Upper Solway flats and marshes (South Shore), Cumbria

[NY 143 569]–[NY 353 648]

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Introduction

The Upper Solway saltmarshes are classic estuarine marshes, which exhibit outstanding geomorphological features. A prominent marsh cliff occurs along most of the seaward edge of the Upper Solway marshes and pinpoints those parts of the marshes that are undergoing erosion. Creek systems in various stages of development are found on all of the saltmarshes and on Burgh and Rockcliffe Marshes exhibit a widely spaced dendritic pattern. Several types of saltpans are also found on the marshes. The saltmarshes exhibit some of the finest examples in Great Britain of marsh terraces that are believed to be formed by creek migration and isostatic uplift.

Description

The saltmarshes on the southern shore of the Solway Firth extend from Grune Point near Skinburness in the west, to Rockcliffe Marsh in the east at the mouth of the Esk (see (Figure 10.1) for general location and (Figure 10.12)). Within Moricambe Bay, *c.* 1190 ha of saltmarsh extends from Skinburness Marsh south of Grune Point towards the south-east, and includes Newton Marsh, which lies between the estuaries of the rivers Waver and Wampool. Marsh is absent from the north-east shore of Moricambe Bay but occurs along a narrow fringe at Cardurnock Flatts. At Burgh Marsh, to the south of the River Eden estuary, the *c.* 524 ha (Burd, 1989) of salt-marsh is up to 1.25 km wide and is unbroken by large creeks. Rockcliffe Marsh extends to about 565 ha (Burd, 1989) and reaches over 3 km wide although it is punctuated by wide creek mouths. As with most of the Solway marshes, the Upper Solway marshes are often backed by low terraces that separate the present saltmarsh from the emerged carse surfaces, which lie to the landward side. All of these salunarshes are based on a fine-grained sandy substrate that supports essentially similar plant communities, namely common saltmarsh–grass–fescue (*Puccinellia–Festuca*)and the dominant species, saltmarsh rush *Juncus gerardii,* which covers up to 64% of the site area (Burd, 1989). Rockcliffe is particularly important in terms of its size and its retention of an unusually wide transition between non-saline and saline habitats. Transitional grassland plants such as dog's-tail grass *Cynosurus,* buttercup *Ranunculus,* clover *Difolium* and hawkbit *Leontodon* are found in abundance on these marshes but are not found at all in estuaries to the south of Ravenglass (Fahy *et al*., 1993). *Spartina* is not yet widespread in the Solway but is found at Southwick in small amounts and at Orchardton, on the northern side of the Solway.

The northern shore of Grune Point is composed of a gravel spit upper beach fronted by 500 m of sandflats extending to low water. Active longshore drift of gravels occurs northwestward along the northern shore (Fahy *et al*., 1993) and provides shelter for the development of saltmarshes within Moricambe Bay. The highest parts of Grune Point, particularly along the north-western side, are locally capped by dune sand. Skinburness Marsh lies south of Grune Point and is well terraced with extensive creek and saltpan development terminating at a rapidly accreting frontal margin close to Grune Point (Perkins, 1973) that is dominated by samphire *Salicornia* (Marshall, 1962). Elsewhere the marsh edge is cliffed and subject to intermittent erosion. The marshes of Moricambe Bay were noted by Marshall (1962) to be composed of over 90% fine-grained sand in both the saltmarshes and the bare sandflats, a characteristic shared throughout the Upper Solway. Most of the fine-grained sand was regarded by Marshall to be of marine origin, although some may have been reworked from the fine-grained sands of the emerged carse deposits. The modern marshes are terraced with small steps of between 0.3 m and 0.6 m in height occurring between the terraces. The higher of these terraces often separates the present marsh from the emerged carse behind. The emerged carse surface also displays terraces, the lower of which reaches up to 6.4 m OD, with the upper terrace attaining +7.3 m OD at Moricambe Bay and Burgh Marsh.

A major area of saltmarsh occurs along the southern shore of the Eden estuary at Burgh Marsh (Figure 10.12). The channel of the River Eden flows along the front edge of the marsh and appears to be migrating southwards in this area at the present time so that there is an absence of significant sandflat in front of the salt-marsh. However, extensive sandflat occurs on the northern side of the Eden channel and on the south side of the Esk channel. The highest parts of these sandflats have developed into saltmarshes dominated by saltmarsh rush *Juncus gerardii* with common saltmarsh-grass *Puccinellia* and fescue *Festuca* (Firth *et al.,* 2000). Allen (1989) reports relict, partially buried, erosional bluffs on the surface of Burgh Marsh, which are interpreted to indicate that oscillations in the proximity of the channel of the Eden over time, that have resulted in cycles of erosion and accretion.

The largest expanse of saltmarsh in the Upper Solway is Rockcliffe Marsh (Figure 10.17). Much of the upper central saltmarsh is relatively flat but around the margins and in the western part the marsh surface is incised by numerous creeks with extensive intervening areas of saltpans. Many of the creek mouths on the north-eastern margin adjacent to the Esk channel are narrow and deeply incised, although elsewhere on the north-west and southern margin the creeks are wide and characterized by areas of accretion with pioneer vegetation. Both the northern and southern margins have been expanding rapidly in response to the migration of the Esk and Eden channels towards the north and south respectively, leaving between a large low-energy zone that is occupied by the present marsh. Maps dating back to 1776 (ABP, 1991, in Black *et al.,* 1994) suggest that this is part of a long-term trend initiated by the southwards migration of the channel of the River Eden in the 19th century, but continued land uplift almost certainly contributes to the creation of a more emergent surface (Firth *et al.,* 2000). Between 1946 and 1973, Rockcliffe Marsh experienced a net expansion of 414 ha (15 ha a^{-1}) (Rowe, 1978).

Interpretation

The vegetation quality and degree of development on the Upper Solway marshes is thought to indicate that they comprise a relatively old, stabilized marsh system (Burd, 1989). The presence of eroded seaward edges up to 2 m high on many of the marshes lends support to this hypothesis and suggests that the developing marshes have been subject to cycles of erosion and deposition depending upon the relative proximity of river channels and the rate of sea-level change. It is likely that the broad transitions to mature upper marsh and freshwater communities that are so well displayed in the Upper Solway marshes are also related to the history of sea-level change experienced by the area. The transitions away from salt-affected vegetation so well-represented on the Upper Solway Marshes are of considerable importance because such zonations have been largely destroyed by land-claim in many other British saltmarsh systems. Although artificial embankments and walls are present along many of the intertidal reaches of rivers draining into the inner Solway and on some low-lying areas inland of Rockcliffe Marsh and Moricambe Bay, direct physical human impact on most of the Upper Solway saltmarshes remains minimal, although some of the saltmarshes have a history of turf-cutting and most are still grazed.

The Upper Solway Marshes also provide the finest examples in Britain of marsh terraces formed by the combined action of creek migration and land uplift. The terraces were first regarded by Dixon *et al.* (1926) as strong evidence for recent changes of sea level. They regarded the combination of gradual seawards decrease in altitude of the emerged 'carse' surfaces and the continued growth of Grune Point and small terraced flats on the modern saltmarsh as evidence for continuous uplift. However, Marshall (1962) interpreted the stepped nature of the marshes to be mainly erosional, since where they were present the terraces never graded into each other and the step was at an approximately constant height. This was thought to demonstrate alternation between erosion and accretion, probably the result of erosion by shifting river channels. The most likely scenario probably involves both of the above processes.

All of the marshes have eroded and accreted large areas during the 20th century. In Moricambe Bay, a loss of 39 ha of saltmarsh at Skinburness Marsh between 1860 and 1900 was balanced by accretion of 105 ha (Steers, 1946a). The *Salicornia*-dominated part of the marsh at Skinburness extended laterally by over 50 m between July 1959 and March 1961 (Marshall, 1962). At this time most of the edge of Burgh Marsh and the south-east edge of Rockcliffe Marsh the edge was characterized by high (2.0 m) cliffs, although elsewhere the marsh edge undergoing erosion was between 0.3 and 0.6 m above the adjacent sandflat (Marshall, 1962). Such erosion in this low wave-energy environment was attributed by Marshall to result largely from shifts in river channels rather than to wave activity. Indeed, with the possible exception of Cardurnock Flans, all of the marshes are sheltered from substantial wave activity The Moricambe Bay marshes are protected by Grune Point and a north-west-facing bay entrance that restricts the fetch of the dominant south-westerly waves. Rockcliffe Marsh lies at the head of a meandering estuary that reduces the access of westerly waves to only 1 km and is fronted by many kilometres of intertidal sand-flats. As a result, patterns of erosion and accretion on the marshes are largely dictated by changes in river channels and by the long-term emergence of the coast.

(Table 10.3) Estimated areal accretion in hectares between 1864 and 1946, 1946 and 1973, 1973 and 1993 for selected inner Solway saltmarshes. (Based on data from Marshall, 1962; Rowe, 1978 and Pye and French, 1993.) All areas in ha. Caerlaverock Marsh is in the Solway Firth (north shore) GCR site.

Marsh	1864	1946	1993	1894–1964	1946–1973[1]	1946–1993[2]
Rockcliffe	664	709	565	+45	+414	–144
Burgh	688	534	524	–154	–82	–10
Skinburness	445	506	n/a	+61	+100	n/a
Caerlaverock	194	607	563	+413	–93	–44

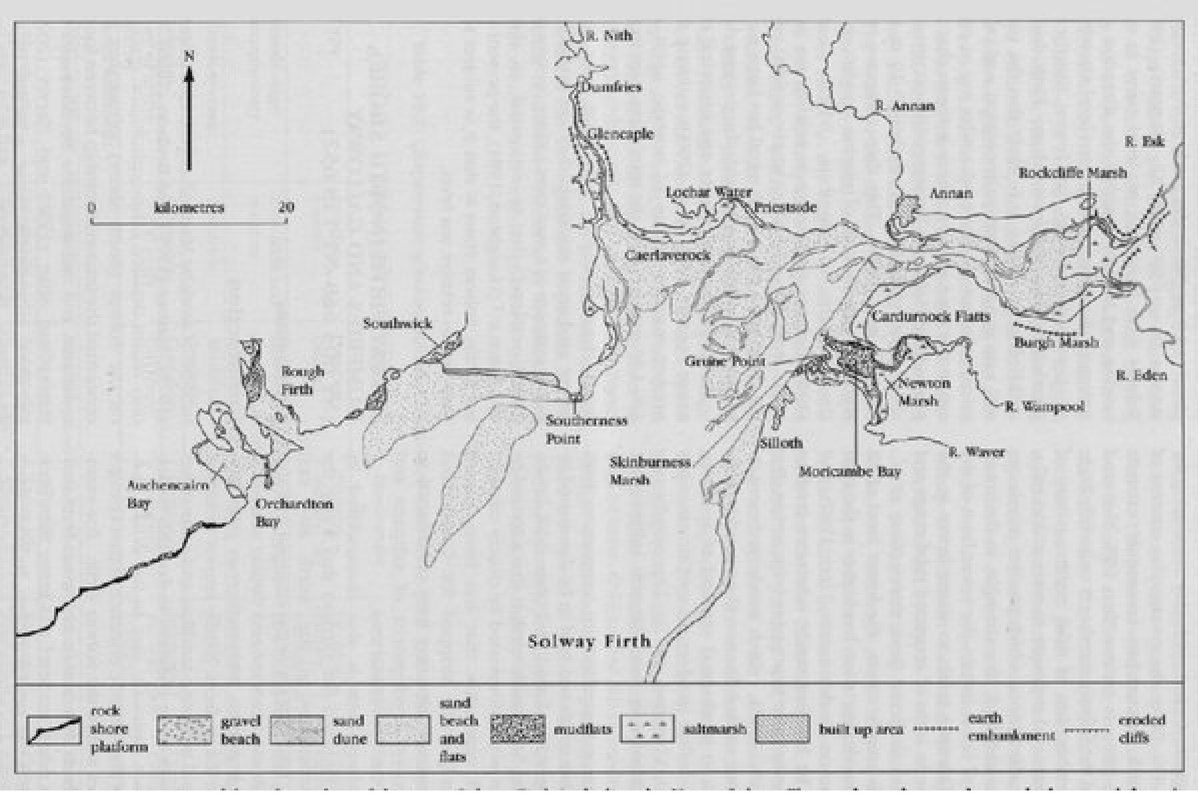
[1] Rowe (1978)
[2] Pye and French (1993)

Long-term estimates of erosion and accretion are possible by using areal comparisons of maps by Marshall (1962) and Pye and French (1993) over the period 1864 to 1993 (Table 10.3). These indicate that Rockcliffe and Skinburness Marshes gained area from 1864 to 1973, but then reduced in area over the period 1946 to 1993. In the (-MSC of Rockcliffe, Rowe (1978) shows that rapid gains were made between 1966 and 1973 (430 ha) but the data of Pye and French (1993) indicate a subsequent loss in area by 1993. Such substantial and recent erosion seems unlikely given the location of Rockcliffe Marsh, and it may be that methodological differences in estimating accretion areas is responsible for this apparent anomaly. Where marsh edges undergoing erosion occur, mapping the boundaries is more secure than where accretion dominates and the actual edge is uncertain and seasonally mobile. (Figure 10.17) shows the marsh edge at Rockcliffe between 1946 and 1978 as mapped by Rowe (1978). It is possible that the apparent present trend towards erosion of the saltmarsh edge suggested by (Table 10.3) is related to the present rise in global sea level of about 1–2.5 mm a^{-1} (Houghton, 1994). The best estimates of actual rates of isostatic uplift in the Upper Solway lie in the range 0.4–0.56 mm a^{-1}, since these compare with uplift rates from recent geological evidence (Firth *et al.,* 2000). It thus appears possible that, after a long period of emergence, the Upper Solway is presently subject to a slow rise in relative sea level and that this may produce a future trend of more-widespread marsh-edge erosion and more-limited and localized areas of salt-marsh accretion.

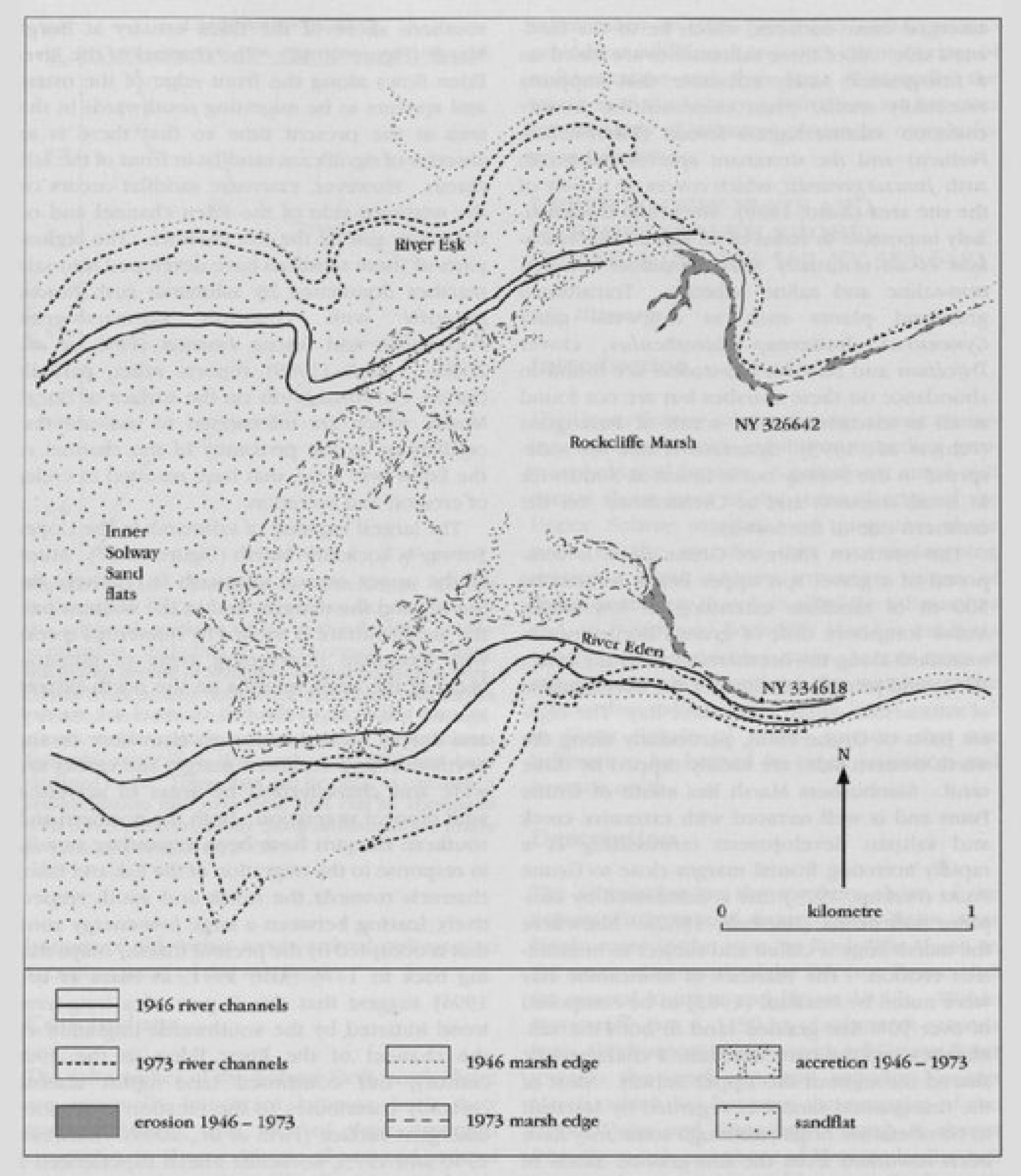
Conclusions

The Upper Solway Marshes together represent an area characterized by outstanding examples of emerged saltmarsh on which the geomorphological and vegetational effects of accretion in an inner estuary location have been accentuated in the past by isostatic uplift. In spite of this, some edges undergoing erosion, and distinct terraces on both the present and emerged marsh surfaces, indicate that changing locations of river and estuary channels are also responsible for cycles of erosion and accretion. At some places and times, such local effects may be more significant to the local development of the marsh than the longer-term effects of isostasy. Although little work has been done on development of these marshes, it is likely that the creek and saltpan networks relate closely to the interaction of erosion and accretion resulting from both local river regimes and general isostatic effects. After a long period of emergence, the more recent trend towards erosion of the saltmarsh edge may be a function of a slow rise in relative sea level.

(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 10.12) Location of the saltmarshes of the inner Solway Firth including the Upper Solway Flats and marshes on the south shore and the saltmarshes of the Solway Firth (north shore). The 2842 ha of saltmarsh found at these sites comprises 79% of all the saltmarsh in the Solway and 8% of all British saltmarshes. (After Pye and French, 1993.)



(Figure 10.17) Migration of the Rivers Esk and Eden over the period 1846–1973 has contributed to rapid accretion and westward migration of Rockcliffe Marsh that continues today. A healthy supply of sediment comes from the extensive nearshore and intertidal sandflats, augmented by fluvial sediment from the two rivers. (After Rowe, 1978.)

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