THE FLOOD HUB

Coastal Management Booklet

Image: The Flood Hub

Image: Coastal erosion at Ulrome, East Yorks cc-by-sa/2.0 - © phillip andrew carl taylor - geograph.org.uk/p/1515059

INTRODUCTION

Coastlines naturally erode over time. In England and Wales the management of the coastline is divided into 22 Shoreline Management Plans (SMPs). SMPs are developed by Coastal Groups consisting of members mainly from local councils and the Environment Agency. The SMPs set the 'direction' of how each part of the coast will be managed for the short term (0-20 years), the medium-term (20-50 years) and the long-term (50-100 years). To do this, the most sustainable management policy is chosen from one of the following four management policy options:

Hold the Line - maintain or change the current standard of protection to keep the shoreline in its current position.

Advance the Line - building new defences on the seaward side of the original defences. Use of this policy is limited to those policy units where significant land reclamation is considered.

Managed Realignment - allowing the shoreline to move backwards or forwards, with management to control or limit movement (such as reducing erosion or building new defences on the landward side of the original defences).

No Active Intervention - where there is no investment in coastal defences or operations.

Management policy options will have been appraised and publicly consulted upon before they are chosen. Polices may also change over time if they become financially, practically or environmentally unfeasible.

There are various approaches and methods used to mitigate the threats posed to coastal communities and infrastructure by coastal flooding and erosion.

COASTAL MANAGEMENT APPROACHES

Hard Engineering

Hard engineered coastal defences generally involve the placement of artificial structures which are used stop or slow the natural processes of erosion, flooding and sea level rise. They are highly visible solutions which help to reassure coastal communities. However, they are expensive to construct, require expensive ongoing maintenance programmes, and by installing hard engineering solutions in one place there could be detrimental effects further along the coast.

The methods used to manage the effects of coastal erosion and flood risk have typically involved building defences which deflect the power of waves and high tides. Hard engineered coastal protection may seem like the best option to protect seaside towns, cities and popular tourist destinations, but;

- they are constantly subjected to impacts from the sea and are costly to install and monitor.
- they may be quickly outdated and require costly maintenance.
- they protect land which is now of little value.

Rising sea levels, along with the high cost of maintaining sea defences, call for more cost effective and sustainable methods of coastal protection.

Soft Engineering

Soft engineering techniques involve working with nature to manage the coastline. Natural Flood Management (NFM) is used to manage coastal flood risk and erosion using natural methods and measures. This can be done by improving the number of natural buffers which help to absorb tidal and wave energy through the replacement of eroded material, replanting beach plants and grasses which trap sand, or breaching or removing previously built management schemes to allow the shoreline to roll back naturally. NFM measures can be placed on the coast, in intertidal areas or both. Some coastal NFM schemes, such as those where eroded material is replaced, will require ongoing maintenance programmes as they may have a relatively short lifespan.

COASTAL NFM: MANAGED REALIGNMENT

Managed realignment is the planned breach or relocation of sea defences further inland which creates sustainable, environmentally beneficial intertidal habitat in the form of mud flats and salt marshes. These coastal marshes help to dissipate wave energy and protect against erosion, act as carbon sinks and provide a rich environment for wildlife. Managed realignment is also a long term option to building higher sea walls or larger defences as sea levels rise in the future.

Case Study: Hesketh Out Marsh East Manged Realignment

In August 2017 the Environment Agency and the RSPB saw the completion of the Hesketh Out Marsh East Managed Realignment Scheme become the largest scheme of its kind in the UK.

The project is located on the shore of the Ribble estuary near Preston. It involved restoring 160 hectares of land, that was reclaimed from the estuary for growing crops in the 1980s, back to marshland by reinstating man made embankments in shore.

Sections of earlier flood embankments were then removed, allowing tides in to flood and drain the land. Not only does the scheme help to protect 140 properties and nearby infrastructure by dissipating tidal energy, but it also provides an environment in which fish, migrating birds and marine life can now thrive.

Image: The Environment Agency. Hesketh Out Marsh West in the Ribble Estuary during the construction phase

COASTAL NFM: DUNE REGENERATION

Sand dunes are natural barriers which can protect coastal towns and villages from high tides and flooding. Dunes form above the level of high tide when the plants that live in these salty, damp conditions trap wind-blown sand, which over time accumulates and increases the height and width of the dunes. As the dunes increase in size, more habitat is created in which more plants and ecosystems can live.

Dunes are dynamic and constantly change due to varying wind speed and direction, rising sea levels or storm surges that cause waves to reach higher up the beach and erode the dunes. The recreational activity of visitors to the dunes can also disturb the natural process of their formation. To slow the erosion of these natural coastal flood defences, there are techniques which can help to stabilise the areas where there has been dune loss:

Dune Fencing

Built seaward of the dunes, fencing inhibits trampling from recreational beach users allowing sand to settle and increase dune size.

This method can be used in combination with dune planting to encourage seaward dune growth.

Image: Sand dunes at Formby Point ca by-sa 2.0 - © David Dixon - geograph.org.uk/p/5689575

Dune Planting

Plants such as Lyme or Marram Grass help to stabilise the dunes by trapping sand, as their root systems are extensive and mat together.

Established plants also reduce wind speed over the dunes, slowing erosion. Plants may be self sustaining after an initial period of establishment.

Image: Dune stabilisation at Menie ca by-sa 2.0 - by Peter Robinson - geograph.org.uk/p/1887199

Dune Thatching

Covering the face of dunes with bundles of straw, branches and even old Christmas trees in some areas, increases sand accretion and protects dune vegetation.

A benefit of this technique is that there is no establishment time required.

Image: The Flood Hub

Case Study: Fylde Sand Dunes

On the Fylde coast there are approximately 80 hectares of sand dunes. This reflects an 80% loss of these natural flood defences in the last 150 years as the coastal resort developed from the 19th century onwards.

In 2008, Fylde Borough Council and The Wildlife Trust commissioned a sand dunes management programme to look at how the dunes could be improved and enhanced. Working with natural processes, dune fencing was constructed to encourage sand accretion and also keep visitors out.

Waste trees were planted to speed up the process of accretion, and Marram Grass was then planted to stabilise the sand when the plants became established.

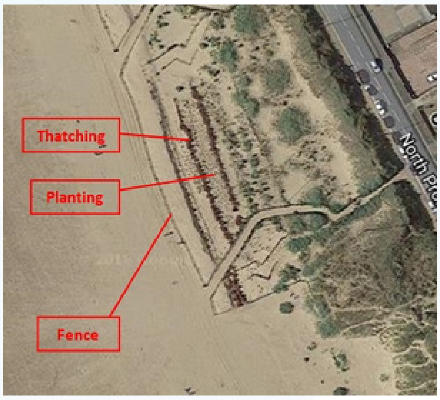

Image: Fylde Sand Dunes Project

COASTAL NFM: BEACH NOURISHMENT

Beach nourishment is the replacement of material which has been lost from beaches by sea or wind erosion. Replenishing material lost to erosion rather than building large hard engineered defences will keep the beach looking natural whilst providing protection from flooding to the local community.

Long term management plans are required for nourishment projects as the replenished material may erode in a relatively short space of time, resulting in the process needing to be repeated periodically, and at considerable cost.

Dredging

Material is dredged from the sea bed and pumped to shore along with large amounts of water. As the dredged material is pumped onto the beach the water drains away leaving the sand behind.

Image: cc-by-sa/2.0 - Building up the beach cc-by-sa/2.0 - © Evelyn Simak - geograph.org.uk/p/995159

Reprofiling

This involves the reshaping of the beach by moving material by machine from areas of accretion to areas where erosion has taken place.

Image: cc-by-sa/2.0 - Beach, Pevensey Bay by Ian Capper geograph.org.uk/p/6062512

Transporting

Dredged material from other areas, or gravel/sand that has been quarried on shore can be transported to site by truck to replace eroded material where required.

Image: cc-by-sa/2.0 - Replenishing West Beach by John Stephen geograph.org.uk/p/4362851

Case Study: Lincolnshire Beach Nourishment

The Lincolnshire coastline has experienced the effects of coastal erosion for thousands of years. The area is popular with tourists and holidaymakers and also contains valuable agricultural land. For the past 24 years the largest beach nourishment programme in the UK has been protecting 20 km of shoreline, alleviating flood risk for 30,000 homes and 19,000 static caravans. The annual cost of the work is approximately £6 million (Royal Haskoning).

High tides and storm surges constantly erode the beaches along the coast between Skegness and Mablethorpe, increasing the potential flood risk along the low lying coastal flood plain.

To replace the eroded material, Team Van Oord used a Trailing Suction Hopper Dredger to suck up sand 12 miles off shore. The material is then brought close to shore and pumped through large pipes onto the beach where it is reprofiled by a bulldozer and excavator, this process is repeated twice per day at high tide.

Each year approximately 400,000m³ of material is replenished along the coast using GPS to achieve the required design level. The replacement material also provides a buffer to the hard engineered coastal defences reducing the possibility of them becoming undermined by the effects of scour.

Image: ca by by-sa 2.0 - Ship to Shore by David Martin - geograph.org.uk/p/6211958

COASTAL FLOOD DEFENCES: CLIFF STABILISATION

Cliffs can fail due to a number of different factors, such as composition or rock type, geological structure (faults, joints, etc), and climate and wave energy. There are soft and loose cliffs made up of sand, silt, clay, marl or chalk which are more prone to erosion and landslides, and hard cliffs made up of limestone, granite or sandstone. Erosion of cliffs in coastal areas results in the retreat of the coastline because the amount of material which is eroded exceeds that which is deposited. Stabilisation techniques are used to limit the amount of erosion and the potential for landslides, collapse and falling rocks.

One cliff stabilisation technique is to reduce the slope of the cliff and revegetate the cliff top. Planting vegetation helps to strengthen the cliff structure and increase cohesion, which will help to keep the cliff in place, prevent cliff material from slumping and prevent landslides.

Another method can be to drain any excess water from the cliff. This will prevent water from flowing along planes of weakness which can lead to rock and sediment sliding to the base of the cliff. It will also limit the likelihood of liquefaction which can cause mudflows.

Advantages and Disadvantages

- ✓ Reduces risk of injury to beach users by slumping or sliding of cliff material.
- ✓ Enables the development of buildings and facilities on the cliff top with a reduced risk of collapse and failure.
- ✓ The stability of the cliffs will encourage tourism in coastal resorts and will have economic benefits for the area.
- ✓ Planting vegetation on cliff tops will increase the biodiversity of the area as it will act as a food source or habitat for wildlife.

- ✗ Vegetation growth is not immediate and will take time, therefore this may be more of a long term solution.
- ✗ Trampling across areas where the seeds have been planted can disrupt and prevent vegetation growth.

Image: cc by-sa /2.0 - South Coast Cliffs by Nigel Freeman - geograph.org.uk/p/581176

Case Study: Scarborough - March 2018

Scarborough Borough Council has approved urgent work to stabilise cliffs in Filey to protect the only access road to a hamlet of 45 properties from crumbling into the sea. The scheme will involve cliff drainage, soil reinforcement, and planting to reduce the risk of landslips. The work will be carried out in three phases and is expected to be completed by the end of 2019. A £572,000 Flood Defence Grant from the Government will fund the project which is being delivered by the Environment Agency.

Hard Engineering

COASTAL FLOOD DEFENCES: REVETMENTS

Revetments are sloping structures built on embankments or shorelines, along the base of cliffs, or in front of sea walls to absorb and dissipate the energy of waves in order to reduce coastal erosion. They can be made of concrete, stone, asphalt or wood, and the height of the revetments is designed to stop waves overtopping the defence. Revetments can be both permeable and impermeable. Permeable revetments are generally built from rock or concrete armour, gabions, and timber. They reduce the erosive power of waves by dissipating their energy as they reach the shore. Impermeable revetments are continuous sloping defences made of stone or concrete which act as a fixed line of defence and are designed to act as a barrier against high tides and storm surges.

Image: cc by-sa /2.0 - Wooden Revetment by Evelyn Simak - geograph.org.uk/p/799647

Advantages and Disadvantages

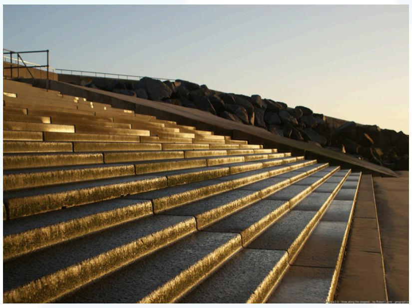

Image: cc by-sa 2.0 - View along the stepped revetment on Dymchurch beach by Robert Lamb - geograph.org.uk/p/5107534

- ✔ Impermeable revetments have a life expectancy of around 30-50 years.
- ✔ They are relatively low maintenance.

- ✘ Revetments are expensive to build, but cheaper than flood walls.
- ✘ They can have a big visual impact on the landscape.
- ✘ They can make some beaches inaccessible to locals and tourists.
- ✘ Erosion at the base of the structure can cause structure failure.
- ✘ They can disrupt natural dune processes.

Case Study: Fairhaven and Church Scar Sea Defence Project

The Fairhaven and Church Scar Sea Defence Project replaced existing sea wall defences which were failing and reaching the end of their expected life span. The old defences were built in the 1890s and required regular maintenance and emergency repairs to prevent a breach. Potential flood wall failure at Fairhaven Lake would mean frequent tidal flooding of low lying areas, buildings, and the embankment before the highway, and at Church Scar would mean rapid erosion and flooding of low lying land at Lytham.

The £22m project was carried out to provide new coastal defences and an upgrade to the promenades along the Fylde coast at Fairhaven, Church Scar and Granny's Bay. Construction work began in March 2018 and was completed in July 2020. The scheme protects around 2,400 residential properties, infrastructure and schools from coastal erosion and flooding and aims sustain economic growth.

Image: cc by-sa 2.0 - The beach and sea defences south of Fairhaven Lake by Alexander P Kapp - geograph.org.uk/p/2850473

COASTAL FLOOD DEFENCES: GROYNES

Groynes are low-lying wood or concrete structures which are situated out to sea from the shore. They are designed to dissipate wave energy, trap sediment, and restrict the transfer of sediment away from the beach through long shore drift. Longshore drift is caused when prevailing winds blow waves across the shore at an angle which carries sediment along the beach. Groynes prevent this process and therefore slow erosion at the shore. They can be permeable or impermeable. Permeable groynes allow some sediment to pass through and some longshore drift to take place. However, impermeable groynes are solid and prevent the transfer of any sediment.

Image: cc by-sa 2.0 - Dovercourt groynes by Bob Jones - geography.org.uk/p/748828

Advantages and Disadvantages

- ✔ Easy to construct.
- ✔ Long term durability and low maintenance.
- ✔ Reduce the need for the beach to be maintained through beach nourishment and recycling of sand.

- ✘ Wooden groynes are less durable than rock groynes.
- ✘ Can have a negative, visual effect on the landscape.
- ✘ Prevent sediment being transported to beaches further down the coast and therefore increase the amount of erosion and sediment loss at those beaches.
- ✘ The down drift erosion caused by the groynes may cause the need for regular maintenance and beach nourishment on the downstream side.

Case Study: Walney Island, Cumbria

Image: cc by-sa 2.0 - Walney Island Groynes by Rob Farrow - geography.org.uk/p/3711839

Walney Island is a narrow island off the west coast of England, which forms a part of Barrow-in-Furness. The island is home to 13,000 residents and is approximately 11 miles in length and covers 5 square miles. The island is relatively narrow at points, with the narrowest section being 250 metres wide.

The west coast of the island is exposed to the Irish Sea and the east coast has many low-lying wet marshlands. Exposure to high tides and storm surges has caused progressive coastal erosion over time as well as extreme flood events. Often, these flood events have been capable of breaching the narrowest parts of the island, separating the south of the island from the north, and at times this has cut off access to the more rural communities and businesses. In order to reduce flood risk and limit the amount of coastal erosion, wooden groynes have been built along the coastline. It is hoped that these defences will also prevent the island being divided during high tides.

COASTAL FLOOD DEFENCES: BREAKWATERS

Breakwaters are offshore sloped or vertical concrete walls designed to reduce the erosive power of waves out at sea so that once they reach the shore the wave energy is reduced. An additional benefit of breakwaters is that they create calmer waters for ships. Breakwaters can be made from rock, stone or concrete and some run parallel to the shoreline.

Advantages and Disadvantages

- ✔ Reduce the amount of long shore drift which prevents the transport and erosion of sediment along the shore.
- ✔ Low maintenance.
- ✔ Provide good protection for bays.
- ✔ Do not prevent natural dune processes from taking place.

Image: cc by-sa 2.0 - Douglas Breakwater by Andrew Abbott - geograph.org.uk/p/3160449

- ✘ Not aesthetically pleasing.
- ✘ Expensive to build.
- ✘ Can cause strong currents which may be hazardous to the public.
- ✘ During periods of high tide, can be over-topped, effectiveness reduced, and dangerous to the public walking along them as they could get trapped.
- ✘ Risk of being destroyed during storm events with expensive repair and maintenance costs.

Case Study: Fish-tail groynes/breakwater in Morecambe

Morecambe is located on the North West coast of Lancashire. The area has always been at risk from coastal flooding and erosion through coastal storms and high tides. In order to limit the amount of coastal flooding, erosion and sediment transportation, fish-tail groynes have been built using limestone blocks out to sea from the shore to dissipate wave energy and retain sand on the beach. The groynes prevent the process of longshore drift so that sediment isn't transported further down the bay away from Morecambe. The groynes are very similar to breakwaters in terms of size and design. The groynes have reduced wave energy considerably, and as a result sediment accretion on the beach has shifted from coarse material to silts and clays.

Image: cc by-sa 2.0 - Fish-tail groyne Morecambe by Ian Taylor - geograph.org.uk/3236944

COASTAL FLOOD DEFENCES: SEA WALLS

Sea walls are a solid barrier made from concrete, masonry, or gabions and are designed to prevent high tides and storm surges reaching inland and causing flooding. They can have a variety of profiles such as sloped, stepped or vertical, and are designed to withstand the force of waves for around 30 to 50 years. A number of sea walls have been constructed across the UK to reduce the risk of flooding, however, they require frequent maintenance so that they don't fail.

Image: cc by-sa 2.0 - Sea Wall below Highcliffe Castle Golf Club by Fernweh- geograph.org.uk/p/782406

Advantages and Disadvantages

- ✓ Provide good, short to medium term protection.
- ✓ Protect property, people and leisure/economic facilities from coastal flooding and erosion.
- ✓ Allow development of property and facilities up to the shore line.
- ✓ Prevent the base of cliffs being eroded, reducing the risk of rock falls and collapse.

- ✗ Very expensive.
- ✗ The force of tidal waves can scour away and erode ground beneath the wall, which can lead to failure and collapse.
- ✗ Require ongoing maintenance in the long term to ensure they are not affected by issues such as climate change.
- ✗ Can have a negative effect on the visual aspect of the landscape.

Case Study: Rossall and Anchorsholme, Lancashire

Image: cc by-sa 2.0 - Mary's Shell to Rossall by Carroll Pierce - geograph.org.uk/p/7164949

The £63million coastal defence scheme was officially opened in June 2018 and is designed to protect and reduce the risk of flooding to 7,500 homes, the town's tramway, schools and hospitals. The project was led by Wyre Council, the Environment Agency and Balfour Beatty and is made up of two kilometres of sea walls designed to hold back major storm waves from the Irish Sea for the next 100 years. The walls have also been designed to protect against the effects of future climate change and sea level rise. The scheme has improved the local environment by creating a new ecology park on the landward side of the defences, increasing biodiversity, improving the visual aspect and improving the environmental footprint. It is already classed as a Biological Heritage site due to the rarer species of flora and fauna that grow in the park.