.8 Holderness and coastal erosion

In this section, you'll learn why and how rates of coastal erosion vary, plus the problems that this can cause.

Yorkshire is disappearing up to three times as fast

A dry spring and a soggy summer have been blamed for the sharply increased coastal erosion along Yorkshire's eastern flank, bordering the North Sea.

Engineers from the East Riding of Yorkshire District Council have been out surveying their stretch of collapsing cliffs, south of Bridlington. The results vary, but in places the county's coastline has retreated – that is, has eroded – by a startling 7 metres in just a year.

As a result, more properties teetering above the beach have been added to the list of homes no longer considered safe. Retired couples in Aldborough, 10 km south of Hornsea, face almost certain evacuation.

Adapted from *The Guardian*, September 2012

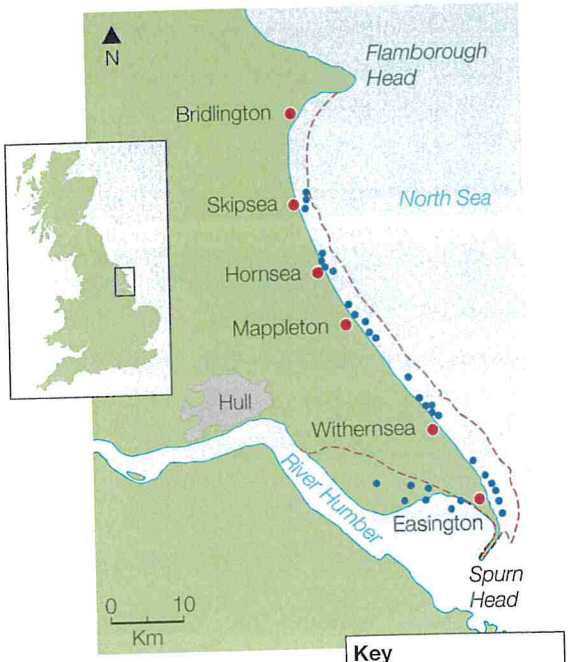

Figure 1 *How Holderness has changed since Roman times*

The Holderness coast ... going ... going...

For centuries, erosion has been a problem along the coast of the East Riding of Yorkshire, known as Holderness, which stretches between Bridlington and Flamborough Head in the north, and Spurn Head in the south. It has the fastest-eroding coastline in Europe. On average, it loses nearly 2 metres of coastline every year. Since Roman times, the Holderness coast has retreated by 4 km – and at least 29 villages have been lost to the sea (see Figure 1).

Figure 3 *The chalk cliffs at Flamborough Head*

Why is erosion such a problem at Holderness?

Rates of coastal erosion vary, due to a range of physical and human factors – all of which can change in both the short- and the long-term.

However, there are three main reasons why the coastline at Holderness is retreating so rapidly:

- geology
- fetch
- longshore drift and beach material.

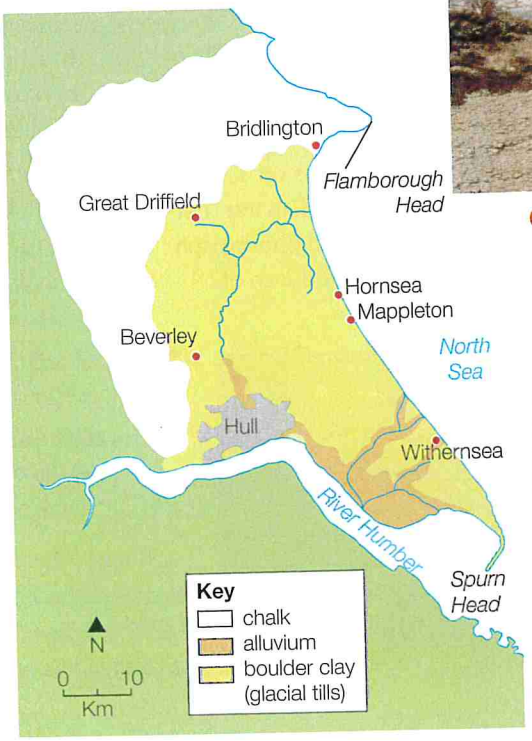

Figure 2 *The geology of the Holderness coast*

Figure 4 *Holderness – low, unstable cliffs composed of boulder clay*

Geology

- Most of the Holderness coast consists of **boulder clay** (see Figures 2 and 4). Boulder clay is also known as glacial till, or drift, and is a mixture of fine clays, sands and boulders deposited by glaciers after the last Ice Age. Boulder clay is structurally weak, and has little resistance to erosion. It produces shallow, sloping cliffs between 5 and 20 metres high.
- The chalk band that surrounds the boulder clay (see Figure 2) has created a headland at Flamborough Head (see Figure 3). Erosion along fault lines and bedding planes has created features such as cliffs, arches and stacks.

Fetch

One of the main factors affecting the rate of erosion is wave energy. This, in turn, depends on the fetch (how far the waves have travelled). Holderness is exposed to winds and waves from the north-east, with a small fetch of about 500–800 km across the North Sea. That isn't far – compared to the fetch of waves crossing the world's oceans – but the waves attacking the Holderness coast are also influenced by other factors, which help to increase their size and power:

- Currents (or **swell**) circulate around the UK from the Atlantic Ocean into the North Sea (see Figure 5). The Atlantic's fetch is 5000 km or more, so its currents add energy to the waves in the North Sea. Therefore, there are often powerful **destructive waves** at work along this coastline.
- Low-pressure **weather systems** and winter storms passing over the North Sea are often intense – producing locally strong winds and waves (see Figure 6). Low-pressure air weighs less, raising sea levels, which in turn produce much higher tides than normal (that reach the cliff base).
- Small, almost-enclosed seas (such as the Mediterranean and North Sea) often generate huge waves during storms. Waves move within the sea, but cannot disperse their energy – rather like water slopping up against the side of a washbasin.
- The **sea floor** is relatively deep along the Holderness coast, so waves reach the cliffs without first being weakened by friction with shallow beaches.

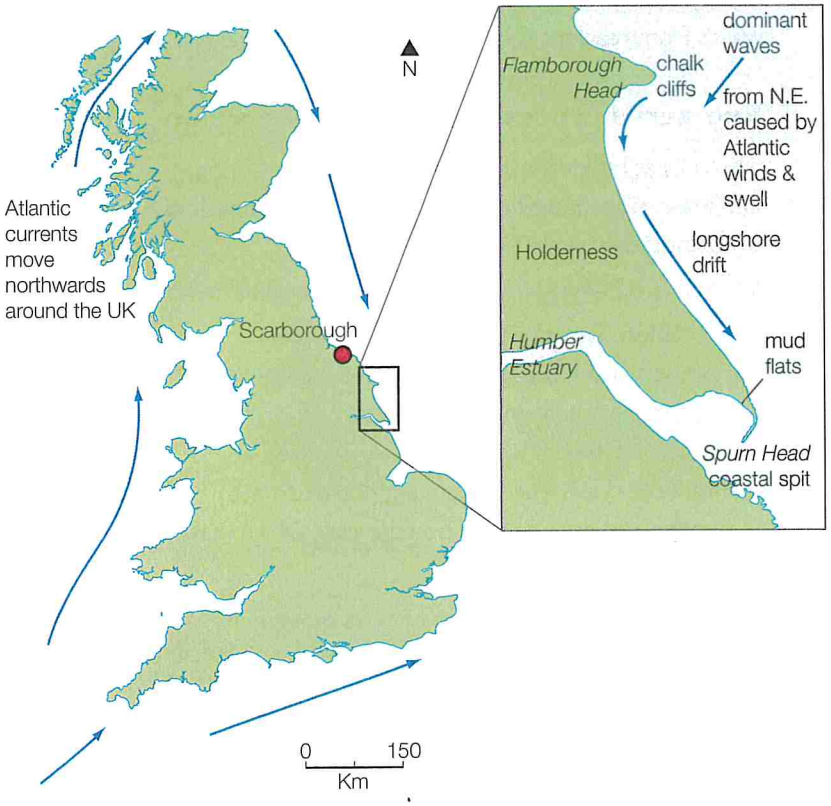

Figure 5 *The fetch of the Holderness coast, and the additional swell circulating from the Atlantic*

Figure 6 *North Sea storm waves at Scarborough, just north of Holderness*

Longshore drift and beach material

- The beaches at Holderness are its main problem. The boulder clay erodes to produce mainly clay particles, which are fine and easily transported out to sea in suspension, rather than accumulating on-shore as beach sand. Although there are beaches, they are narrow and they offer little friction to absorb wave energy. Plus, there is never enough sand to stop the waves from reaching the base of the cliffs at high tide.
- The tides flow southwards (see Figure 5 inset) – transporting sand south by **longshore drift** (see page 112), and leaving the cliffs at Holderness poorly protected against wave attack. Beaches south of Hornsea have reduced in width, because an imbalance exists between the input of sand (deposited by swash) and the removal of sand (by backwash).

Sub-aerial processes and coastal erosion

The cliffs at Holderness are affected by weathering and mass movement (collectively known as sub-aerial processes; see page 118).

- Chemical weathering is relatively ineffective at Holderness, except on the chalk cliffs at Flamborough Head. Mechanical and biological weathering are far more significant.
  The main types of weathering experienced at Holderness are freeze-thaw and the alternate wetting and drying of the boulder clay, which makes it crumbly in dry periods.
- **Slumping** is the main form of mass movement affecting the boulder clay cliffs at Holderness. The alternate wetting and drying of the clay causes expansion and shrinkage – producing cracks during long, dry periods. Subsequent rains then enter the cracked clay and percolate into the cliff, which becomes lubricated and much heavier. The weakened cliff cannot support the extra weight, and the clay slides downslope under gravity. The slumped material collects at the cliff base (see Figure 7) and is then removed by the sea – causing the cliff line to retreat.

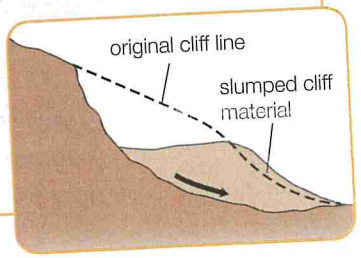

Figure 7 *Slumping in action*

Human actions and coastal retreat

It's not just physical factors that affect coastal retreat. The **actions** that people and organisations (collectively known as **players**) take can impact on coastal retreat – and the outcome isn't always positive.

BACKGROUND

Key players on the Holderness coast

1 Central government agencies

The Environment Agency is responsible for coastal management (along with the local authorities). Its budget from central government has been cut since 2010.

2 Local government

The local authorities are jointly responsible for coastal management with the Environment Agency. However, in 2010, local-government funding was cut by central government, which restricted local councils to minimal increases in Council Tax.

3 Stakeholders in the local economy

- The tourist industry (including campsites) wants greater spending on coastal protection.
- Farmers want money spent to protect their farmland, which is of lower value than urban spaces.
- Residents at, for example, Hornsea and Mappleton want guaranteed coastal protection for their homes and businesses.
- Insurance companies are increasingly refusing to insure vulnerable properties.

4 Environmental stakeholders

English Nature and the RSPB want to protect Spurn Head (one of the UK's largest coastal spits), so a continuing flow of sand southwards by longshore drift is essential. One of the most-important assets of this spit is the protection that it gives to the mudflats of the Humber Estuary (one of the UK's most important birdlife reserves).

The impact of coastal management

The graph in Figure 8 shows erosion rates opposite the locations to which they relate. The gaps on the graph show where coastal defences are preventing erosion. However, the graph also shows that higher rates of erosion occur immediately to the south of those same coastal defences. For example, the sea wall, groynes and rock armour at Hornsea (see below) protect part of the coast, but they also interrupt the flow of beach material by longshore drift. The beach downdrift of Hornsea, at Mappleton, is then starved of material and its cliffs are exposed to wave attack. This is known as **terminal groyne syndrome**, and it affects many UK coasts.

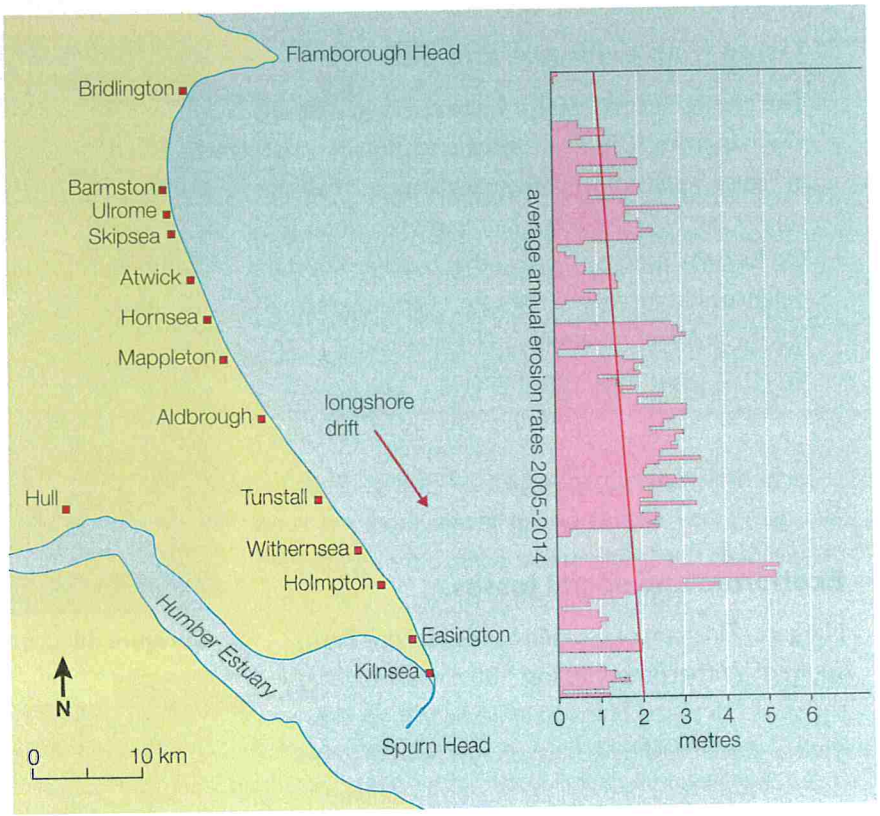

Figure 8 *Erosion rates along the Holderness coast, 2005-2014*

- The first sea wall was built at Hornsea in 1870. It lasted for 6 years.
- In 1906, a stronger sea wall was built. It has now been extended five times.
- At the southern end, the defences were reconfigured in 1977. The T-shaped rock armour structure is designed to allow beach sediment to accumulate and pass behind it.
- The groynes built at Hornsea starved Mappleton (further south) of sediment. By the 1990s, nearly 4 metres of cliff were being eroded at Mappleton each year.

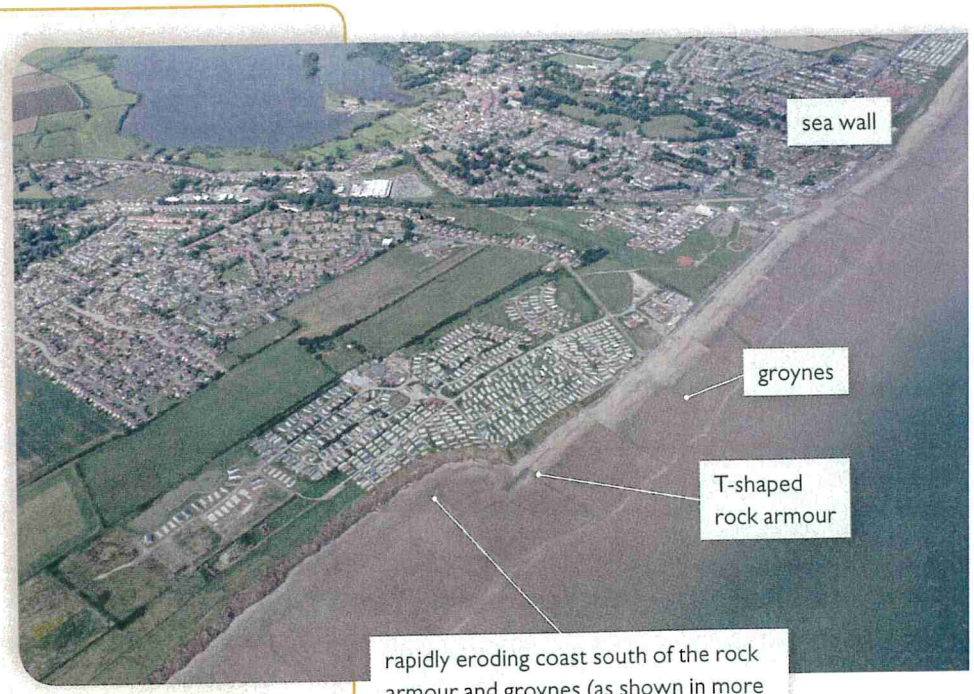

Figure 9 *Hornsea – coastal defences*

Figure 11 on page 130 shows the position of the cliff top at Hornsea at different dates between 1854 and 2005. It illustrates that coastal retreat remains a continuing problem along this stretch of coast – in particular, immediately south of Hornsea's coastal defences, where the cliff top has retreated significantly since 1977-8 (when the rock armour was built).

Using map evidence and GIS

The photo in Figure 10 has been overlain with an OS map from 1852. It shows the section of coast in Figure 9 just south of the rock armour. You can clearly see how the coast has retreated since 1852. On its own, it doesn't prove that building coastal defences has increased the rate of coastal retreat – but if you look at it alongside Figures 8 and 11, the evidence becomes overwhelming.

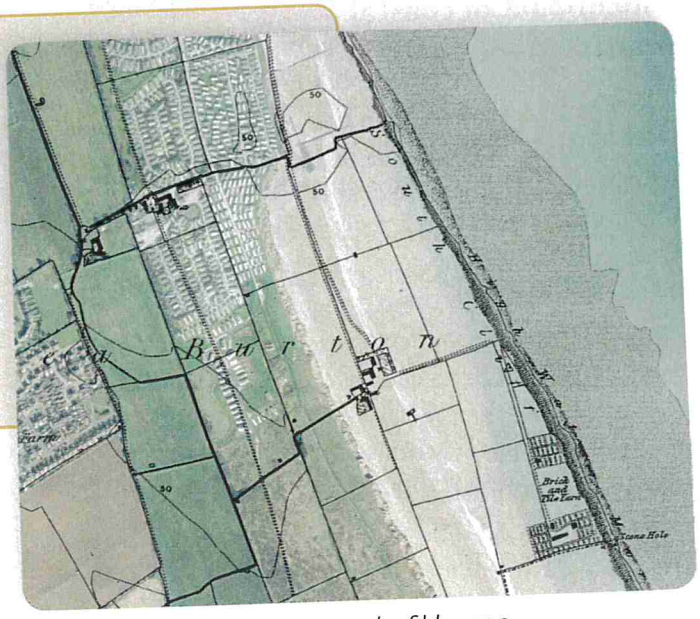

Figure 10 *Coastal retreat south of Hornsea*

Economic and social losses

Margaret Fincham of Golden Sands Holiday Park, south of Withernsea, has lost 100 chalets to the sea in 15 years. She said *'If we hadn't lost the chalets, there could have been an extra 400 people visiting Withernsea and helping the local economy.'*

Withernsea isn't alone in suffering **economic** losses due to coastal erosion. It is predicted that 200 homes and several roads will fall into the sea between Flamborough Head and Spurn Point by 2100 (see Figure 12). Nationally, The Environment Agency suggests that 7000 homes will disappear due to coastal erosion by the same date.

Individuals lose out both **socially** and **financially** as a result of coastal erosion, and very little financial help is available for them. No compensation is paid out for the loss of private property or land caused by coastal erosion in England.

Between 2010 and 2012, the East Riding of Yorkshire Council used £1.2 million of direct money from Defra to trial different ways of helping people adapt to living on an eroding coastline. They gave some financial assistance to 36 households along the coast, supported 16 relocations and 43 property demolitions. The remainder of the money was used to help residents through the relocation and adaptation packages described on page 131.

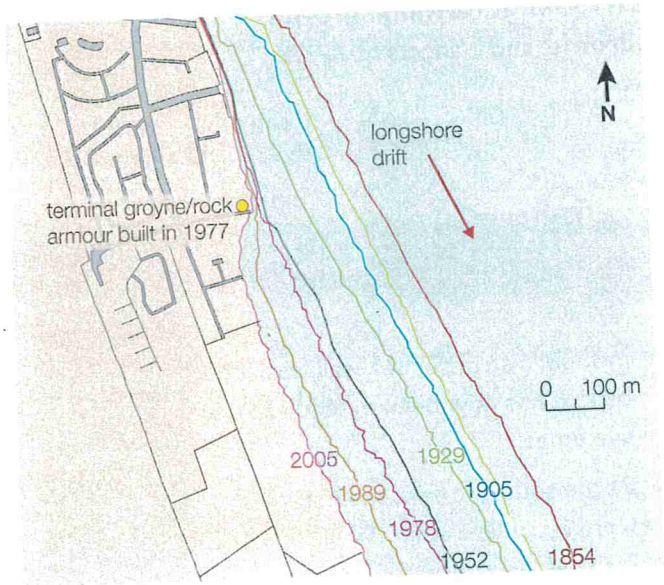

Figure 11 *Cliff top positions at Hornsea, 1854-2005*

Figure 12 *Homes and caravan parks are under threat on the Holderness coast*

East Riding Coastal Change Fund

This fund offers some limited help in terms of financial assistance, as well as free advice for those residents affected by coastal erosion. Its **relocation package** can fund:

- the demolition costs for a property
- some relocation costs (e.g. hiring a removal van) – up to a maximum of £1000.
- the expenses caused by relocating to a new home – up to a maximum of £200.

The fund also offers an **adaptation package**, which can help to pay for:

- rollback – the expenses incurred as a result of an individual's decision to replace a threatened coastal property with a new home inland. But it only covers things like planning application fees. Rollback was introduced particularly to address the risk to caravan parks, farms and homes in areas where coastal defences are not viable.
- assistance grants – to adapt properties which may be at risk from coastal erosion in the future (e.g. relocating septic tanks/waste pipes, and changing the access routes to some properties).

Over to you

1 In pairs, draw a large map of Holderness to show its main physical and human features. Add details about:
- its geology and where most erosion is taking place
- the influence of fetch, wave size, and tides
- the direction of longshore drift and the features produced.

2 Still working in pairs, copy and complete the following table to classify human and physical factors that influence the rate of coastal erosion.

	Human	Physical
Short-term (i.e. a season, or a one-off event)		
Medium-term (i.e. from months to a few years)		
Long-term (i.e. many years or decades)		

3 Design a spider diagram to show (**a**) the economic and (**b**) the social impacts of erosion along the Holderness coast.

On your own

4 **a** Copy Figure 7 in Section 5.12 (the conflict matrix). Complete the players for the examples in this section about coastal erosion at Holderness.

b Identify which groups at Holderness (**a**) agree and (**b**) disagree, and explain why this might be.

5 Google the phrase 'East Yorkshire coastal erosion Hull University' for its display of photo strips of the Holderness coast. Using strips TA47 and TA48, assess erosion rates at Hornsea.

6 **a** Using Figure 11, take two transects from the cliff top to the shoreline. Then copy and complete the table below for each transect, in order to calculate the average rates of erosion per year for each of these seven time periods.

Time periods	Number of years	Erosion in metres	Erosion per year
1854-1888			
1888-1905			
1905-1929			
1929-1952			
1952-1978			
1978-1989			
1989-2005			

b Plot the rate of erosion per year on a graph. How have rates of erosion changed?

c Based on the current rate of erosion, estimate how much additional land is likely to be lost to the sea by 2025.

Exam-style questions

AS 1 Assess the impacts of coastal management along one stretch of coastline. *(12 marks)*

A 2 Assess the relative importance of factors which have led to rapid coastal erosion along a stretch of coastline. *(12 marks)*