Coastal landform and landscape development: The East Riding of Yorkshire coastline

Coastal landscape development 3.1.3.3

The coast of the East Riding of Yorkshire (including the Holderness coast)

The East Riding of Yorkshire coast provides some of the most variable coastal features in a 70km stretch of contrasting landscapes and coastal processes. Features of erosion dominate the northern sections while the most rapidly eroding coast in Europe occupies the central plain of Holderness, with the southern end given a distinctive profile with the growing spit of Spurn Point extending into the Humber estuary and sheltering the mudflats and saltmarshes of the Humber Estuary behind. The factors responsible for the contrasting coastal landscapes extend over space (spatial factors) and time (temporal factors).

Spatial factors

Lithology and rock structure

At the northern end of East Yorkshire there are thick layers (over 300m) of Upper Cretaceous chalk that originated in warm tropical seas around 75 million years ago. These are gently dipping on a north west/south east axis, outcropping at their highest at Bempton cliffs 4 km north of Flamborough Head and gently shelving until they disappear under glacial deposits at Bridlington on the south side of the headland. The layers of chalk are largely undisturbed for the most part, exposed at right angles to the cliff face and, consequently, forming vertical cliffs over 100m. high (the highest sea cliffs on the east coast of Britain).

At Flamborough Head the chalk has been subject to tectonic movement with extensive faulting and folding at Selwick's Bay that have fractured the chalk more fully, allowing agents of weathering and marine erosion to erode bays into the promontory. Weaknesses in the chalk have enabled distinctive features of erosion to develop around Flamborough Head in contrast with the relatively massive beds of more undisturbed, resistant chalk just north at Bempton. Caves, arches, stacks and blow-holes are common and lateral erosion of chalk promontories by wave refraction have indented the coast at this point even further. There are extensive wave cut platforms in the small coves and bays of Flamborough Head denoting cliff retreat over thousands of years.

Sediment transfer

The prevailing north easterly winds drive onshore waves that generate longshore movement of sediment from north to south along the coast. Chalk debris from Flamborough Head is deposited all along the coast as far as Spurn Point in the south. From a zone of net erosion and sediment loss in the north, the sediment budget changes to net deposition and sediment gain in the south in the form of the spit Spurn Head.

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At the southern end of the county the River Humber, one of Britain's largest drainage systems capturing over 20% of British river water, enters the North Sea. Not only has it prevented the spit of Spurn Point becoming a bar, but it deposits far more sediment into the sub-cell than is provided just from coastline mass movement and marine erosion. The combination of this river sediment encountering the southward littoral movement of marine sediment has enabled a larger spit to form than otherwise would have been the case. The turbulence between the two currents meeting at right angles deposits river and marine sediment at the end of the 4.8km. long spit, continuously extending its length. Behind (to the west) of the spit the calm tidal waters of the Humber estuary have created large mudflats that develop into saltmarsh successions closer to the shore.

Temporal factors

Ancient processes

The deposition of the shells and skeletons of marine sea creatures 75m. years ago and subsequent uplift of the lithified sedimentary rock 15m. years later are responsible for the basic structure of the northern part of the East Yorkshire coast. The chalk has been subject to erosion at various phases since then.

Quaternary processes

The last major advance of ice during the Pleistocene era (began 2.5m years ago) came to an end 18 000 years ago. The rapidly melting ice sheets left a layer of glacial till over the entire region, plastering the exposed chalk and depositing boulder clay to such an extent that it became the Holderness Plain as ice sheets retreated. As sea levels rose rapidly around 10 000 years ago this unconsolidated material became the new coastline of the region. Rapid coastal retreat has occurred ever since and continues today. With an average retreat of 1.6m of coast each year, over 2km have been lost since Roman times and the constant slumping and removal by littoral drift is the key characteristic of the mid-section of the East Yorkshire coast.

Century cycles

It is thought the development of the Spurn spit operates on a 350-year cycle of development, growth, extension, breaching at the neck and washing away, before a new cycle of growth begins at the new position of the retreated coastline. The current spit is thought to be reaching the end of the cycle: the neck is regularly breached and the lifeboat families that lived at Spurn Head have now been permanently moved off the spit.

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Short term cycles

The tidal range of the Humber estuary varies from 2.8m at average neap tide to 5.7m at average spring tide. This contributes to the extensive development of mudflats on the north bank of the Humber estuary. Sea level rise is expected to inhibit the development of saltmarsh successions that would otherwise be expected to take place. One result is managed retreat developments taking place near Paull to the east of Hull which are creating human-induced saltmarsh habitats in an effort to contain rising sea levels and absorb periodic flooding.

Exam style questions:

1. **For one feature of coastal erosion examine the role played by subaerial weathering in its development (9 marks)**

2. **'The development of distinctive coastal landscapes is largely to do with the type of rock that is found at the coast in particular sections of coastline.' Assess the validity of this statement. (20 marks)**

Coastal management: the Holderness coast

Coastal management 3.1.3.4

The Holderness coast

The sediment cell that encompasses the Holderness coast extends from Flamborough Head in the north to The Wash in the south. However, a sub-cell exists from Flamborough Head to Sunk Island – the Humber estuary mudflats that lie to the west and behind the extensive spit of Spurn.

The East Riding of Yorkshire shoreline management plan (SMP) identifies Flamborough Head as requiring 'No active intervention', largely because the resistant chalk of the headland is eroding so slowly that there are few issues requiring management.

The Holderness plain extending south from the headland to the Humber estuary is another matter. The soft glacial till of the Holderness Plain deposited at the end of the last glacial maximum 20 000 years ago is the fastest eroding coastline in Europe with an average loss of 1.6m per year; under extreme conditions up to 2m can be lost in a places in a particularly severe winter storm. The majority of the plain is Grade 2 agricultural land supporting grain cultivation and pig farms. This does not warrant the cost of protection so the majority of the coast is designated 'No active intervention' recognising that it will continue to retreat rapidly.
However, there are three categories of key exception along the coast that have 'Hold the line' designations in the SMP, releasing funding for coastal protection measures. These are all key human developments that it would be politically, socially, economically and – in one case – strategically unacceptable to allow to fall into the sea.

Mappleton: critical infrastructure protection

The once-inland small village of Mappleton has fewer than 200 inhabitants but received a £3.5m coastal defence in 1991, not so much to protect the village but the coast road that runs through the village. The B1242 is the main north-south transport route linking the towns of Withernsea, Hornsea and Bridlington and essential for emergency services to operate between each of the settlements. A bend in the main road is critically close to the retreating cliff edge in Mappleton so hard engineering defences were put in place funded from central and local UK government and an EU grant. The protection involves:

- Two granite boulder groynes extending into the sea designed to capture sediment being transported southwards by longshore (littoral) drift by prevailing north east winds and waves with the intention of accumulating sand into a wider and higher protective beach.
- Similar granite boulders providing rock armour along the base of the boulder clay cliff.
- Landscaping of the cliff profile into a shallower angle so that slumping is less likely to occur.
- Deliberate seeding of the cliff surface with grass species to bind the surface and reduce slumping.

The protection has proved popular with residents of Mappleton in that is has arrested cliff retreat and protected homes and the economic value of businesses in the village. In addition, a

car park and toilets at the top of the cliff was constructed and attracts many visitors, who bring business to the village shop, pub and garage.

However, the car park is now threatened with erosion as the cliff has started retreating rapidly in recent years where the southern end of the rock amour ends and lateral erosion of, what in effect is becoming a protected promontory, takes place. In addition, land-owners 2 km to the south of Mappleton claim that cliff erosion has been faster since the measures were put in place. Farm buildings have been lost and families have had to move out into nearby villages inland. They claim that the beach in front of their properties has been 'robbed' of sand that is trapped – as intended – at Mappleton. A narrow beach offers less frictional resistance to advancing waves and high energy impacts are more frequent and intense as a result.

Major settlement protection: Bridlington, Hornsea and Withernsea.

The coastal tourist towns of the Holderness Plain are populated with 6 000+ residents each and have been designated for protection. At all three, hard engineering measures include concrete sea wall, groynes and, at Hornsea concrete revetment and at Hornsea and Withernsea, more recent rock armour. The costs of maintenance and repair are high, but the economic value of the settlements is such that their protection has been guaranteed up until 2100. The forecast map of the coastline profile by that date shows that both Hornsea and Withernsea may develop as promontories as their retreat is arrested while the unprotected coastline continues to retreat. This is likely to extend the area requiring outflanking protection as the lateral sides of the mini-headlands become exposed to erosion.

Easington gas terminal: strategic energy protection

The small village of Easington, just north of Spurn, lies 1 km inland from the coast. However, a major gas terminal is located on the coast. Originally built to receive natural gas from gas fields in the British sector of the North Sea to the east, it is now the key onshore end of the Langeled gas pipeline exporting Norwegian gas to the UK and accounting for 20% of the UKs gas imports. The coastal gas processing facility is protected by a combination of rip-rap, concrete blocks and gabions.

Unlike the tourist settlements, which have their 'Hold the line' status guaranteed up to 2100, the protection at Easington is only guaranteed as long as the gas terminal is functioning. Should it close, then the coastline will revert to 'No active intervention' and the village may face a rapidly-approaching cliff-line.

Exam style questions:

1. **Justify why a hard engineering coastal protection strategy may be selected when soft engineering options are available. (9 marks)**

2. **Analyse the need for, and evaluate the success of, a coastal management scheme you have studied. (20 marks)**