Robin Hood’s Bay: Coastal erosion and geology

Robin Hood’s Bay has a history of coastal erosion and landslides. In 1780 much of the original road into the village, King Street, was lost and since 1780 more than 200 properties have been lost as a consequence of cliff top recession. Up to 22m of coastline has been lost since 1895 particularly near the Victoria Hotel and the main road into the village.

The Problems

The main problems are:

- the condition of existing coastal defences on the southern section of the village
- coastal erosion and slope instability along the unprotected sections of coast adjacent to the northern part of the village

It is mainly exposure to wave action which is causing the slow retreat of the coast. The dominant waves are from the north and northeast where the fetch is over 1500 km long. The main wave energy therefore runs southwards, straight along the northern cliff face and impacts almost directly on to the village frontage.

Profiles of the cliffs show that geomorphological influences are significant. There is evidence of active slope erosion, cliff-top recession and slope instability. Movement within the clay slopes above the sea cliffs is dependent on retreat of the lower sections of the sea cliffs. As the cliffs retreat, landslides on the mid-slope section lose support from beneath and reactivation of landslips may occur with the till slopes degrading to a more stable slope angle. The movement affects localised areas of the slope with loss of land at the top of the slope as witnessed by realignment of the coastal cliff path. The movement tends to occur as ‘one-off’ slips rather than being a continuous, gradual process.

Recession rates depend on the strength of the underlying rocks. An average rate of 0.3m per year is given for Robin Hood’s Bay but this is likely to increase in the future compared to historic rates due to climate change.
Coastal Defences

The building of the large concrete wall in 1975 has largely stopped erosion along the southern part of the village but instability still occurs in places higher up the cliff above the defences. The wall acts as a retaining wall and a coastal defence structure but it is now in poor condition in places, with several visible defects and undercutting at the toe. There is also potential for outflanking at its western end where it joins a short section of exposed cliff.

The old stone walls either side of the slipway, built before 1890, are showing a number of large cracks which also need attention. If nothing was done to repair and strengthen these defences, eventually the processes of coastal erosion and slope instability would recommence. As a consequence, some 44 properties in this location would become affected by coastal erosion over the next 100 years.

Due to landslides on the steep slope below the upper village during the 1990s the construction of new sea defences were undertaken in 2000. The new defences include the new concrete wall at beach level just below West Scar. This new wall is backfilled with gravel and its front is protected by rock armour. The slope above the seawall has also been regraded.

Rock armour was also extended 200m south of the old village to help reduce landslide movements.

North of the sea walls the cliffs are unprotected and exposed to wave attack. Here, marine and seepage erosion are ongoing causing landslides on the glacial till slopes above the cliffs. These processes have led to intermittent cliff top recession. At present the rear cliff top is visibly encroaching into the Victoria Hotel gardens and is extremely close to the road which provides the only road access into the village.

Could / Should Anything Be Done About Coastal Erosion?

Robin Hood’s Bay is an important tourist attraction because of its unique character and cultural heritage and the outstanding beauty of the surrounding countryside and coastline.

Robin Hood’s Bay is within:
- the North York Moors National Park
- the North Yorkshire and Cleveland Heritage Coast
- a Site of Special Scientific Interest (SSSI) designated for its important geological interest
- a Special Area of Conservation (SAC) designated for its plant communities important within Europe.
The Cleveland Way National Trail runs through Robin Hood’s Bay and the Coast to Coast path from Cumbria finishes in Robin Hood’s Bay. The village’s character, its cultural heritage and its geological significance are important to the tourist industry of the whole region and as a vital and sustainable coastal community.

Continued recession in this area would result in the loss of 18 residential properties over the next 100 years and endanger the only road access into the lower village. The first losses are predicted in around 30 years based on long term average recession rates. However, the type of recession is likely to be a major landslip that would affect an extensive area of land in a single event and the timing of such an event is difficult to predict. It could result in direct losses arising from the loss of cliff top land and property, together with services and infrastructure with an estimated value of £5.89m. Indirect losses arising as a consequence of instability following a major event could total £17m together with substantial impacts on tourism and the local economy.

In recognition of the risks from coastal erosion to people, the village and the environment, a strategy for coastal defence has now been developed.

**Robin Hood’s Bay Coastal Defence Strategy**

In recognition of the risks from coastal erosion to people, the village and the environment, a strategy for coastal defence has now been developed. It took several years of studies, monitoring the coast line and public consultations for the strategy to be developed and agreed by a wide partnership of agencies including Scarborough Borough Council, The Environment Agency and The National Park Authority. The strategy is a plan to manage the risks from coastal erosion in a sustainable way. This means protecting or managing the people, the village and the environment in a way which is affordable. The table below shows the options available.

<table>
<thead>
<tr>
<th>Management Options</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>No Active Intervention</td>
<td>Walk away and undertake no further management</td>
</tr>
<tr>
<td>No Active Intervention</td>
<td>Walk away and undertake no further management other than for public safety</td>
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<tr>
<td>Active Intervention –</td>
<td>Defences, where present, are maintained but risks increase over time due to climate changes</td>
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<tr>
<td>Maintain Defences</td>
<td></td>
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<tr>
<td>Active Intervention –</td>
<td>Defences, where present, are maintained and raised / strengthened in line with climate changes to keep risks at present-day levels</td>
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<tr>
<td>Sustain Defences</td>
<td></td>
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<tr>
<td>Active Intervention –</td>
<td>Defences, where present, are maintained and improved or, where not present, are newly constructed to reduce risks below present-day levels</td>
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<tr>
<td>Improve Defences</td>
<td></td>
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<tr>
<td>Advance the Line</td>
<td>New defences are constructed seaward of presently undefended frontages</td>
</tr>
<tr>
<td>Managed Realignment</td>
<td>Realigning or removal of existing defences</td>
</tr>
<tr>
<td>Adaptive Management</td>
<td>Monitoring undefended cliffs and coastal slopes and adapt to changes (e.g. emergency plans and property roll-back)</td>
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The action that was finally agreed is:

- **‘Adaptive Management’ in the northern section of the village and ‘Active Intervention Maintain Defences’ in the southern section.**

This means that there would be no new defences built along the coastline but existing defences would be maintained. With climate change this means that defences would continue to be maintained for 60-90 years (through capital improvement schemes at around 30 year intervals), after which the standard of service provided by the defences would reduce over time.

The risks to people and property in the undefended northern section of the village would be managed initially through cliff top and foreshore monitoring and drainage and ground investigations. The diversion of surface water that is out-falling at the cliff could potentially delay erosion.
to the 18 properties in the northern part of the village. At an appropriate future time, depending on results of the monitoring investigations, a property roll back scheme would be implemented. This would involve abandonment of up to 18 properties over the next 100 years and allowing for replacement buildings on the property owners’ land or other land that could possibly be released by The National Park Authority in liaison with Scarborough Borough Council.

The Geology of Robin Hood’s Bay

The shape of this beautiful bay is due to the underlying rocks and to the different rates at which they have, and continue to be, eroded.

The rocks that have created Robin Hood’s Bay are mostly sedimentary shales, mudstones and sandstones. These sediments were deposited in seas and river deltas between 200 and 150 million years ago during the Jurassic Period. Then, around 70 million years ago, earth movements pushed these layers of rock upwards to form a rounded dome shape. The top of the dome has gradually been worn away by erosion leaving a rocky platform exposed. At low tide a pattern of long, curved ridges and troughs (scaurs) is visible. These are all that remain of the layers of rock that were pushed up into the dome shape. The scaurs reflect the different rates of erosion of different shales and the structure of the dome.

The oldest rocks in the bay are shales and mudstones of the Lower Jurassic. Being relatively soft much of these have been eroded away to create the inlet of the bay. On top of these are younger layers of harder sandstones and soft mudstones from the Middle Jurassic. The harder sandstones are more resistant to erosion and form the rocky sea cliffs to the north and south of the bay. Differences in rock type influence the shape of the coastline - steep slopes and cliffs correspond to the more resistant rocks such as sandstone; gentler slopes are more typically formed from shale and clay.

On top of these Jurassic rocks is a layer of till (boulder clay) deposited by glaciers towards the end of the last Ice Age around 10,000 years ago. The glacial till varies considerably in thickness and composition and contains particles of silt, sand and gravel plus pebbles and boulders of all sizes held together by red clay. Much of this material is from the local area but some has been transported many miles by glaciers.
On the beach you can find a great variety of pebbles including granite from Shap in Cumbria, limestone from the Pennines, dolerite from Northumberland and even rhomb porphyry from Scandinavia.

There is little in terms of beach sediments as the shore mainly comprises the exposed rock platform, although there are some small sandy beaches at the bottom of the cliff. Although there is some movement of material southwards between shoreline features, there is little evidence of significant sediment transport along the actual shoreline.

The coastal cliffs and rocky shore are one of Britain’s classic localities for geological study and have been studied by geologists for over 200 years.

Here there is a continuously exposed sequence of Lower Jurassic rocks in which a variety of different types of ammonite fossils has been found. Ammonites evolved relatively quickly and scientists have identified specific species that lived only during specific time periods. These ‘index species’ can be used to date rocks - a study called biostratigraphy. The Robin Hood’s Bay ammonite fossils are of great importance as they help scientists to work out the age of other Jurassic rocks in Europe.

A great variety of other valuable fossils have also been found here including marine reptiles such as ichthyosaurs and crocodiles, some of which can be seen in Whitby Museum.

**Effect of coastal erosion on Geological Interest**

Natural England has stated that geologically designated SSSIs should be allowed to erode naturally as there is potential to expose new geological interest features, and this is viewed by Natural England as a positive impact. Stabilisation of rock outcrops is considered to have a negative impact on the SSSI. As such, the approach of Adaptive Management along much of the frontage is considered likely to have a positive impact on the geological interest features of the SSSIs.

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