3.10 Coastal processes on the Holderness coast

In this case study you will apply coastal processes and landscape outcomes to a coastal environment at a local scale and also engage with field data

Case study

The Holderness coastal system

The Holderness coast is a well-known stretch of coastline in eastern England. It forms a subcell in Sediment Cell 2 (Figure **2**, 3.1) and essentially comprises three distinct coastal units (Figure **1**):

- Flamborough Head in the north, a chalk promontory that exhibits many typical landforms associated with coastal erosion
- Bridlington Bay to Spurn Head, an extensive zone of erosion and sediment transfer characterised by a very rapid rate of cliff retreat
- Spurn Head, a classic spit formed at the estuary of the River Humber.

Within this subcell, the main input is erosion of the weak and unconsolidated till cliffs. Some of the finer sediment is washed offshore to form an output from the system while the slightly coarser material is moved southwards as a transfer involving longshore drift. Some sediment is deposited to form Spurn Head, while a significant amount continues south towards the Wash and East Anglia.

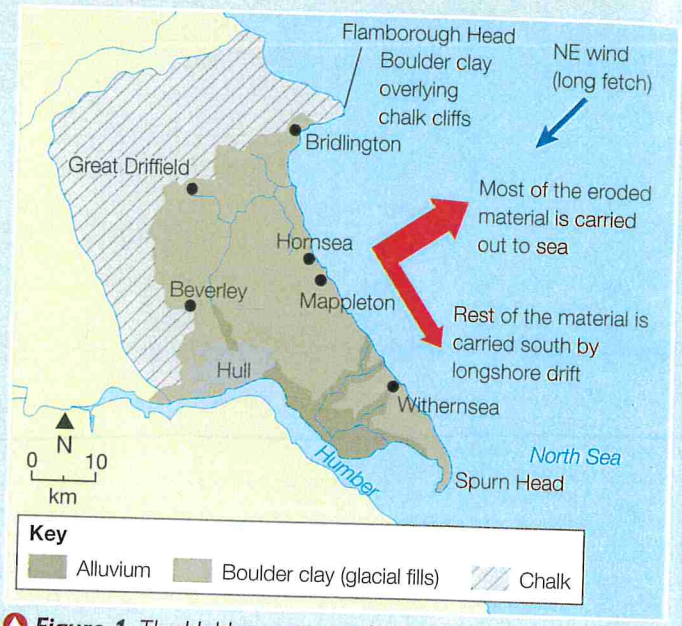
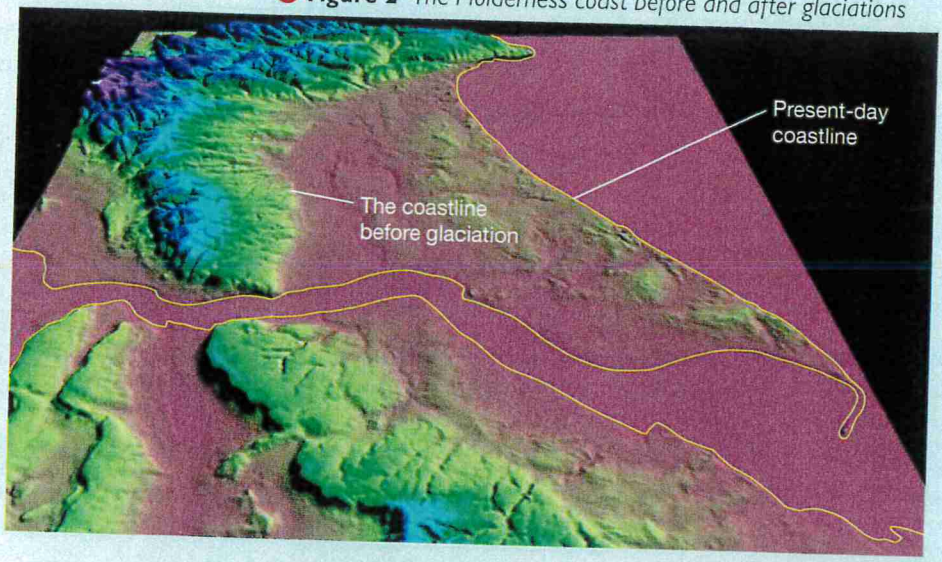


Figure 1 *The Holderness coastal system*

Factors affecting the coastal system

Geology is an important factor affecting the processes and landforms of the Holderness coast. Chalk, a relatively resistant rock, forms a broad arc in the region, stretching from the Lincolnshire Wolds in the south to the coast at Flamborough Head. Notice in Figure **2** that the eastern edge of the chalk outcrop formed the preglacial coastline and that the great sweep of the present day coastal zone is the result of sediment carried and dumped by ice sheets originating from Scandinavia. As sea levels rose at the end of the last glacial period, the North Sea took shape and started to erode the thick till deposits to help form the present-day cliffs.

Figure 2 *The Holderness coast before and after glaciations*



When the wind is blowing from the north-east (direction of greatest fetch), it can drive powerful waves towards the Holderness coast. Occasionally, areas of extremely low pressure move down the North Sea, funnelling water and creating storm surges several metres high. These low-frequency, high-magnitude events can lead to significant erosion and flooding – in 1953 more than 300 people lost their lives along the east coast of England during such an event. As a result of these powerful north-east waves, longshore drift operates from north to south along the Holderness coast.

In response to the rapid rate of erosion and the threat to settlement and infrastructure, parts of the coastline have been protected with hard-engineering structures such as sea walls, rock armour and groynes (see 3.9). Although these interventions have helped to protect specific localities, such as Hornsea and Mappleton, they have deprived areas further south of sediment, thereby exacerbating coastal erosion. The lack of a beach renders cliffs much more vulnerable to undercutting and collapse (Figure **3**).

Figure 3 *Recent erosion threatening the settlement of Skipsea, where rates of erosion are 2 metres a year*

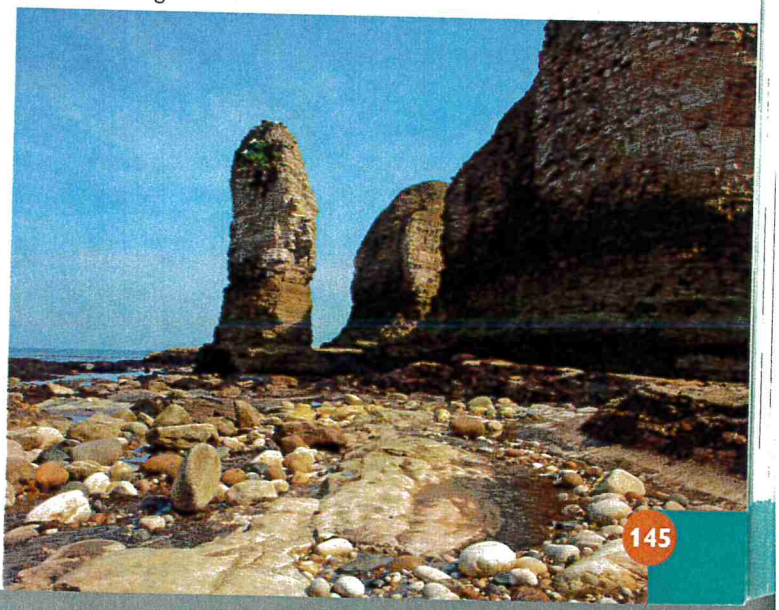
Flamborough Head

Jutting into the North Sea from the east coast of England, Flamborough Head is one of the most recognisable features on a map of the UK (Figures **1**, **4** and **5**). The main reason for the formation of the headland is because it is made of chalk – a resistant, sedimentary rock.

Chalk has a very distinctive white colour, as can be seen in Figure **4**. The layers or beds of the chalk are clearly visible and are roughly horizontal (Figure **5**). Vertical cracks run through the chalk (*joints*). In some places whole sections of chalk have been displaced along lines called *faults*. These joints and faults are weaknesses in the chalk, which are readily exploited by the processes of weathering and erosion to form narrow clefts in the coastline. One major faultline has been exploited to form Selwick's Bay (Figure **4**).

Figure 4 *Distinctive chalk cliffs at Selwicks Bay, Flamborough Head*

Figure 5 *Landforms of coastal erosion at Flamborough Head*



The sea is actively eroding and undercutting the base of the cliffs leading to frequent rockfalls. The high tide line is clearly shown by the dark staining at the foot of the cliffs in Figure **5**. Over time the cliff retreats, forming wave-cut platforms and stacks.

When waves approach the coastline they are bent or refracted by the shape of the coast. The waves are therefore curved and have low energy in the bay, resulting in a deposited beach. The more exposed headlands bear the full force of the incoming waves – this is why they are often characterised by steep cliffs and other features of coastal erosion.

Case study

Bridlington Bay to Spurn Head

This stretch of coast has retreated by up to 5 km since Roman times, which accounts for the loss of several settlements and ports by erosion. With rates of erosion in excess of 1 m per year (and up to 10 m per year in places), the Holderness coast has one of the most rapid rates of erosion in Europe.

Although erosion creates threats, it does generate a vast amount of sediment that feeds the sediment cell. Much of the finer sediment is carried offshore but a great deal of coarse sediment is transferred by longshore drift to the south, building up beaches and reducing erosion (a negative feedback for the system).

Spurn Head itself is nourished by this sediment transfer and it has an important role in protecting the towns and land bordering the River Humber from the effects of storm waves and flooding. Further south, the Wash is an important sediment sink protecting towns such as King's Lynn. There is even evidence that some sediment from Holderness ends up on the coast of the Netherlands, helping to protect it from flooding. This is a massive planning conundrum – should erosion be halted to protect a few houses and agricultural land or should it be allowed to continue because it is a vital source of sediment?

Figure 6 *Rapidly eroding cliffs on the Holderness coast*

Several factors account for the rapid rate of erosion of the Holderness coast:

- long fetch and powerful waves from the north-east
- weak and unconsolidated till cliffs
- extensive mass movement, especially slumping, caused by undercutting and saturation of clay within the cliffs
- narrow beach making the cliffs vulnerable to wave attack and undercutting
- lack of coastal defences.

Spurn Head

Spurn Head spit represents a temporary sediment store or sink (Figure **7**). Much of the material that forms the spit is derived from the Holderness coast and is transferred south by longshore drift. On reaching the River Humber estuary, the deposited sediment grows out to form a narrow finger of new land. Notice its curved tip resulting primarily from direct wave action.

Spurn Head is extremely narrow for much of its length and has frequently been breached and destroyed by major storms (hence its classification as a temporary store). It first formed some 8000 years ago at the end of the last glacial period and evidence suggests that the feature has gone through a number of cycles of growth and decline, lasting on average about 250 years.

Following a massive breach in 1849, groynes and revetments (wooden barriers) were erected to stabilise the spit. In subsequent years, when military forts were established at Spurn Point, the Royal Engineers took over the task of maintaining coastal defences. In the 1950s the military left and, in 1960, the spit was bought by the Yorkshire Naturalists' Trust. Unable to afford the maintenance costs of the spit, the Trust had to allow some of the sea defences to fall into disrepair. When the largest tidal surge in 60 years hit Spurn Point in 2013, the defences could not cope – buildings were destroyed and the access road swept away.

Figure 7 *Spurn Head from the air*