Dengie Marsh, Essex

[TR 030 089]–[TR 025 963]

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Introduction

The Dengie peninsula (see (Figure 10.1) for general location), like many parts of the Essex coast, has been progressively land-claimed by a series of embankments constructed on the upper marshes. These walls are now fronted by salt-marsh and intertidal flats in excess of 2 km wide. The tidal range is 3.8 m. The northern part of the saltmarsh is fronted by shell and sand ridges (Greensmith and Tucker, 1965, 1967, 1968, 1969, 1973a,b, 1975), and parts of the intertidal area is marked by the development of mud mounds (Greensmith and Tucker, 1965, 1967). Farther south, the main area of saltmarsh at Dengie has been the subject of a number of studies of sediment transport and creek development (Bayliss-Smith *et al.*, 1979; Reed, 1986, 1987, 1988; Reed *et al.,* 1985; Stoddart and Bayliss-Smith, 1985; Pye and French, 1993). Changes in the coastline were described by Robinson (1953a), but more recent changes in the marshland area have been estimated by Harmsworth and Long (1986) and Burd (1992). Pethick (1989, 1991) has described the effects of, and recovery from, a storm event in January 1989.

Description

The Dengie peninsula is fronted by an extensive area of saltmarsh that is narrow at its northern and southern extremities and up to 600 m wide at Bridgewick. The marsh covers about 480 ha, of which about 16% (about 80 ha) was lost by erosion between 1970 and 1981 (Harmsworth and Long, 1986). Burd (1992) estimates that between 1973 and 1988 changes within six blocks of the saltmarsh, based upon measurements of the position of the marsh front, ranged from accretion of 1.1 m a^{-1} to erosion of 7.6 m a^{-1} (Figure 10.10)b. Overall the marsh front lost on average 2.6 m a^{-1}. Mean low-water mark moved landwards at an average of 28.4 m a^{-1} at Sales Point, 8.7 m a^{-1} at St Peter's channel and 13.3 m a^{-1} at Watch House, thus steepening the foreshore (Pye and French, 1993). A total area of 473.8 ha in 1973 was reduced by 10% by 1988 (Burd, 1992), and this was the smallest net loss on all the Essex and north Kent saltmarshes.

On the landward side, the marsh is bounded by a 19th century sea-wall, the latest in a series of land-claims that started in the 16th century. The saltmarsh morphology at Dengie is particularly interesting. The marsh surface stands mainly at 2.5 m OD and is essentially planar with, unusually, no differentiation into upper and lower marsh. The marsh is dissected by numerous creeks and saltpan systems. Dengie also possesses many subsurface 'pipes'. The role of these subsurface features in bringing about salt-pan formation was reported initially in Nigg Bay, Ross and Cromarty, Scotland (Kesel and Smith, 1978). It was subsequently recognized as occurring more widely, in the Ythan marsh, the marshes of south Wales, and in Shetland and Lewis (Smith, 1978).

Saltmarsh erosion was dominant along the Dengie peninsula (Harmsworth and Long, 1986) during the period 1960 to 1981, a trend that has been confirmed by Burd (1992). Net loss between 1973 and 1988 was 46.7 ha, much being accounted for by the January 1978 storm (Pye and French, 1993). Greensmith and Tucker (1965) showed that erosion was not uniform with a range of saltmarsh edge retreat from zero to 270 m. Boorman and Ranwell (1977), in contrast, regarded Dengie as one of the few saltmarshes of south-east England that was accreting. Reed (1988) recorded short-term vertical accretion of 5–14 mm a^{-1}. However, the Anglian Water Authority (1980) reported the marsh as being dominated by erosion. Harmsworth and Long (1986) suggest that the characteristic pattern may be one of successive construction and erosion, depending upon rates of sea-level change and the degree of exposure to wave action. The outer edge of the marsh is marked by a distinct saltmarsh cliff (Harmsworth and Long, 1986), but much of the edge of the marsh, particularly at its northern end at Bradwell, is eroded into a zone of mud mounds (Greensmith and Tucker, 1965). The seaward rim of the marsh surface is intermittently overridden by transgressive shell ridges (Greensmith and Tucker, 1965, 1967, 1969, 1973a,b). As these cheniers transgress the saltmarsh, it is buried for a period of time before re-appearing seawards of the beach. Farther inland, the marsh lies over a series of chenier features especially at Sales

Point. The coastline appears to have been affected by erosion after the Roman period for there is some evidence to suggest that the Roman fort of Othona, the present site of St Peter's Chapel, extended at least 120 m farther seawards than the present cliffline. Some fragments of submerged masonry within the marshland have been described as a Roman harbour (Johnson, 1976).

The chenier at Sales Point is predominantly formed by shells (51%) and sand (47%), unlike the cheniers at Colne Point (St Osyth Marsh GCR site). There is no tendency to overall coarsening upwards, but the backslope is usually dominated by coarse-grained sediments, mainly large shell fragments (Greensmith and Tucker, 1965, 1969). The chenier cross-section was described as asymmetric, steepest on the landward side (Greensmith and Tucker, 1975). However, in January 1992, much of the northern part of the chenier had been eroded to form a cliff about 0.35 m in height and expose layering of the structure. Farther south, the form described by Greensmith and Tucker remained characteristic. Since 1947, the beach has migrated landwards at annual rates of up to 8 m, but it has also extended southwards as well as suffering occasional breaches. As a result, parts of the chenier and the saltmarsh undergo erosion, as well as providing, in the case of the chenier, reworked supplies of sediment for chenier building. The exposure of former saltmarsh on the foreshore and the growth of algal mats both affect the development of the chenier. The first refracts waves approaching the beach, the latter prevents re-distribution of sand and shells from the beach.

Interpretation

This is a rare example in Britain of an open coast marsh. Three issues have been examined separately in this site:

1. the growth of cheniers and their relationship to changes of sea level,
2. the reasons for the erosion of the salt-marsh, and
3. the links between sedimentation and creek development.

Despite the separate approaches, there is a common theme — the link between the forms of the site and the effects of changes in the relationship between the land surface and sea level. Regional sea-level rise on the Essex coast has three components, summarized by Burd (1992) as follows:

1. the general eustatic rise in sea level: estimated to have been 15 cm ± 10 to 20 cm over the past century (Rossiter, 1967; Robin, 1986; Woodworth, 1987, 1990a,b; Misdorp *et al.,* 1990) in the North Sea,
2. increased tidal range: for example 45 cm at Harwich since 1870, and
3. isostatic changes in sea level: based on Shennan (1989), this is estimated at a rise in relative sea level of 1.5 mm a–1.

The fringing beaches are of particular interest. Sales Point chenier is described by Greensmith and Tucker (1975) as a 'type-example'. It contrasts strongly with the cheniers of the Louisiana coast (Byrne *et al.,* 1959), as well as others in New Zealand and Queensland, Australia, examined by Greensmith and Tucker (1975) in at least three respects. It lacks the upwards-coarsening of sediment of the Louisiana cheniers. It contrasts with them in the coarseness of the back-slope, and in having its steepest slope on the landward side, unlike others where the seaward slope is steepest.

Greensmith and Tucker (1975) argued that the Essex cheniers resulted from periods of coastal instability and widespread erosion, in contrast to the type region of Louisiana where coastal stability predominated. They believe that the fundamental tectonic instability of the southern North Sea explains the contrast, and outline an evolutionary sequence for the development of the Essex chenier plain of which Dengie is part. Marine transgression, probably during the period 1434 ± 110 years BP to 1265 ± 100 years BP, brought about erosion of the upper tidal flats and saltmarsh, and initiated mud mounds (Greensmith and Tucker, 1967). Shells, sand and pebbles were released from the flats and provided a source for the initiation of cheniers. Extension by merging and elongation produced spits extending onto the tidal flats. Creeks both interrupted chenier development and were affected by it as tidal flows were diverted. In the later stages of chenier development, expansion of saltmarshes isolated some ridges inland. Several can be traced within the land-claim area between Sales Point and Dengie village. At the outer edge of the saltmarsh, new cheniers developed such as that at Sales Point, but they were subject to growth by elongation and also by erosion, particularly at their landward extremities.

Nevertheless, they represent the later stages of a chenier plain that has prograded over the last 2000 years (Greensmith and Tucker, 1975).

An increase in mean high-water level could be expected to give rise to a change in community composition as a result of increased frequency and duration of submergence. Increased erosion may result simply from changes in the wave climate (Boorman *et al.,* 1989). Despite the retreat of the marsh by some 40 m between 1955 and 1988 (1.2 m a^{-1}), Reed (1988) observed no signs that vegetation at Dengie was stressed. Vertical accretion is taking place at the same time as lateral erosion of the marsh front (Pethick, 1991) and so the marsh surface is able to keep pace with the regional rise in sea level. The adjacent mudflats adjust to sea-level rise by flattening their profile from the land towards the sea. In these circumstances, the saltmarsh is expendable as it provides a supply of sediment to the mudflats (Pethick, 1991). Pethick (1989, 1991) records that major storms in January 1989 brought about both retreat of the marsh front and flattening of the profile of the mudflats. A storm event in October 1989 (Pethick, 1992) with a calculated return period of 1 in 33 years and waves of significant height of 3.4 m produced marsh edge retreat of 5 m. The horizontal surface was also lowered. Between October 1989 and March 1990 the marsh surface recovered its pre-storm altitude and by October 1990 was slightly higher (Pethick, 1992). However, as the frequency and magnitude of extreme events may be increasing (Carter and Draper, 1988), the role of storms in this process of mudflat flattening may become increasingly significant if their frequency exceeds the recovery period.

Harmsworth and Long (1986) argued that the erosion of the saltmarsh edge may result from a change of sea level (or inundation) produced by sinking of the saltmarsh area, a pattern that contrasts with upwards growth during periods of sea-level still-stand. An alternative explanation, specific to Dengie, could be the increased exposure of the saltmarsh that resulted from the loss from the intertidal mudflats of beds of eelgrass *Zostera marina,* which was wiped out by disease in the 1930s (Harmsworth and Long, 1986).

The saltmarshes here are an important area for an examination of saltmarsh sedimentation and erosion, and the linkage between tidal dynamics and sediment transport from intertidal mudflats. Parts of the saltmarshes include subsurface pipes that affect drainage as well as the development of collapse features on the marshes and may account for some development of saltpans (Leeks, 1979). Reed (1988) noted that the Dengie peninsula is affected by a sea-level rise of about 3 mm a^{-1}. However, saltmarsh vegetation shows no sign of stress due to increased submergence incidence. Reed argues that this shows that continued accretion of the marsh sur face is taking place. This accretion depends, however, upon the direct supply of sediment, during over-marsh tides, from the erosion of the marsh edge (Reed, 1988). The sediment pathways depend, however, upon the velocities that occur within creeks, for example in Bridge Creek on Dengie Marsh, velocity pulses occur on flood tides (Reed, 1987). More critically, she demonstrated that it is essential for the variability of velocity within creek systems to be observed before the time interval for sampling of velocity and discharge in tidal creeks is determined. It follows that calculation of sediment fluxes within creeks may be significantly affected by the temporal sampling as well as its spatial extent. Asymmetry of discharge in creeks plays a significant role in the distribution of sediment within the saltmarsh (Reed, 1987). Stoddart and Bayliss-Smith (1985) have shown, as a result of examining some 700 tidal cycles in these salt-marsh systems, that there is a strong positive sediment flux.

The relationship between the saltmarsh and the sea-walls is a particularly important one. First, the presence of the wall prevents migration of the saltmarsh inland under conditions of rising sea-level. Second, however, the saltmarsh acts as a very important element of coast protection (Pye and French, 1993). Frey and Basan (1985) have suggested that the height of waves crossing saltmarsh can be reduced by as much as 71% and wave energy by 92%. Maximum wave height in storms is reported as being 1 m lower where sea-walls are fronted by saltmarsh (Anglian Water Authority, 1980).

Conclusions

Many GCR sites include saltmarsh features, but Dengie Marsh is one of the few where the salt-marsh is the predominant reason for its inclusion in the GCR and where there have been detailed investigations over several years of the dynamics of the saltmarsh creeks and their role in the overall development of the saltmarsh.

Dengie Marsh is important, firstly because of the development of a substantial chenier plain of which the modern part remains intact and within the site. In particular, the Essex cheniers contrast with the type-form described in Louisiana. In Britain, such features have not been reported often, and where they do occur, for example in Poole Harbour or the Solent, they have not been described in detail. Secondly, Dengie Marsh is important as a research site for monitoring the relationship between saltmarsh development, sedimentation and creek hydrology. Although these processes have been examined elsewhere, this site is the only one in which the saltmarsh is not protected by artificial beach structures and so provides an important contrast with the sites in north Norfolk. Thirdly, the relationships between erosion of saltmarsh, changing sea level and coast protection have also been investigated at Dengie Marsh. The importance of the site in providing data upon which judgements about coast protection can be based is considerable and is a particularly important application of coastal saltmarsh research.

(Figure 10.1) The generalized distribution of active saltmarshes in Great Britain. Key to GCR sites described in the present chapter or Chapter 11 (coastal assemblage GCR sites): 1. Morrich More; 2. Culbin; 3. North Norfolk Coast; 4. St Osyth Marsh; 5. Dengie Marsh; 6. Keyhaven Marsh, Hurst Castle; 7. Burly Inlet, Carmarthen Bay; 8. Solway Firth, North and South shores; 9. Solway Firth, Cree Estuary; 10. Loch Gruinart, Islay, 11. Holy Island. (After Pye and French, 1993.)

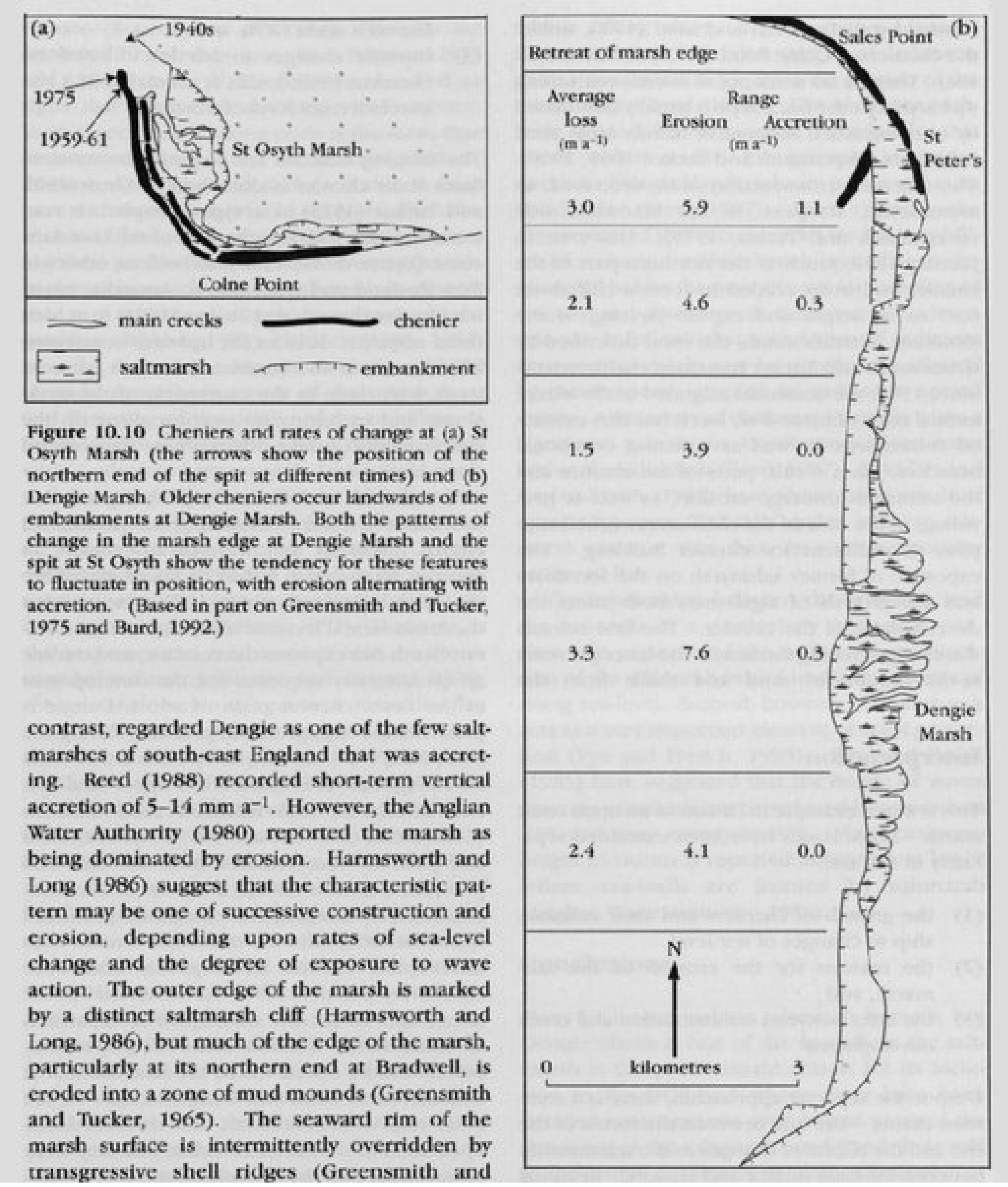

Figure 10.10 Cheniers and rates of change at (a) St Osyth Marsh (the arrows show the position of the northern end of the spit at different times) and (b) Dengie Marsh. Older cheniers occur landwards of the embankments at Dengie Marsh. Both the patterns of change in the marsh edge at Dengie Marsh and the spit at St Osyth show the tendency for these features to fluctuate in position, with erosion alternating with accretion. (Based in part on Greensmith and Tucker, 1975 and Burd, 1992.)

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