SPURN HEAD

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Introduction

The sand and shingle spit of Spurn Point or Head lies on the north side of the mouth of the River Humber (see Figure 8.2 for general location), together with an area of till and alluvium to the north. The northern part of the site is formed by low till cliffs that are being eroded at rates in excess of 2.5 m a^{-1} and which feed sediment to the spit. The spit extends for about 5.5 km south-westwards across the Humber estuary, mainly as a narrow feature about 150 m in width but widening at its distal end to over 350 m. Its maximum altitude reaches about 9 m OD, but for much of its length it rarely exceeds 6 m.

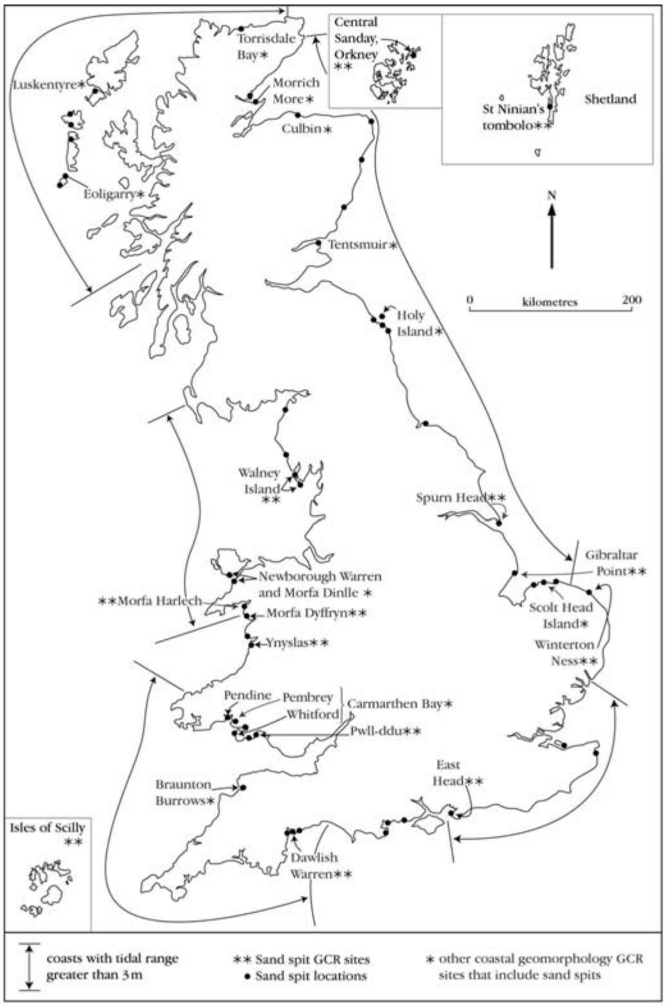

Figure 8.2: The location of sand spits in Great Britain, also indicating other coastal geomorphology GCR sites that contain sand spits in the assemblage. (Modified after Pethick, 1984).

De Boer (1963, 1964, 1967, 1968, 1981) argued that the spit has been characterized by recurring 250-year cycles of partial washing away and re-growth (Figure8.8a). The Institute of Estuarine and Coastal Studies (IECS, 1992) challenged this, suggesting that the present-day morphology of the spit results from 19th century construction work that followed a number of breaches of the spit in the 1840s (Figure 8.8b). The comprehensive documented history of the site arises both from the recorded losses of land and villages and the regular need to relocate lighthouses marking the entrance to the Humber (e.g. Smeaton, 1791). There is no spit of comparable form and length to Spurn Head in a macrotidal environment in the British Isles or probably in Europe. The tidal range in the lower Humber estuary reaches 6.4 m.

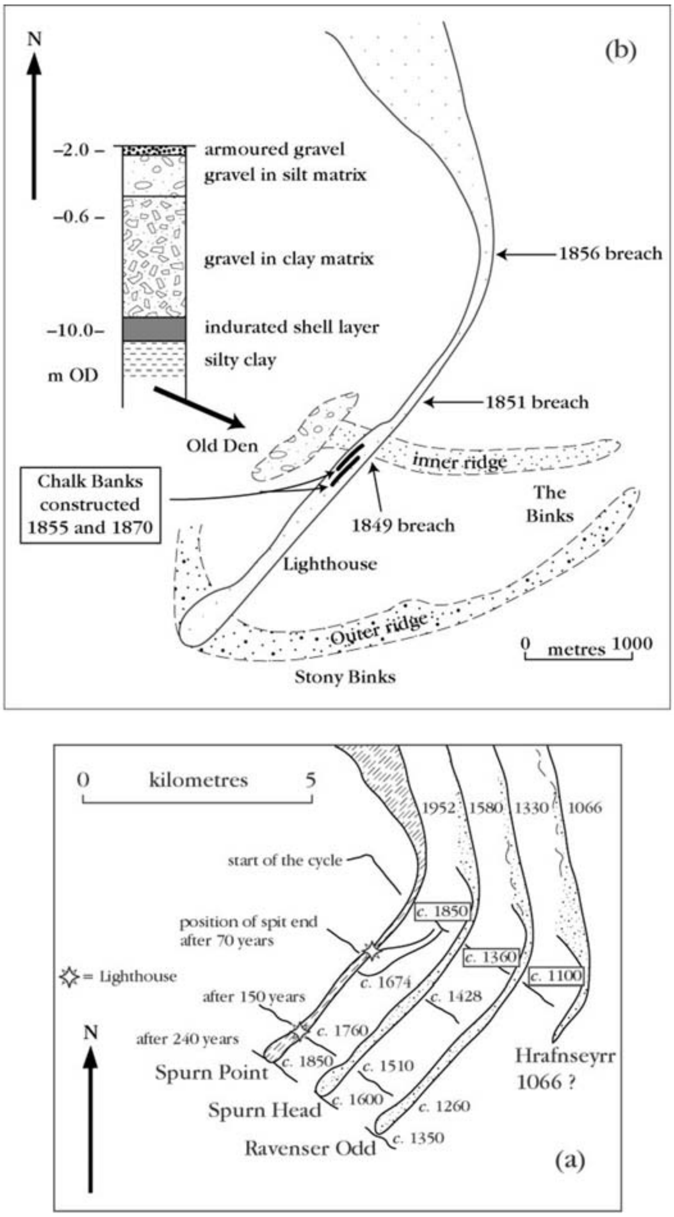

Figure 8.8: Schematic diagram showing the key features including sediment transfers at East Head. (Sa = sand; Sh = shingle). Sand and shingle transported out of Chichester Harbour may be added by wave and aeolian action to longshore transport from the south-east. This may account for the excess of sediment reaching the spit over longshore transport. (After Harlow, 1982.)

Description

The GCR site includes both the spit itself and a cliffed area of till and alluvium to the north-east of Kilnsea. Along the seaward side, the very low cliffs expose sections of Devensian till and alluvium and occasional patches of peat and tree remains. Kilnsea Warren, which forms the northern end of the spit proper and extends a little over 1 km southwards to the narrow neck, is a flattish area between 5 m and 6 m OD, mostly covered by marram*Ammophila arenaria* and sea buckthorn *Hippophae rhamnoides*. The coast changes its alignment from NNE–SSE off How Hill to north–south at the southern end of Kilnsea Warren. At the southern end of High Bents at the curving neck of the spit, a further 0.8 km farther south, the sea coast faces almost south-east. At this point, the narrow neck, only about 30 m wide between high-water marks yet rising to 9 m OD, has been greatly modified by management activities. The remainder of the peninsula is very nearly straight for over 3 km, and is aligned approximately north-east–south-west. It consists of irregular ridges of sand dunes, usually highest on the North Sea coast, and intervening hollows. The foreshore on the Humber side of the peninsula consists of mudflats with patchy cord-grass *Spartina anglica* as far south as the Chalk Banks (Figure 8.8b). Farther south, the muddy shingle of Old Den contrasts with a wide beach of fine-grained sand that extends almost to the tip, commonly built into a ridge and runnel beach, with the ridges curving across the beach. Four hundred metres offshore in the Humber, beyond a shallow muddy channel ('Greedy Gut'), lies 'Old Den', now a shoal of muddy shingle submerged by every tide. In the 17th century it was an island with dunes and vegetation. The area of most vigorous dune growth lies near a shorter jetty, where the prevalent south-westerly wind carries sand from the wide beaches on the Humber side. These dunes increased in height by about 6 m between 1960 and 1974.

Near the tip of the peninsula is an arcuate system of shoals, the Stony Binks, which branch off seawards at a tangent. This complex appeared to de Boer (1964, 1968) to be a shoal system related to the ebb tidal stream running past the point where it has scoured a deep hollow (depth at least 24 m) immediately off the tip. IECS (1992) show that the Binks lie along the line of an arcuate ridge of glacial till (about 15 m below present HWMOST), which extends seawards of Spurn Head north-eastwards along the line of the Binks (Figure 8.8b). A second till ridge about 2.5 km to the north follows a similar curved path running beneath Spurn Head (at about 6 m below HWMOST) near the Chalk Banks and co-incides with the position of the Old Den. During the breach of 1849 this ridge was exposed as a basal sill to the breach. The glacial ridge at the Point is overlain by 15 m of sand, gravel and cobbles. The gravels are exposed along the line of the Binks and the Old Den.

Three cores in the area of Kilnsea Warren to the north of the spit passed through sand and gravel, or through silt and clay with silt bands: all ended in clay at depths of 18 m below the surface (IECS, 1992). Whereas as far south as the Chalk Banks, cores passed from sand and gravel into clay at depths of 10 m to 12 m from the surface, i.e. –4 m to –6 m OD, cores to depths of 18 m in Spurn Warren ended in sand, gravel and boulders. A core taken in 1971 on the foreshore near the lifeboat station near the spatulate tip (TA 398 110) passed from sand and gravel into a firm sandy, silty clay, possibly the Skipsea Till, at between 10.5 m and 12 m from the surface (–12.5 m to –14 m OD) and into Chalk at about 28.5 m from the surface (–30.5 m OD) (IECS, 1992).

During the 17th, 18th and 19th centuries, the low ground between Kilnsea and How Hill at the narrow northern neck of Spurn Head was a partly vegetated wave-swept bank of sand and shingle. During the 18th century ballast-diggers removed gravel and cobbles mostly from this area of the neck. Up to 50 000 tons (*c.* 51 000 tonnes) per year were removed, exceeding the natural rate of removal by up to seven times (IECS, 1992). The selective removal of the larger material greatly reduced the natural gravel foundation of the neck of the spit, weakening it substantially.

The Chalk Bank lies across the site of the great breach that opened in December 1849, which attained a width of 460 m and a depth of 5 m at high water before it was closed in 1855. The dunes in this section remain lower than elsewhere. A series of groynes at 250 m intervals were constructed between 1864 and 1926 and revetments were added about 1884: stakes and wattling were placed along the Humber (west) side, and blocks of chalk dumped. Dune growth was stimulated by the sowing of seeds of marram *Ammophila arenaria* and by thatching, and the surface may have been raised even higher and graded when the Spurn–Kilnsea railway was built around 1915. The neck widened by almost 40 m between 1846 and 1878 (IECS, 1992). The irregular river margin consists of the remains of the bank by which the breach was first closed in 1855: the straighter Chalk Bank was built in 1870. An area of saltmarsh between these banks is connected to the Humber by a tidal creek at the north-eastern end. The seaward side was strengthened by concrete revetments from 1942 onwards: these are now collapsing in places.

Spurn Head, from the lighthouse south-westwards, has been much affected by the establishment of the lifeboat station, by lighthouse construction, and by military fortification. The effects of fortifications are most concentrated within the spatulate tip of Spurn Head. A high and vertical sea-wall separates the beach on the Humber side of the peninsula from the interior of the spit where there are the remains of both civilian and military buildings and gun pits.

Interpretation

When the Devensian ice retreated probably about 14 000 years BP, leaving the Skipsea Till (Catt and Penny, 1966; Penny *et al.*, 1969; Madgett, 1975; Madgett and Catt, 1978), which forms the cliffs at the north of the site, sea level was low and much of the area was land. Sea level rise during the Holocene Epoch led to flooding of the North Sea and the Humber and the process regime that resulted in the formation of a spit ancestral to the present one (de Boer, 1981).

As the early Holocene sea level rose, the transgression of the gravels would have been prevented by the presence of pre-exisiting glacial ridges and two islands probably formed along the line of the Binks and Old Den. With sea level close to present-day levels by about 6000 years BP (IECS, 1992), longshore transport from the cliffs undergoing erosion at Holderness carried sand southwards to Spurn Head. From a sandy beach veneering the gravel, aeolian processes carried sand inland to form small dunes. A proto-Spurn Head would have comprised an intertidal gravel ridge from the mainland to an island in the present-day position of the Chalk Banks, with the island of Old Den to the south and west.

The earliest historical record of a peninsula occurs in the 7th century AD and four predecessors of the present-day feature may have succeeded each other at the mouth of the Humber (de Boer, 1964). Hydrographical conditions at the mouth of the Humber in the 16th century were probably similar to those of the present time (de Boer and Carr, 1969; de Boer, 1973; de Boer and Skelton, 1969). A series of breaches reduced Spurn Head in the 1850s to a string of small islands according to the Admiralty Chart of 1852. Thereafter, the peninsula was maintained by artificial defences against erosion and thus differs from its predecessors (de Boer, 1981).

The earlier development of Spurn Head, as described by de Boer (1964), combined extension of the peninsula by growth at the tip and a westwards retreat of the spit as a whole. The breaches on which de Boer based his 250-year cycle occurred in 1360, 1600 and 1849. The first ‘breach' occurred when Ravenser Odd (in the vicinity of the present-day Chalk Banks) was abandoned after 60 years of continued erosion. IECS (1992) noted the co-incidence of the erosion of Spurn Head with the flooding of the Broads, attributing both to the 12th and 13th century sea-level rise, and speculated that it is this rather than the over-lengthening hypothesized by de Boer that accounts for the abandoning of Ravenser Odd. According to de Boer, the present-day peninsula developed after its predecessor had been breached about 1608 (de Boer, 1963, 1964, 1967; de Boer and Carr, 1969). The evidence for the ‘breach' of 1600 is disputed by IECS (1992), which contradicts the view that the island, Old Den, came into existence when the predecessor of the present-day spit was breached around 1600 (de Boer, 1963, 1964, 1968, 1981; de Boer and Carr, 1969). The Old Den is clearly portrayed on maps of 1540 and so the view that it originated as a result of the breach must be questioned. Subsequently, the spit grew rapidly southwards to reach the position of the present-day lighthouse by about 1750. Since at least 1290, it had ended at the Chalk Banks. IECS considers that this rapid extension may co-incide with fall in sea level from the mid-17th to mid-19th centuries, which may have resulted from the ‘Little Ice Age'. The intertidal gravel beaches between the two till ridges would have been exposed, allowing sand accumulation and dune building. As a result the sand supply to the Old Den dunes was reduced. They gradually eroded during the 17th and early 18th centuries and, by 1750, Old Den had been reduced to an intertidal gravel mound.

Remarkably, the 1953 storm surge failed to breach the peninsula, though causing some damage, and a comparison of the peninsula's condition in 1849 and 1953 is instructive. Before 1849, little if anything had been done to keep erosion in check. The neck of the peninsula was bare of dunes and wave-swept at high spring tides. This condition had become more pronounced since the beginning of the 19th century, and it appears that waves broke across the neck of the peninsula and carried with them beach material that would otherwise have been moved south. The spatulate tip of the peninsula was attacked by waves from both the sea and the river side, and reduced to a strip little wider than the rest of the peninsula. The broader tip at present is the result of accretion on the Humber (west) side of beach material carried round the tip, and when this supply is cut off the tip becomes attenuated.

A combination of several factors appears to have caused the 'breach' of 1849, including the selective removal of gravel and cobbles from the neck, and the loss of intertidal and aeolian sand supplied on the western side of the spit. Before 1808, when the North Channel was finally closed, it carried sand and fine-grained gravels during the flood tide into the channel and beyond. Aeolian transport carried sand from the banks not only to the western side of the spit but also along the entire estuarine shoreline of the Bight. Aeolian transfer is of the utmost importance to the western shoreline sediment budget, especially in the vicinity of the Old Den (IECS, 1992). The 1849 breach (de Boer, 1964) occurred sufficiently far south for the effects of wave erosion on the seaward side to be added to wave erosion of the river side, and far enough along the spit to be exposed to wave erosion in the lower Humber produced by north-westerly gales. The residual effects of riverside accretion farther south prevented the whole of the distal end of the spit from being swept away in such conditions: the results of the storm surge were thus limited to the opening of the breach across the neck.

The 1849 breach, once formed, developed into a tidal channel with streams of possibly 3–3.5 m s^{-1} running through it. It rapidly enlarged to a width of about 60 m and a depth of 5 m at high-water spring tides. Small ships began to use it instead of going round the point. The Old Den was enlarged at that time by the deposition of material swept through and scoured from the breach by the flood tide (de Boer, 1964). The development of the spit was very considerably changed by the closing of the breaches in the 1850s by the erection and maintenance of groynes and revetments and by the encouragement of dune-colonizing plants, especially marram *Ammophila arenaria* (de Boer, 1981).

Up to the present time, the distal part of the spit has been held in its mid-19th century position. However, over the past 6000 years the spit has migrated westwards at an average rate of about 0.2 m a^{-1}. Comparison of the shoreline on 19th century maps showing Smeaton's lighthouse and the present-day shoreline shows that Spurn Head has been retreating more recently at about 0.5 m a^{-1}. In contrast, the mainland Holderness coast has been retreating at about 2.0 m a^{-1} (IECS, 1992). As a result, Spurn Head now has three parts, a proximal section responding to the high retreat rates of the Holderness coast and a distal spatulate area largely fixed by coast protection activities, separated by a central section which is increasingly exposed to destructive waves coming from northerly and even west of northerly directions. These waves, generated by the strong to gale force winds that accompany the barometric pressure conditions associated with storm surges, are especially destructive. They occurred during both the 1953 storm surge, and the 1849 breach.

The relationship of Spurn Head to the Holderness coast is therefore different now from that in 1849. Erosion has continued unchecked north of Kilnsea: the destruction by the sea of the defences at Kilnsea has also caused rapid retreat of the coast. Relative to the Holderness coast, therefore, Spurn Head as a whole stands in a position more to seaward than it did in 1849, and this may be the primary cause of the present-day rapid erosion, from the northern boundary towards the Narrow Neck.

The wave and tidal processes operating along the shores at Spurn Head have been discussed by Phillips (1962, 1963, 1964), Robinson (1964, 1968) and Hardisty (1982). Along the seaward side, particularly after periods of constructive wave activity, the beach is built into a high, relatively steeply sloping upper beach zone of sand and shingle, and a lower flatter zone of finer-grained sand, sometimes with an intervening runnel. The lower edge of the upper beach is often a sharply demarcated line of seepage, locally called the 'grope'. The height of the beach varies along its length and lower sections, known locally as 'ords' or 'hords' (Phillips, 1964; Scott, 1976; Pringle, 1981), migrate slowly towards the tip of the spit. Erosion is often particularly severe where they occur.

The waves around the spit are responsible for

1. washover processes that transport sand from the eastern shore across the spit to its western shore,

2. longshore transport in the nearshore zone by wave-driven currents southwards to the

southern extremity of the spit, and

3. transport by waves in combination with tidal currents onto the western shore (IECS, 1992).

As a result, most sand accumulates along the southern part of the south-western shore.

The predicted 1-year wave height return periods of 4.75 m at Dimlington (15 km to the north), 2.25 m at Spurn Lighthouse and 3.25 at the RNLI jetty show that the Binks have a crucial role in reducing wave energy inputs to Spurn Point (IECS, 1992; Figure8.9). Modelling wave refraction patterns IECS show that between Kilnsea and the Warden's cottage, with the greatest exposure to the north, wave energy and, as a result, sediment transport increases. Erosion of both the tills and beach sediments follows. As the shoreline swings towards the south-west, however, wave-energy potential decreases and sediment transport is reduced. Deposition increases towards the lighthouse and decreases towards the Point where it is zero (IECS, 1992). This is contrary to the view ofde Boer (1964) who described deposition as occurring at the Point. IECS further suggest that there is sufficient sediment reaching the spit to maintain a positive sediment budget. The transport processes do not, however, carry the sediment to the areas with the greatest sediment deficits and that are therefore most likely to undergo erosion.

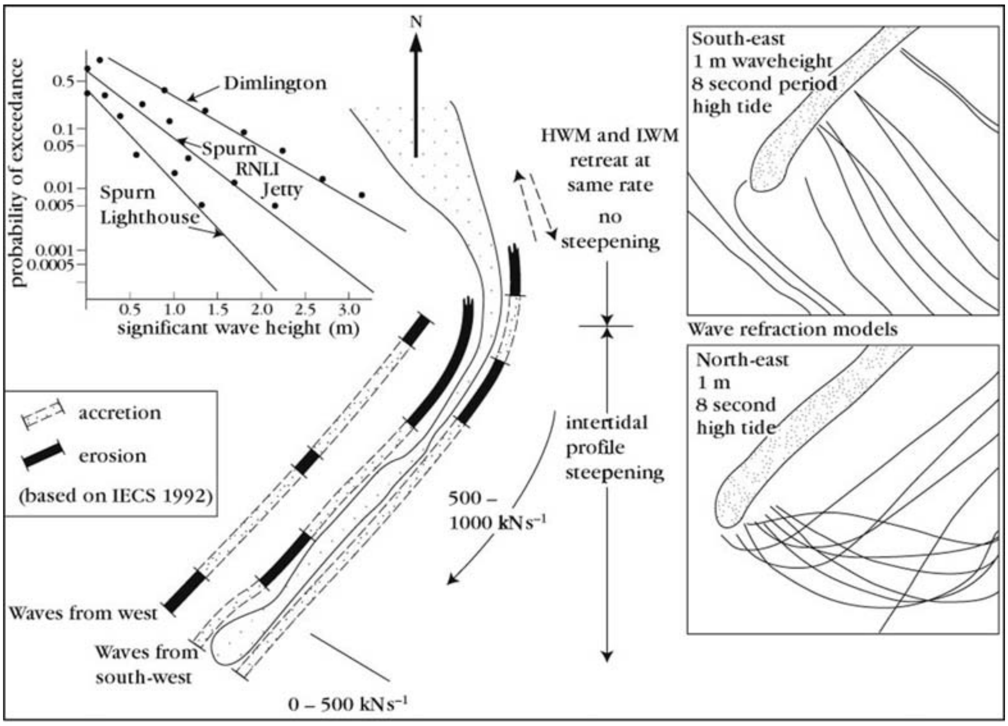

Figure 8.9: Active processes at Spurn Head. Wave-refraction models indicate areas upon which wave energy concentrates. With waves from different directions (shown by the wave orthogonals), the zones of erosion and accretion change, giving rise to possible breaching from both North Sea and Humber sides of the spit. The wave-refraction models show wave convergence and divergence for waves from south-east and north-east, in both cases for waves 1 m-high, of period 8 seconds and at high tide. (After Halcrow, 1988; and IECS, 1992.)

Conclusions

Spurn Head is an outstanding example of a dynamic spit system and is very unusual, if not unique, in that it extends well across the mouth of a macrotidal estuary. Unusually also, there is an exceptionally long historical record extending back to the 7th century AD. Though there are many spits of sand or shingle along the British coast, there are some features of Spurn Head that are exceptional and give it international importance. These features are as follows.

1. It derives its character as an outstanding example of a dynamic spit system from the coastline undergoing rapid erosion of Holderness whence it grows, where the mean annual rate

of retreat over the century 1852–1952 rises in places to 2.75 m, an extreme figure that is among the highest over a comparable period of time anywhere in the world (Valentin, 1954, 1961). Its length and volume reflect the massive longshore transport from the Holderness coast.

2. It is exceptional, nationally and internationally, in that it extends across the mouth of a macrotidal estuary. Few spits are able to maintain comparable size and length in a setting with such a large tidal range.

3. It has an unusually long recorded history of more than 1000 years, exceptional for Great Britain and probably internationally. The comparable length of record for Dungeness offers considerable scope for unrivalled comparative studies.

4. The cyclic pattern of development proposed by de Boer is disputed by a view that the spit has a much more stable position due to Holocene gravel ridges and wave energy distribution.

5. The breaches in the spit are explained by different circumstances: in 1360 by sea-level rise, in 1650 by sea-level fall and in 1849 by gravel extraction and changes in longshore sediment transport.

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