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CHANGES ON THE COASTLINE OF SOUTHWEST ENGLAND - A REVIEW

by

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A B S T R A C T

During the last hundred years, progradation was uncommon in that area. It had only minimal association with cliff erosion. It concerned mainly the free distal ends of sand and shingle spits, the artificial constructions which interrupt longshore sediment transport, and was related in Cornwall with deposition of china clay spoil. It occured also on beaches where erosion in one sector is accompanied by accretion on another. Cliff erosion is concentrated along clay and sand coasts. On beaches, the largest volumes are moved in transfers between upper and lower beaches in storms. Many beaches depend on links with the nearshore seabed. Generally beaches appear to be in decline, but this seems to be independent of cliff protection.

R E S U M E

Pendant les cent dernières années, les plages de cette région ont été rarement progradées, et une telle progradation a eu peu de relations avec l'érosion concomitante de falaises. Elle s'est produite surtout à des extrémités distales de flèches de sable et de galets, ou à la suite de constructions artificielles interrompant la dérive littorale, ou bien là où l'on a déversé des restes d'exploitation de kaolin (Cornwall). Elle est survenue aussi sur des plages où il y a eu érosion par endroits et dépôt en d'autres. L'érosion de falaises se produit surtout dans des argiles et des sables. Les plus grands mouvements de sédiments de plages se font en transferts entre haute et basse plage lors de tempêtes. Beaucoup de plages sont associées aux mouvements dans les fonds voisins. En général, les plages sont plutôt en recul, mais ceci semble indépendant de la protection artificielle des falaises.

K E Y W O R D S : Coastal changes, South-West England, Cliffs, Sandy beaches.

M O T S C L E S : Evolution littorale, Angleterre du Sud-Ouest, Falaises, Plages.

INTRODUCTION

The purpose of this paper is to review the changes which have taken place on the coasts of southwest England during the last hundred years and to examine the role of cliff changes in the development of the sand beaches. The paper concludes with a sample study of a cliff-beach sediment transport system.

The area under study is the long indented coastline of southwest England from Bournemouth on the English Channel coast to Weston-super-Mare on the coast of the Bristol Channel. Although dominated by resistant rocks, this coastline includes many areas of marshes and sandy beaches which are affected by relatively rapid changes. The indented character of the coast causes much isolation of distinct sediment movement cells. Unlike other parts of England and Wales (Figure I) there are few areas where extensive accretion has occurred. Likewise, erosion is restricted and few sea walls have been constructed despite the growth of tourist resorts.

1. CHANGES DURING THE LAST HUNDRED YEARS

1.1. The Royal Commission on Coast Erosion (RCCE)

The RCCE reported in 1911 that 19426 ha of land had been gained during the previous 30 years, but only 2687 ha lost. It also noted that 28372 ha intertidal land was lost to the sea in contrast to 9322 ha gained. The intertidal zone was becoming steeper, but the implications were either ignored or overlooked. Without exception, writers since RCCE have emphasised the net gain of land, but have failed to recognise that a net volumetric loss of coastal sediment was taking place. The pattern reported by RCCE (1911) is repeated in SW England (Table 1).

TABLE 1

Coastline changes in SW England (RCCE 1911)

County	Net change	
	Land Area	Intertidal Area
Dorset	+ 7	- 54
Devon	+ 41	- 158
Cornwall	+ 17	- 21
Somerset	+ 90	- 265

COASTAL CHANGES

since c.1870

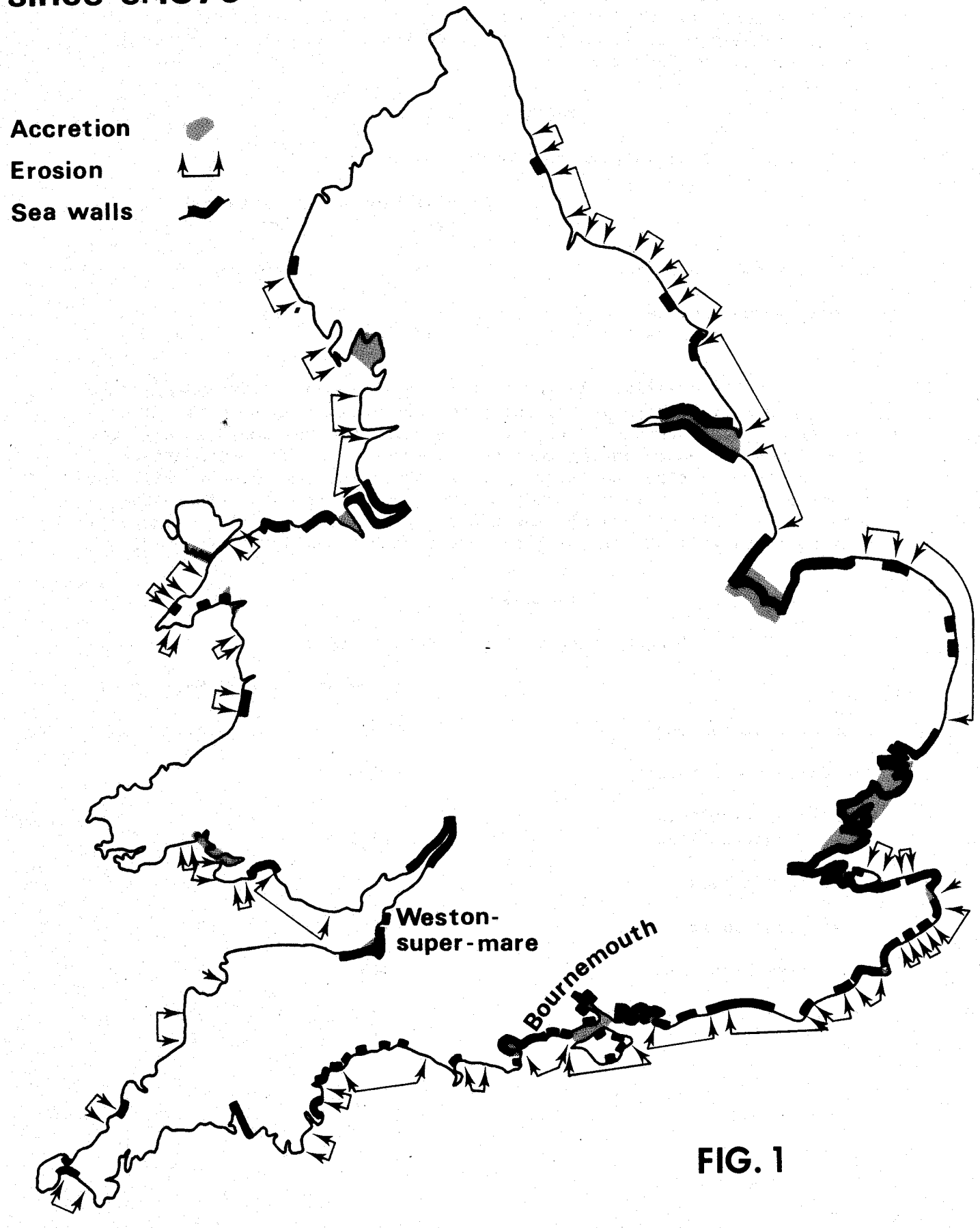


FIG. 1

1.2. Changes since RCCE

Much of the coastline of southern Britain has been protected by sea walls, but these engineering works have been concentrated in SE England (Figure I). In SW England, E. Dorset and SE Devon where cliffs are cut in weaker sands, shales and clays are the main areas of coastal engineering works (Table 2).

TABLE 2

Coastline protection by sea walls.

	Coastal length km	Protected km	%
Kent, Sussex & Hampshire	548	302	55
Dorset, Devon, Cornwall & Somerset	987	80	8

The coastline is marked by very little net progradation during the last hundred years. Despite the limitations pointed out by Carr (1962), the Ordnance Survey plans remain the most accessible source of evidence of change during the last hundred years. From comparison of plans surveyed during the latter part of the nineteenth century with more recent re-survey, it is evident that progradation is associated mainly with the free distal ends of sand and shingle spits, and with artificial constructions which interrupt longshore sediment transport (Table 3)

TABLE 3

Length of prograding coastline (km)

	SE England	SW England
Free spit distal end	19.7	5.0
Sand or shingle beach	9.0	7.5
Updrift of artificial constructions	15.2	-
Cliff foot debris	3.6	-
Total progradation	47.5	12.5
Total coastline	640	895
% progradation	7.4	1.3

Progradation is associated in SW England with two main processes:

a. redistribution of sediment on beaches where erosion on one sector is accompanied by accretion on another.

b. deposition of china clay spoil.

1.3. Redistribution of sediment

There have been a number of separate studies of beaches in SW England (Diver 1931, Kidson 1964, Robinson 1975, 1955, Carr 1971, Steers 1964) which have the common characteristic that erosion in one part is accompanied by deposition in another. Little sediment reaches these beaches from cliff erosion and the compartment - alisation of the coastline inhibits longshore sediment transfers. At Teignmouth, Robinson (1975) has argued that a cell of sediment movement receives no input from either north where walls built about 1840 prevent cliff erosion or south, a view disputed by the Hydraulics Research Station (1958). At Dawlish, Kidson (1964) reported that growth of the spit towards the east was accompanied by erosion of its landward end. Shingle ridges at Torcross and Hurst Castle have been eroded at their landward ends. At South Haven, Carr (1971) has demonstrated that erosion at its southern end (whence sediment is transported) is associated with deposition further north.

1.4. Deposition of mining spoil

Everard (1959) has shown that the deposition of spoil from china clay mining in Cornwall has brought about progradation of beaches at Pentewan, Carlyon and Par. The Royal Commission on Environmental Pollution (1972) estimated that about 1 000 000 tonnes per year of china clay waste enter Mevagissey and St Austell Bays.

1.5. The impact of recreation

Although trampling by visitors and the resulting gullying and destruction of vegetation are locally a problem, only small quantities of sediment are added to the coastal sediment budget. At Kynance Cove, Goldsmith (1978) estimated that 150 tonnes of soil was eroded by trampling and at Hengistbury Head about 9×10^3 m^3 has been eroded by trampling but 1.02×10^6 m^3 by subaerial and marine processes since 1969. At Cubert Common established relic dunes have recently been eroded where vegetation was damaged by grazing horses and cattle and by cars. The perceived damage is much greater in all these cases than the geomorphological changes which take place.

1.6. Changes in coastal marshes

The most rapid natural changes in coastal marshes during the last hundred years were associated with the spread of Spartina X which reached its maximum extent about 50 years ago. There has since been a general reduction in its area, partly associated with reclamation of the landward areas (Table 4).

TABLE 4

Changes in marshland since c.1800

Estuary	Total ha	Reclamation ha	%
Poole Harbour	227	98	43
Southampton	675	575	85
Portsmouth	237	183	77
Langstone	74	74	100
Chichester	280	253	90
Total	1493	1183	79

1.7. Cliff changes

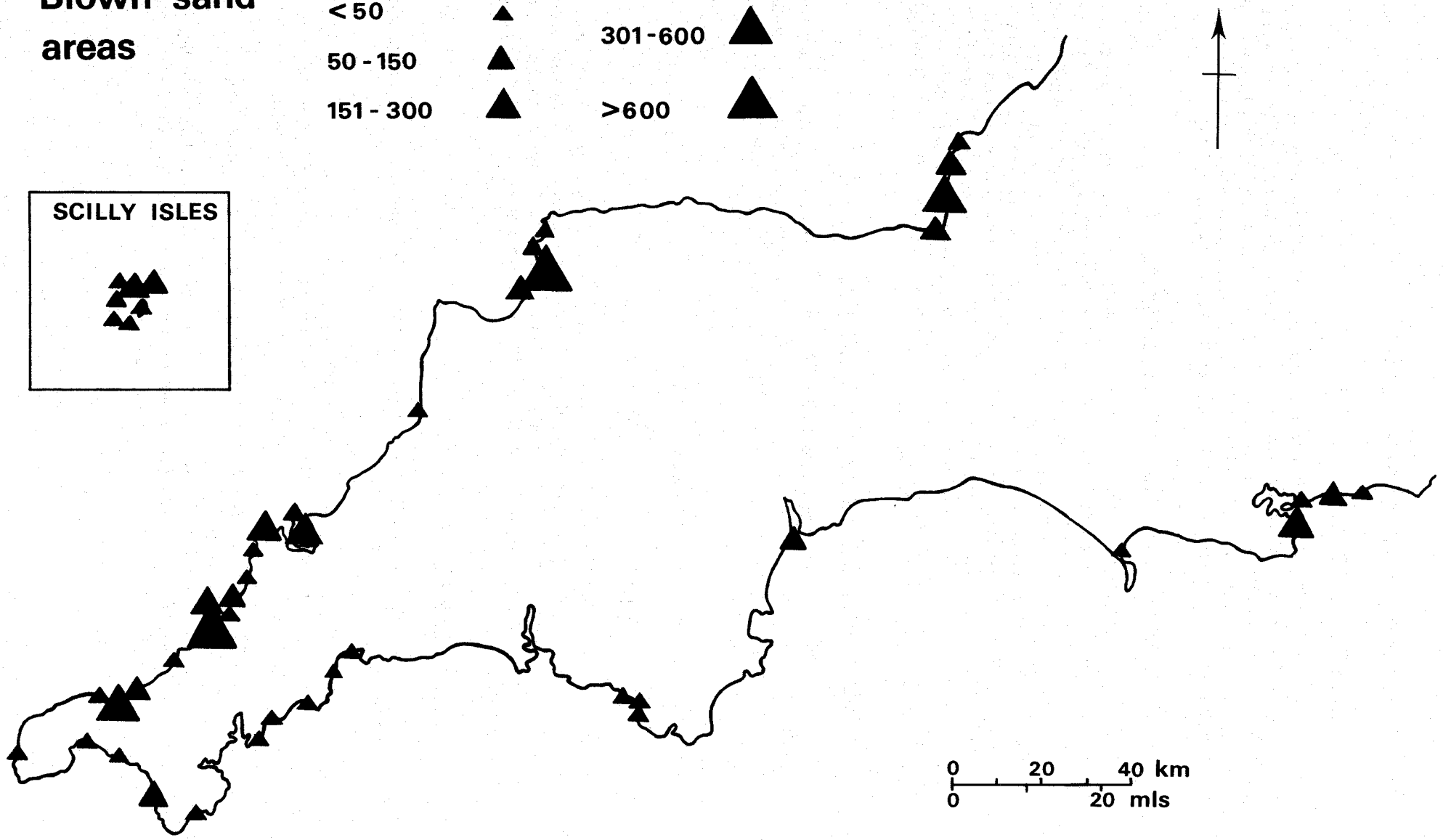
No study of this coastline can ignore the considerable changes in cliff form which have occurred in the landslides of east Devon and west Dorset. They have been well documented (e.g. Arber 1941, Brunsden and Jones 1976). Changes are frequent but because of the high clay content of these cliffs, little change results in the subjacent beaches. The most rapid changes have occurred in south east Dorset where Tertiary sands and clays outcrop.

1.8. Sediment storage

There are extensive areas of both active and stabilised blown sand around SW England (Figure 2). Some of these areas have been built upon (e.g. Weston-super-Mare) or used as golf courses. Erosion by wind or as a result of recreational trampling redistributes this sand within these dune systems. Only very small amounts of sediment leave these sediment stores to enter the beach systems.

FIG. 2

Blown sand areas



2. SEDIMENT BUDGETS AND CLIFF EROSION

2.1. Present knowledge

Hails (1977) has recently reiterated the view expressed by Steers (1962) that little was known of the relationship between eroding cliffs and the beaches associated with them. Most studies of eroding coasts have emphasised the cliffs or the beaches, although there are some notable exceptions (Zeigler et al 1964, Clayton 1977).

2.2. Magnitude and frequency of cliff changes

Cliffs are affected by a spectrum of changes of varying magnitudes and frequencies. Many small frequent events at the cliff foot or on the cliff face may be as important as a single large change in the cliff top. In SW England, cliff changes are not continuous but take place at infrequent intervals usually associated with infrequent meteorological or oceanic events. Near Brixham, heavy prolonged rainfall and high tides associated with gales, initiate most change (Derbyshire et al 1979). Brunsden and Jones (in press) believe that changes in the complex cliffs of Fairy Dell indicate a cyclic pattern of development with a return period of about 100 years.

2.3. Contribution of cliff erosion to beaches

The present contribution of cliff erosion to beach development is small, most material currently entering the beaches being fine sand or smaller in size. Many cliffs have been protected and many others erode only very slowly.

3. RECENT CHANGES IN SOUTH EAST DORSET

3.1. Coastal changes

The coastline of SE Dorset illustrates many of the characteristics of SW England and its recent changes emphasise the necessity of linking cliff changes and beach development. Most of the coastline has now been protected by walls near Bournemouth, but progradation continues at South Haven.

3.2. Sediment sources (Figure 3)

During the last decade, sediment has reached the coastline from three main sources:

a. rivers flowing into the estuaries.
Most of this sediment is fine and remains within the estuaries as a result of flocculation and marsh sedimentation.

b. cliff erosion, increasingly limited by protection works.

c. offshore banks, as a result of a beach replenishment scheme by which sand was dredged from banks about 8 km south of Bournemouth and transported to the beaches.

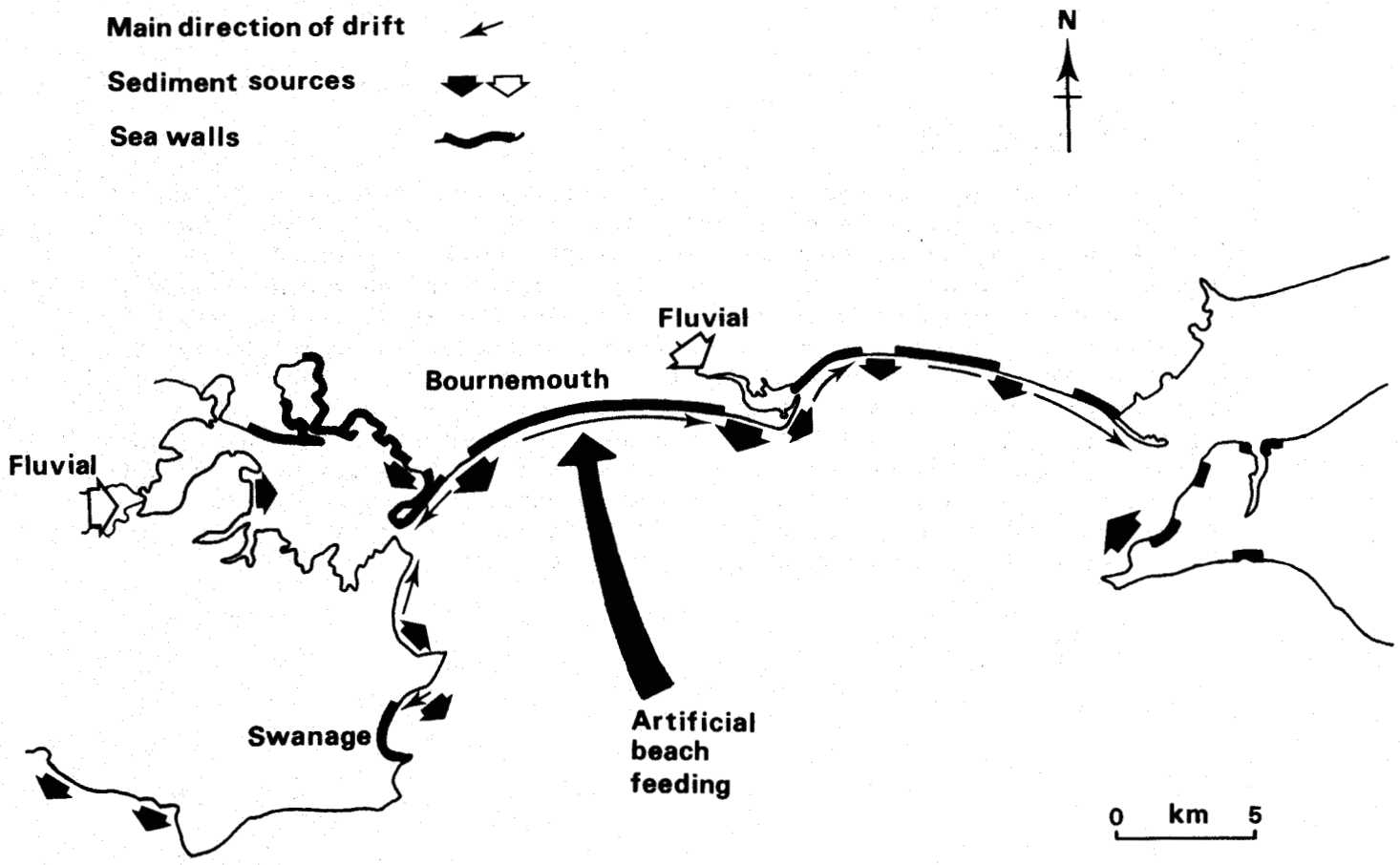


Fig 3

3.3. Sediment transport

On the open coast, sediment transport is generally from west to east. It is modified at the mouth of Poole Harbour (Figure 3). The sandy beach at Studland has become progressively narrower whereas further north it has widened. Chalk pebbles from the cliffs of Ballard Down travel about 1.5 km before destruction. Active cliff erosion at Hengistbury Head produces small additions to the beaches which are transported eastwards to be trapped by a large groyne constructed in 1938.

3.4. Cliff-beach relationships

Because the total volume of cliff derived sediment is small when compared to the total beach volume, and much larger volumes are moved in transfers between upper and lower beaches in storms, it was felt necessary to survey regularly and intensively a small area of cliff and beach. Surveys since 1967 have therefore concentrated on the cliffs and winged spit at Shipstal Point (May 1976). The nature of the coastline here is such that there is only one direct source of beach sediment, the eroding cliffs. Erosion of the cliffs has been infrequent and so changes in the beach following an input of sediment can be assessed. Initial results suggested that major cliff changes produced a response in subjacent beaches which was large but rapidly disappeared. Towards the spit distal end, a much dampened and lagged response occurred (Figure 4). More recent results confirm the cliff foot response but do not reveal the more distant lagged response.

3.5. Wider application

Study of the beaches at Studland reveal relic forms and a wide historical beach which is being investigated further. The volume of sediment eroded along the beach is about one tenth of the volume deposited. The cliffs are not eroding sufficiently rapidly to maintain the sediment supply. The offshore supply needs further investigation. Yet the Shipstal Point study shows that a very small cliff (250 m) can produce and maintain a total beach length of 500 m. Nevertheless it is unusual, for the characteristic pattern of progradation is associated not with cliff erosion but with transfers from offshore banks to beaches and along shore (Carter 1975). This is nowhere better illustrated than at East Head in West Sussex where despite the recent prevention of cliff erosion and longshore transport by the construction of walls and groynes, a dune system has grown steadily in area. At the same time, offshore banks have diminished.

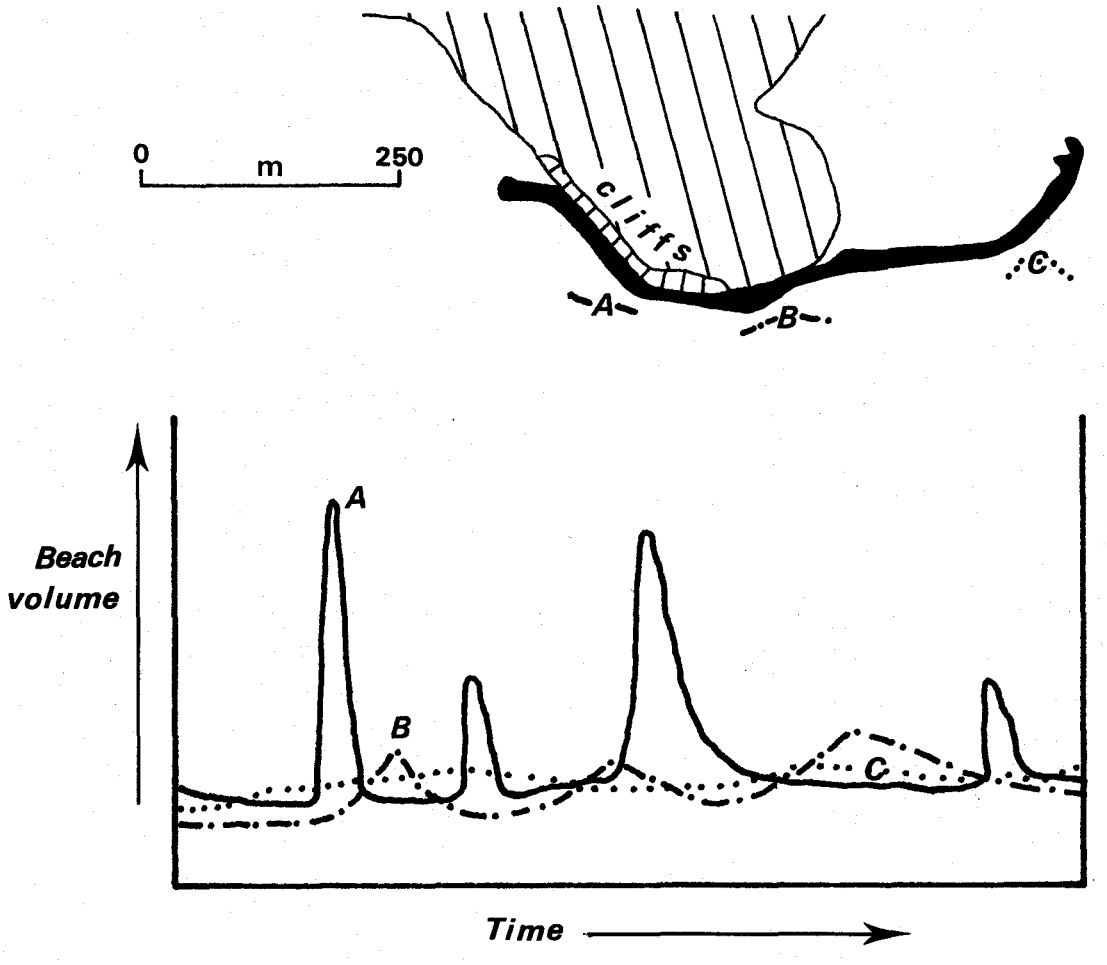


Fig 4 Beach response to cliff erosion

TABLE 5

Areal changes in East Head

Date	Area (ha)
1846	8.9
1875	5.2
1898	6.5
1911	2.3
1933	17.9
Seawalls and groynes constructed 1950 onwards	
1975	30.8

CONCLUSION

The limited progradation of beaches in SW England has only minimal association with cliff erosion. Longshore transport of sediment is inhibited by the complexity of the coastline. Many beaches depend on links between the nearshore seabed and the beaches. Further research is necessary to establish these links as well as to identify the relationships between cliff changes and beach development. Generally beaches appear to be in a stage of decline, but changes seem to be independent of cliff protection.

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