end of the last glacial period. The cliffs of the Seven Sisters, which have a maximum height of 165 m, are undergoing quite rapid recession, at an average rate of about 0.6 metres per year, measured from historic Ordnance Survey maps dating back to 1873, data from the EU Environment Agency, air photos made by the German Luftwaffe and now held in the US-Archives and more recent GIS techniques (BERM-project) and often exceeding 1 m per year over shorter periods. The cliffs erode as a series of rock falls (chalk cliffs) and as small landslides (sandstone cliffs), followed by a period of several years in which no further movement takes place at that point.

During major rock falls such as the one which occurred on January, 11th 1999 at Beachy Head (see Figure 4) up to 200 m of cliff were loosened by persistent rain. There is some benefit to coastal processes from cliff-falls in the area, not from the chalk that temporarily accumulates at the foot of the cliff but more from the flint that is often contained within the chalk. The flint lasts longer in the system than chalk as this quickly degrades and dissolves.

Though erosion has always taken place at the Sussex coastline, recently human interventions have increased the erosion along the Sussex cliffs. Defending the soft cliffs against erosion causes a sediment deficit further downstream and the construction of piers and groins cause an interruption of the long shore transport and thus leeside erosion. Furthermore, because sea walls and groins have largely fixed the coastline, the coast has lost its resilience.

Furthermore, there are commercial and government agencies that 'mine' shingle (from the beach and in deeper water) for e.g. construction purposes. For example near Rye Harbour, successive shingle ridges developing in a northeasterly direction form an area covering 10.2 km². In between the shingle ridges agricultural land (a mix of arable and sheep grazing) now exists on what was once salt marsh. Shingle extraction earlier this century has resulted in the creation of three major pits.



Fig. 4: Rock fall at Beachy Head.

1.2 Socio-economic aspects

1.2.1 Population rate

The population density for southeast England is shown in *Fig.5*. It can be seen that the population density at the coast is higher than the average population density (2 persons/ha = 200 persons/km²) in this area. Along the South Downs



coast between Selsey and Beachy Head the population density is very high, almost everywhere higher than 400 persons/km².

1.2.2 Major functions of the coastal zone

The major functions along the South Downs coastline are agriculture, tourism and recreation, light industry, nature conservation and residential development. More detail about these functions at different sites is given in the site description in the section about eroding sites.

1.2.3 Land use

Land use at the South Downs case study area mainly comprises built up land around the urban concentrations. In between agricultural land is present, especially in the western low-lying coast of the South Downs.

1.2.4 Assessment of capital at risk

Due to the relatively rapid erosion rates, most of the towns along the Sussex coast are at risk. Sea defences in front of the towns minimize the damage to property. However, along the taller cliffs damage cannot always be prevented. For example at Birling Gap several cottages have already been lost to cliff erosion. The population density (>400 persons/km²) and recreational value of the South Downs coast is very high, therefore the area in general is considered to be at high risk. This capital at risk can differ locally.

Fig. 5: Population density in southeast England (in persons/ha).

2. PROBLEM DESCRIPTION

2.1 Eroding sites

The eroding sites of the South Downs coast are described below from west to east. A description of the coast is given, generally, concerning present erosion and historic measures taken at the site.

➤ Western part of South Downs: Selsey to Shoreham

In Figure 6, the western coastal area of the South Downs is shown; the main towns are Selsey, Pagham, Bognor Regis, Littlehampton and Worthing.



Fig. 6: Overview western coastal stretch South Downs.

Many of the coastal towns at the western coastal stretch (relatively low-lying) grew up around the turn of the last century due to the tourist industry and the belief in the health enhancing coastal airs. High quality farmland is a key feature of the western coastal plain.

Selsey Bill can be seen in the top of Figure 7, with the mouth Pagham Harbour in the mid-ground. The shingle spits and bars can clearly be seen even though the shot was taken near high water. The site is a Site of Special Scientific Interest, Special Area of Conservation, Special Protection Area and a Ramsar site. It is an important site for nesting Terns and the shingle ridges support colonies of Yellow Horned Poppy and Chiding Pink.

What is now Pagham Lagoon used to be the outlet to Pagham Harbour in the late 1800s and was formed when the migration of the shingle spits sealed the outfall to the sea.



Fig. 7: Spits and bars at Pagham Harbour.

Further east, Aldwick Bay, has a naturally accreting beach giving way further east to the timber groind recreational beaches of Bognor Regis, Felpham and Middleton.

At Worthing, in common with many other areas, development has reached up to the shoreline. Timber groins can be seen developing the familiar ziz-zag pattern of shingle, as they reduce the rate at which shingle is carried along the coast.



Fig. 8: Brighton coast with pier.

Further west, Shoreham Harbour supports a commercial operation, with timber and aggregate ships regularly discharging their cargoes. This commercial operation exists alongside a smaller pleasure sailing fleet.

The locked harbour is on a spur of the River Adur, which is controlled by two harbour arms. Shingle builds against the western arm and material is by-passed eastwards to help reinforce the narrow, timber groined beach fronting the Harbour. At Shoreham, also another coastal lagoon can be found, where supporting various species of flora and fauna.

➤ Eastern part of South Downs: Shoreham to Beachy Head

In Figure 9, the eastern coastal stretch of the South Downs is shown. The main towns in this area are Brighton, Newhaven and Seaford. East of Brighton, the land is relatively high and continues to be so through to Newhaven - a distance of approximately 13km. Further east of Newhaven, the land is low-lying.

Much of Brighton is fronted by a wide shingle bank, especially the area immediately west of the Marina. There are a number of large masonry groins in the main beach and these generally give way to a more traditional timber groins in the west. The coastline was protected by ad hoc defences in the 1800s; prior to this the coast was typically eroding by as much as 2½ m per year. With the increase in development in the 1920s & 30s came a more concerted effort to defend the coast against erosion.



Fig. 9: Overview eastern coastal stretch South Downs.

Brighton Marina was constructed in the open sea, from pre-cast concrete caissons sunk to the seabed, in the 1960s. The Marina now supports high quality residential property and various retail and leisure units. It has a large pleasure craft mooring facility; fishing and dive boats also operate out of the Marina.

The port of Newhaven is on the River Ouse. The main port operation is a cross-channel ferry to Dieppe and the approaches are regularly dredged to allow these ships to operate.

Seaford is located a bit further eastward. Seaford has a wide shingle bank, regularly recycled by the Environment Agency, to provide a defence against the prevailing southwesterly storms, which attack with great force.



Fig. 10: Brighton Marina.

A number of rivers discharge to the sea along the frontage; notably the Cuckmere at Exceat just east of Seaford, where the artificial cut was made in 1846. The disconnected meanders can be seen in [Picture 6](#). This area is being examined as a site where a more natural and sustainable defence can be established; controlled breaches are to be formed in the banks and areas of pasture allowed to flood and revert to floodplain, the meanders may also later be re-established, by reconnection to the main channel.

At Birling Gap, where the high chalk cliffs of the South Downs meet the sea at the eastern end of the frontage, an old dry river channel presents a weaker defence than the surrounding chalk cliffs. The resulting increased erosion has provided an area where there are conflicting opinions. Should there be human intervention to safeguard the small number of properties on the cliff-top or should the natural process of cliff recession continue to safeguard this Site of Special Scientific Interest. Unfortunately for those living on or near the cliff-top, economic considerations also come into play; the benefit of defending the coast must be weighed against the cost, now and in the future, of providing a defence. This is true of the whole coastline.

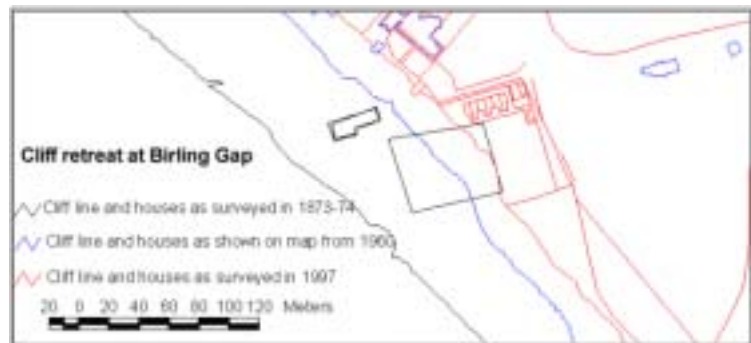


Fig. 11: Local erosion at Birling Gap, threat to houses.



Fig. 12: Threatened building at Birling Gap.

2.2 Impacts

At the low-lying areas in the western part of the case study area the densely populated towns are threatened to be flooded. Furthermore, recreational beaches are eroded and recreational facilities are threatened. Development has reached up to the shoreline, and therefore is threatened, at almost the entire western coastal stretch. At the cliffs in the eastern part of the case study the erosion is mainly threatening houses on the cliffs and infrastructure, such as coastal roads along the cliff line.



3. SOLUTIONS/MEASURES

3.1 Policy options

Up until now the policy option has been hold the line in places where significant infrastructure or housing concentrations are present. Here, economic considerations come into play; the benefit of defending the coast must be weighed against the cost, now and in the future, of providing a defence.

The National Trust over the last few years had adopted a changing policy; it has accepted the inevitability of change on the coast. This decision was made for various reasons such as the inevitability of change, the benefits change can bring, and the damage which trying to prevent it can cause. They argue that there are esthetical reasons; some defence works are ungainly and entirely out of place on unspoilt stretches of coast, and technical reasons; defences cut off the supply of sand and shingle vital to maintain features along other parts of the coast, displaces the effects of erosion from one point to another. The National Trust's stance is not always popular and can cause conflicts, an example is shown in Box 1.

However, the Trust accepts that change is not an option in some places, for example where there are large towns, ports or nuclear power stations. It realises that different strategies will be needed in different places, implying a case-by-case approach.

Box 1: Example of conflicts with new policy of accepting change at the coast.

In March 2001 the government announced the result of a Public Enquiry into the fate of the cliff at Birling Gap in Sussex. Over the last 100 years, several coastal cottages on the cliff top have fallen into the sea below due to erosion. Local residents therefore wanted a sea wall constructed to delay the erosion of the cliff and to give their homes, close to the cliff edge, a longer life. The Trust and other conservation bodies (English Nature and the Sussex Downs Conservation Board) took the unpopular position that a sea wall was both undesirable and unsustainable, and would damage the nationally important geological, geomorphologic and biological interests. The Public Enquiry and the government accepted the conservationists' view. Regarding 'human rights' as in the right to respect a person's private and family life, his home and his correspondence and also to the protection of property, a balance was struck between the interests of the community and the individual's rights. This means that the 'right' to be protected by coastal protection schemes, flood defence, stabilisation, etc., needs to be balanced on a case-by-case basis with the need to protect the environment.

The government's policy aim is to reduce the risk to people and the developed and natural environment from flooding and coastal erosion by encouraging the provision of technically, environmentally and economically sound and sustainable defence measures. There are 3 main objectives:

- A: To encourage the provision of adequate and cost-effective flood warning systems.
- B: To encourage the provision of adequate, economically, technically and environmentally sound and sustainable flood and coastal defence measures.
- C: To discourage inappropriate development in areas of risk from flooding and coastal erosion.



3.2 Strategy

3.2.1 Approach related to the problem

During the last seventy years, all except those sections of coast backed by high cliffs have been groined and immediately to the east of Brighton groins have been installed even in front of tall cliffs to help reduce coastal retreat that threatens cliff-top properties and the coastal highway. However, faced with the prospect of climatic change and possible sea level rise this century, there is concern that the erosion rate will increase. To anticipate this, the ROCC (Risk of Cliff Collapses) project was set up. Its main aim is to try to find out which areas may be most vulnerable to such future changes, so that planners and engineers can make appropriate decisions.

Instead of seeing the sea as a force, which must be stopped by a solid wall, the researchers investigated the protective value of the submerged natural rocky platforms that lie just underneath the cliffs. These platforms have a significant impact on the rate of cliff erosion - a wide platform will reduce the rate enormously, whereas a narrow platform will imperil the cliffs. Up until now, a sea wall has been seen as the most effective form of defence.

It has become clear that sea defences have only been effective for a limited time before they have had to be rebuilt. This is often because the rocky shore platform that forms their foundation has been eroded from around and beneath them. Through research, smaller amounts of money may be used to combat the problem by protecting or building up the intertidal platforms and saving the Sussex coastline.

Furthermore, today, where appropriate, the "hard" defences of concrete seawall and timber breastworks are being replaced with the "soft engineering" of shingle beach management systems and rock structures. Whilst the rock used is in itself hard, the defence systems constructed with it and the wider shingle beaches are considered "soft" because they absorb wave energy, rather than reflecting it with seawalls, as in the past. Wave reflections encourage scour to occur and thus remove beach material from the shoreline.

3.2.2 Issues concerning life and property

Residents are being warned through a 'Flood Defence' and a 'Flood Warning' system. Both systems have teams with a detailed knowledge of how rivers and low-lying coastal areas respond to the rain and the tides. The teams issue flood warnings when necessary and ensure that the emergency workforce keep existing flood defences in good order. Before new flood defences are built, approval and funds must be gained from the Local Flood Defence Committee and the Department for Environment, Food and Rural Affairs (DEFRA).

3.3 Technical measures

Western part of South Downs: Selsey to Shoreham

With a few exceptions, the western part of the case area is entirely defended by timber groin fields, often backed by concrete seawalls. The recreational beaches of Bognor Regis, Felpham, Middleton and Brighton are groined in this way. Some details are available about a protection scheme at Elmer, Littlehampton and at Shoreham and Lancing.

➤ **Elmer protection scheme**

In most cases the case area is defended by timber groin fields, however rock has been used in a number of innovative projects as in the scheme seen at Elmer. The old timber groins were unable to efficiently maintain a suitably wide shingle beach, due to the increased sediment transport rates caused by the change in beach plan shape.

The detached breakwaters (about 8 were built) reduce wave energy whilst allowing some littoral drift to continue. The scheme was a joint project between the local authority and the national Rivers Authority (Now Environment Agency) and cost around £6 million (€8,5 million), in a number of phases. The main phase was constructed in 1992/93 and involved 200,000 cubic metres of imported shingle and 100,000 ton of rock.



Fig. 13: Rock groin system at Elmer, Littlehampton.

➤ **Shoreham and Lancing**

The start of this scheme follows the completion of the River Arun to Adur Coastal Defence Strategy. The Environment Agency has launched a new £ 10 million (€ 14 million) flood defence scheme for Shoreham and Lancing. The scheme will provide improved defences for over 3.3 kilometres of coastline and help to protect over £ 94 million pounds (€ 135 million) worth of property and assets including 1300 homes and 90 commercial premises. It will also secure the future of the Widewater lagoon which is a unique wildlife reserve where one Britain's rarest animals a sea anemone called *Edwardsia ivelli* may still be living. Widewater is a manmade brackish lagoon, approximately 1200 metres long and 50 metres at its widest point when the lagoon is in flood. It was created from the original Adur estuary after been landlocked by longshore drift and violent storms. Man has built up banks on the perimeter of the lagoon to prevent flooding to the nearby-reclaimed land, now turned to residential use. The quantity of water contained within the lagoon and salinity are liable to fluctuate wildly. The flood plain covers an area of 18.5 acres.

The works involve the construction of 33 new rock breakwaters (cost £ 3.5 Million= € 5 million) and the importation of 200,000 cubic metres of shingle. Most of the materials will be delivered by sea. The work was planned to have started in September 2002, to avoid interruption of the holiday season.

The work started at the Widewater and continued west towards Worthing. The first part of the scheme includes enhancement to the lagoon at Widewater. A piping system will be installed to promote higher water levels in the lagoon during the summer months. In recent years the Widewater has experienced low water levels and this has damaged the fragile habitat that houses several rare species of birds and seaflora and -fauna. The pipe system will provide a more stable environment that will lead to considerable improvements to the whole area for residents, for wildlife and for visitors.

Eastern part of South Downs: Shoreham to Beachy Head

➤ Brighton up to Peacehaven

In 1935, coastal protection works east of Brighton (Black Rock) up to Rottingdean were built to protect a 7 km length of the South Coast Road. A flint-faced, concrete sea wall and promenade was built into the rock of the beach platform, behind which the cliff face was cut back (graded) to a stable 'self-weathering' angle of about 72°. During construction, the material from the cliff trimming, 200,000m³ of chalk, was dumped on the shore platform. The construction (finished in 1933) was called the 'Undercliff Walk' and was used as a job creation scheme during the recession. Groins (which had been built in various times since the 1870s) were built outward from the sea wall in order to trap beach material and thus help protect the base of the wall. The construction, which had successfully halted cliff recession, could not prevent erosion of the foreshore, and foundations were exposed and undermined. The seawall was then repaired and, amongst other design changes, was constructed to abut against the solid chalk cliff, rather than being filled up with a granular fill which can be quickly removed by wave action if the wall sustains minor damage, encouraging much more serious failure.



Fig. 14: Undercliff Walk at Peacehaven.

With the completion of the first sea wall and groins between Brighton and Rottingdean, the erosion of the coastline further to the east accelerated, and by the 1950s, another section of the South Coast Road and a number of dwellings at Saltdean were threatened. Surveys undertaken at this time showed an annual erosion rate of around 1.3 m per year. The earlier defences were therefore extended eastward toward Portobello in 1964. By the late 1960s, however, the increasing threat of cliff erosion along the coast between Telscombe Cliffs and Peacehaven necessitated the phased construction, between 1977 and 1996, of further ground sea walls as shown below. The total costs for these works were over £5 million (€7 million).

Between Brighton and Friar's Bay, Peacehaven, there now remain only two sections of unprotected cliff, between Saltdean and Portobello and between Portobello and Telscombe Cliffs. Although not actively threatening properties at the moment, cliff erosion is proceeding rapidly, with fresh falls apparent at a glance from the cliff top. Construction to complete the sea wall along this part of the coast will inevitably be necessary within the next 25 years.

➤ **Newhaven up to Seaford (Seaford Bay)**

Further to the east of Brighton at Newhaven, a substantial breakwater (see Figure 15), completed in 1890, has had an important effect in interrupting the eastward littoral drift of shingle, a large bank which forms the beach in Seaford Bay. Whilst the build-up of shingle on the western side of the breakwater has stabilised the cliffs below Newhaven Fort, the breakwater caused erosion of the shingle bank in the bay leading to repeated breaches of the sea wall at Seaford, despite the building and maintaining of groins to reduce beach loss. The terminal groin largely inhibits the output of shingle from Seaford to the east.

Fig. 11: Coastal protection schema Newhaven-Seaford.

The wave induced longshore currents in Seaford bay have an eastward and westward component leading to shingle movement away from the approximate centre of the beach to either side so that the material has to be artificially (with bulldozers) transported back to the centre. The decision to build up the shingle bank using shingle dredged from the Owers bank off Littlehampton, was taken by Southern Water in the early 1980's; completion of this scheme narrowly averted further serious damage and flooding during the 'hurricane' of October 1987. However this shingle (like the shingle used to replenish the beaches at Eastbourne and Pevensey) has a D50 that is smaller than the original shingle and therefore behaves in a different way. Now the artificial shingle bank is maintained on an annual basis by redistributing 30.000 m³/yr shingle from a detainment area by the large concrete groin at the eastern end of the beach. Inevitably, however, the 'knock-on' effect of this scheme has once more been to deprive the cliffs immediately east of Seaford of their normal degree of shingle protection, resulting in further erosion of the cliffs near Seaford Head. Furthermore it has had a considerable impact on the ecology and use of the beach.

4. EFFECTS AND LESSONS LEARNT

4.1 Effects related to erosion

The Elmer protection scheme seems to be successful in widening the beaches and protecting the hinterland from flooding. The Shoreham and Lancing scheme was just finished recently; no information is yet available about the affectivity of this scheme.

The seawall and groin constructions along the Brighton- Newhaven coastline successfully halted cliff recession but could not prevent erosion of the foreshore, and thus foundations were exposed and undermined. The seawall was then repaired and, amongst other design changes, was constructed to abut against the solid chalk cliff, rather than being filled up with a granular fill which can be quickly removed by wave action if the wall sustains minor damage, encouraging much more serious failure. Furthermore, the construction had to be extended several times because dwellings downstream of the protection scheme were threatened.

The artificially maintained shingle beach in the Seaford Bay is successful in protecting and stabilising the cliffs at this coastal stretch. The previous seawall at Seaford at this coastal stretch was breached several times because of erosion of the naturally present shingle beach. However, again downstream of the terminal groin at Seaford Head, the erosion continues and is enhanced by the taken measures.

4.2 Effects related to socio-economic aspects

The policy suggested by the National Trust and other conservation bodies and implemented by the government to not intervene at Birling Gap and stop the erosion, caused much distress to the local inhabitants. The decision meant that the cottages along the cliff will be lost disrupting the social community because effectively it forces them to move and find new homes. However, the decision saved the government a large amount of money associated with the building of unsustainable sea defences with which the erosion would probably only be temporarily checked.

4.3 Effects in neighbouring regions

At the coastal stretch from Brighton to Peacehaven it was clearly seen that protection in one area causes an increase of erosion further downstream. This implies that the downstream area has to be protected too, causing an increase further downstream and so on. This problem is repeated along the entire coastline of Sussex. From Brighton to Peacehaven, now only 2 sections of the entire coastline (about 7km) remain unprotected. These will probably be dealt with within the next 25 years. The effects of defending one part of the coast, have forced the government to defend the entire coastline for a large sum of money.

4.4 Relation with ICZM

An overview of ICZM in progress at the Sussex coast is given below:

- *East Sussex and Brighton & Hove Structure Plan 1991 - 2011* describes in what state Brighton & Hove and East Sussex should be in some fifteen years or so ahead, together with policies and proposals that can be implemented to achieve that vision;



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- *Sustainability Action Plan, East Sussex Sustainability Strategy: The Coastal Regeneration Strategy* has been set up in which partners work on initiatives to support the land based sector, local producers, businesses and communities in rural areas. It includes actions, targets and delivery mechanisms to regenerate the East Sussex coastal strip. Leading agencies are: East Sussex CC; Borough and District Councils; Coastal Regeneration Partnership; Sussex Enterprise. A fully-costed Area Investment Framework (AIF) for the East Sussex coast will also be made;
 - *The South Downs Shoreline Management Plan (SMP)* designates Coastal Transport Cells along the Sussex coastline;
 - *Eastbourne Borough Council Policy statement on flood and coastal defence 23rd April 2001* stems from the Flood and coastal defence policy which is set by the central government Department for Environment, Food and Rural Affairs (DEFRA). The aim of this statement is to reduce the risk to people and the developed and natural environment from flooding and coastal erosion by encouraging the provision of technically, environmentally and economically sound and sustainable defence measures. However, the Council does not accept responsibility for the maintenance of flood defences on private land - this is the responsibility of the landowner;
 - *Brighton Marina to Saltdean Coast Defence Strategy Study* uses recommendations from the South Downs SMP. The strategy outlined for the study area is to “Hold the Line” (i.e. to maintain the coastal defences on the current line), in order to protect the infrastructure and the existing urban development. The government has given a grant of £9.1 million to reconstruct the sea defences between the Marina and Ovingdean.

The Government has publicised a policy aim and three objectives for flood and coastal defence. To ensure a more certain delivery of the aim and objectives by the individual operating authorities the Government has published a series of high-level targets. The first target requires each operating authority to publish a policy statement setting out their plans for delivering the Government’s policy aim and objectives in their area. This will include their assessment of flooding and coastal erosion risk in their area, and the plans for reducing or managing that risk. The Adur District Council’s approach is consistent with the Government’s aim and objectives for flood and coastal defence.

The councils in the case area are all members of the South Downs Coastal Group, which implements the above objectives and manages tidal and coastal defences. The Group further consists of the Environment Agency, Department of Food and Rural Affairs, West Sussex County Council and other coastal related organisations such as Shoreham Port Authority. It considers all aspects of tidal and coastal defences and the effects of defences on the land behind the defence, the environment, tourism, recreational activities, collectively using the research completed along the southern coast and the practical experiences of each member. It produces 'joined up' defence strategies in line with the Guidance from the Department of Food and Rural Affairs.

Five years ago, the Group produced the Shoreline Management Plan from Selsey Bill to Beachy Head. This general Plan has been developed to produce the local Coastal Defence Strategies, up until now two have been completed: River Arun to River Adur and Brighton Marina to River Adur.



4.5 Conclusions

Effectiveness

With the help of plans such as the South Downs Shoreline Management Plan (SMP) coastal defence can be coordinated so that it is effective locally and does not adversely affect the downstream coastline. Before these plans were made and implemented, many of the sea defences were designed on a local scale and did not take into account their downstream effects such as accelerated erosion. Locally however the measures did curb erosion, though the hard structures did suffer storm damage and needed repairing after a certain amount of time.

The current National Trust's viewpoint is that the coast should be left to natural changes as much as possible, for aesthetic and technical reasons (protection decreases sediment supply areas further downstream). The community's interest is put above the individual interests. This viewpoint of course leads to a lot of conflicts. Only if large concentrations of people or large investments are threatened, will the applied policy be held the line.

Possible undesirable effects

Coastal protection schemes also have adverse impacts e.g. on the visual appearance of the cliffs, the maintenance of geological exposures and on the nature of the foreshore and its ecology.

Sometimes, adopted policies may ensure polarised reactions. For example, the policy of the National Trust and other conservative is not to interfere with the course of nature. The government has seconded this policy in the case of Birling Gap, knowing that the consequence of this decision means that several cottages may be lost in the next years. However, local inhabitants wanted a seawall to protect their homes and were, to say the least, unhappy about the decision. In these cases a balance had to be struck between the interests of the community and an individual's rights.

Gaps in information

No specific information was found on all the executed measures at the South Downs coast. However, the most usual techniques have been described and are probably representative for the other protection schemes along this coast.



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