The Physical and Human Causes of Erosion

The Holderness Coast

By The British Geographer

Situation

The Holderness coast is located on the east coast of England and is part of the East Riding of Yorkshire; a lowland agricultural region of England that lies between the chalk hills of the Wolds and the North Sea.

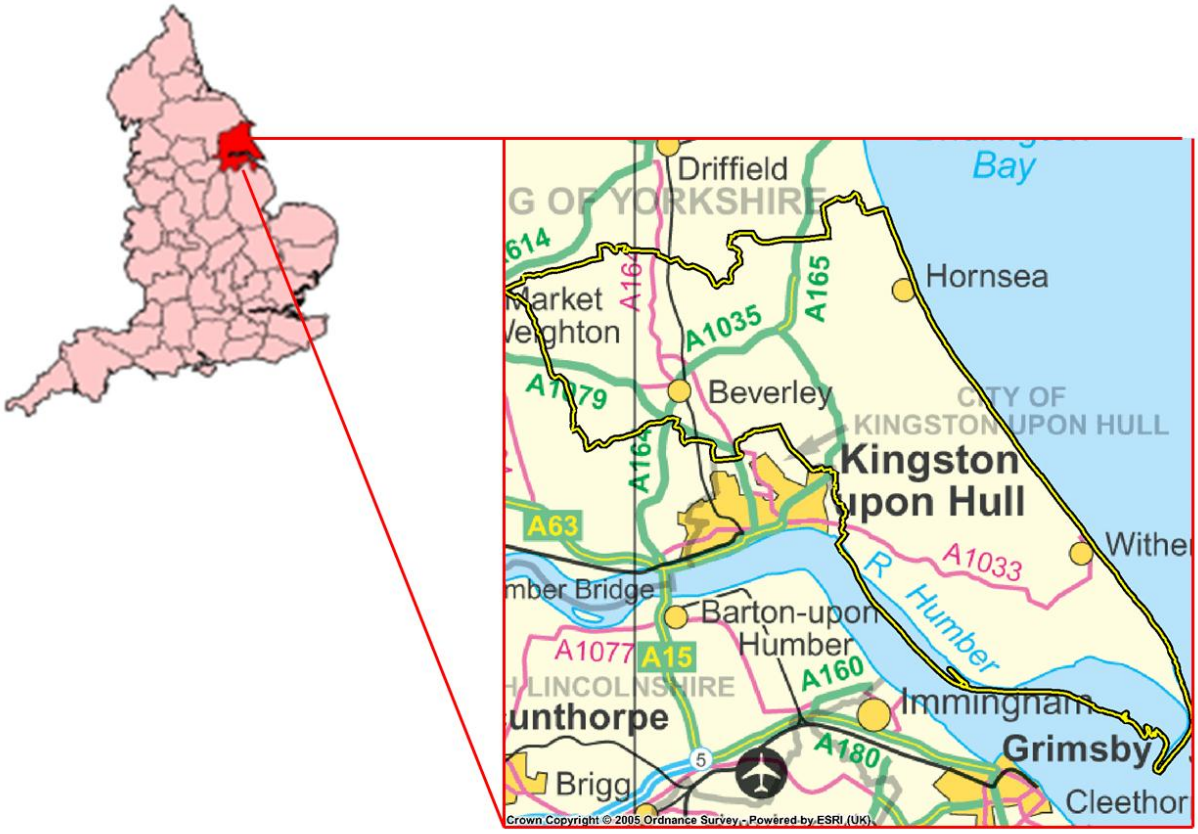


Figure 1

The Holderness Coast is one of Europe's fastest eroding coastlines. The average annual rate of erosion is around 2 metres per year but in some sections of the coast, rates of loss are as high as 10 metres per year. The reason for such high rates of coastal erosion can be attributed to both physical and human causes.

Physical Causes

The main reason for coastal erosion at Holderness is geological. The bedrock is made up of till. This material was deposited by glaciers around 12,000 years ago and is unconsolidated. It is made up of mixture of bulldozed clays and erratics, which are loose rocks of varying type. This boulder clay sits on layer of seaward sloping chalk.

The geology and topography of the coastal plain and chalk hills can be seen in figure 2.

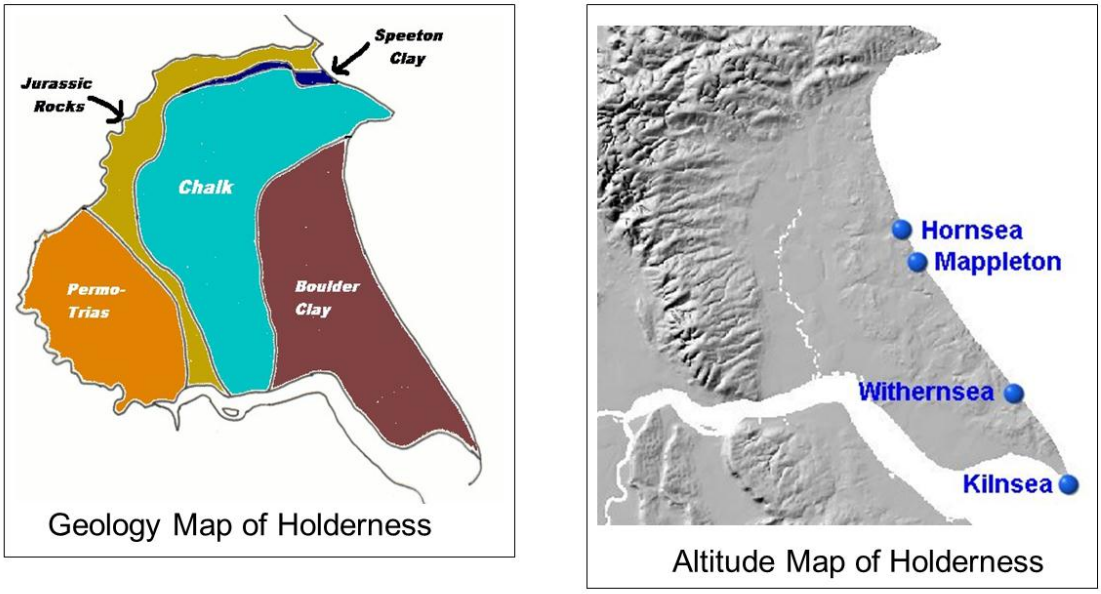


Figure 2

The boulder clay with erratics can be seen in figure 3.

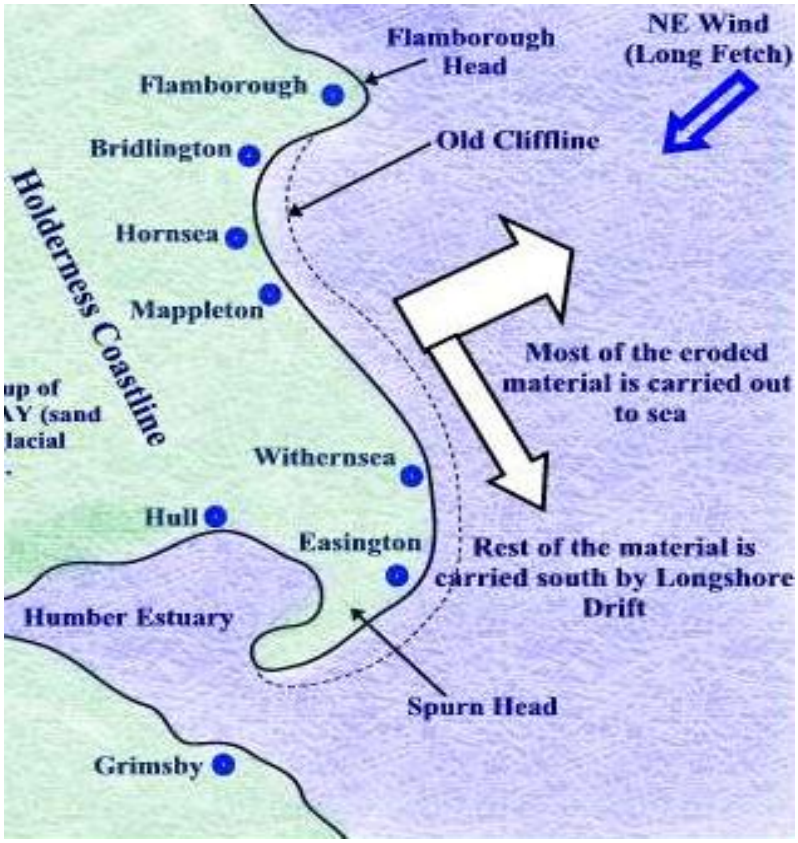
Figure 3

As we can see in figures 2 and 3, the Holderness Coast is a lowland coastal plain deposited by glaciers. The boulder clay is experiencing more rapid rates of erosion compared to the chalk. An outcrop of chalk can be seen to the north and forms the headland, Flamborough Head. The section of coastline is a 60 kilometre stretch from Flamborough Head in the north to Spurn Point in the south.

Boulder clay is eroded in 4 stages.

- The soft boulder clay cliffs become saturated with rain water creating instability.
- The cliff is too steep and fails either as a block of material (slump) or as a slurry slide
- Cliff failure reduces the angle and prevents further erosion for a period as it creates a plug of support
- Large waves from the north east remove the debris as longshore drift to the South. This removes the support and cliff steepens again.

Marine processes play an important role at the Holderness coast. The size of fetch, the frequency of both sea storms associated with passing deperessions, and the process of longshore drift all act to limit the process of deposition to keep a narow beach. This can be seen in figure 4.



A long fetch under the influence of north-easterly winds creates larger waves with strong backwash that erode the exposed cliffs. The location of Holderness is on the track of mid-latitude depressions that increase the frequency of destructive waves. The proportional arrows show that double the amount of sediment is removed in the backwash than transported along the beach through longshore drift. These physical factors interrelate to ensure that beach material doesn't build up. Beach depth therefore remains narrow offering little protection to the weak boulder.clay cliffs.

Figure 4

Human Causes

Humans can influence the rates of erosion through the choice of coastal management they deploy. A number of methods are known to increase rates of erosion. Sea walls, provide solid protection to coastal towns and promenades. However, their curved solid design reflects wave energy rather than absorbing it and so the wave energy is returned to the beach. As a result beaches become eroded and the the sea wall without beach replenishment will become exposed and undermined. In addition, rock islets, which are placed in the nearshore zone parallel to the shore to act as wave breaks help create low energy zones behind. In this way beaches are built up in size. However, between the rock islets beaches are exposed and can accelerate erosion as waves refract around them. Groynes are also a significant problem as they interfere with the natural sediment transfer of the coast. Groynes are placed perpendicular to the coastline to trap sediment as it is moved by longshore drift. In doing so the section of coastline protected by groynes builds up larger beaches. As a consequence however, beach material is stopped from moving down the coast leading to narrower beaches and a speed up in the rate of erosion.

The influence of groynes is evident at Mappleton. Here decison makers have protected the base of the cliff with rock armour and placed two large rock armour groynes to act as groynes to build up the size of the beach. The effects are visible in figure 5:

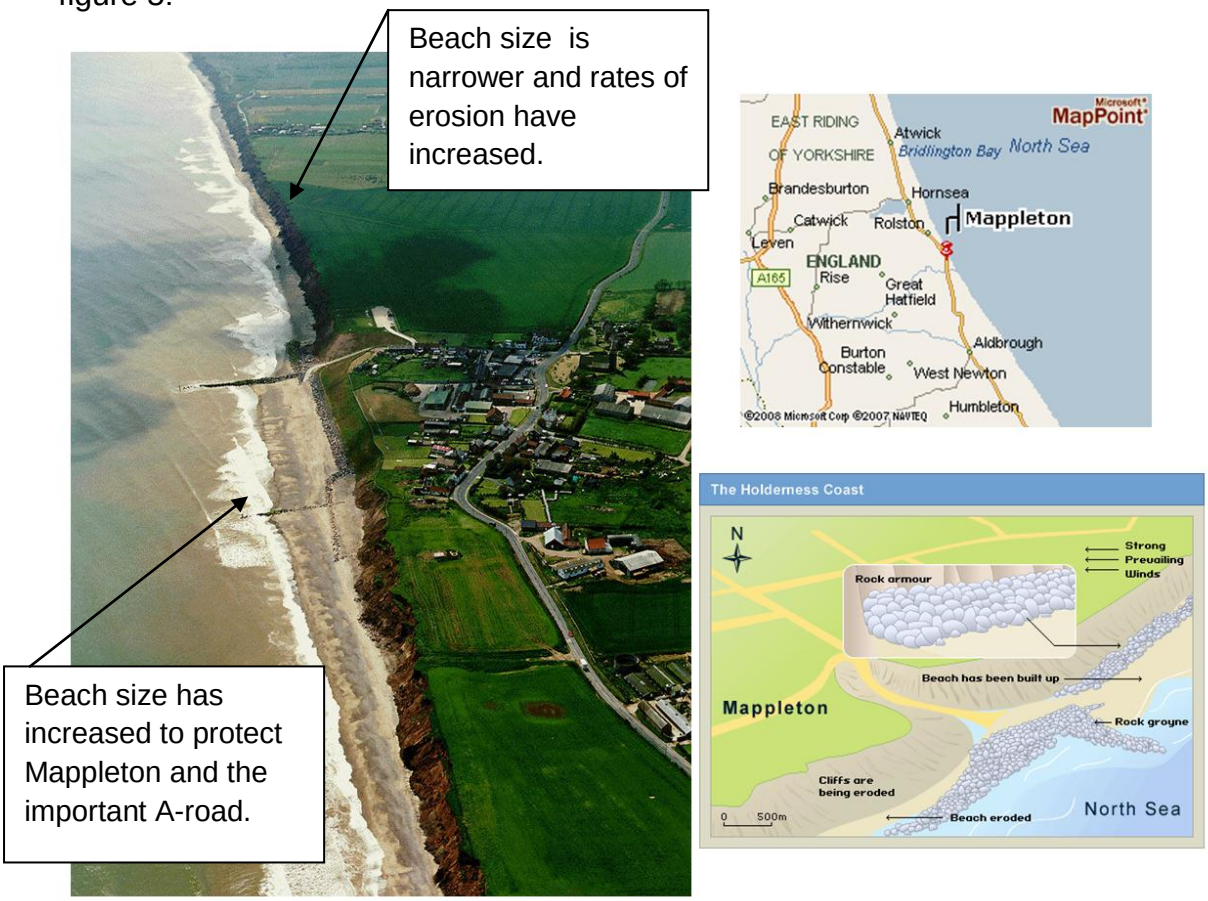


Figure 5

At the tourist resorts of Hornsea, Withenrsea and Bridlington a combination of management schemes have been deployed. These include sea walls, groynes and beach replenishment. Together this stabilizes and protects the cliff and builds up a large beach to protect the sea wall. Rates of erosion increase south of each town as a result of the interuption of longshore drift.

In addition, these towns will experience a process known as outflanking, whereby the towns' defenses will create differentiated rates of erosion. Sections of coast directly north and south will erode faster. Over time the towns will project seawards like a headland. This inturn will create the need for further coastal defense on the sides due to the process of wave refraction concentrating wave energy on the sides.

One final consequence of human cuased erosion is the threrat to Spurn Head, at the Humber Estuary. Spurn Head is a spit, which supports a small salt marsh. However, due to the constant interuption of longshore drfit along the Holderness Coast its sediment balance has been altered. This led to the loss of the old village of Kilnsea,

which was a functioning village in 1900. Today Spurn Head is dangerously narrow and could easily be breached. This can be seen in figure 6.

Figure 6

In the case of the Holderness Coast, we can clearly see that a number of factors are causing the fast rates of retreat. The most important factor is undoubtedly the geology and susceptibility of boulder clay to erosion. This is compounded by the high fetch, frequency of North Sea storms and marine processes that combine to maintain a narrow beach profile. These physical factors are responsible for erosion over a longer time frame. This is evident in the furge 7, a map showing the number of settlements lost since Roman Times. However, it also clear that in more recent times human management has interfered with the sediment balance and natural flows. This has created observed variations in rates of erosion over time and space.

Figure 3: The Holderness coast, showing its retreat since Roman times

Figure 7