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World-wide trends in sandy shoreline changes during the past century
Les tendances mondiales de l'évolution des rivages sableux au cours du siècle dernier

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Article abstract

According to most specialists, during the past century, erosion has been prevalent on sandy shorelines around the World, while sectors of continuing progradation are very restricted. On the world scale the assumption that erosion on some sectors of sandy shorelines is balanced by deposition on other sectors has been shown to be incorrect. A brief analysis of the situation is made. Sectors of sandy shorelines that have advanced during the past century fall into one of the nine categories defined. In addition, nine factors are discussed in regard to sandy shoreline erosion. It is concluded that there is no single explanation to account for the modern prevalence of erosion on the world's sandy shorelines. Further investigations are needed to understand properly both the patterns and rates of changes on sandy shorelines.

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Notes

WORLD-WIDE TRENDS IN SANDY SHORELINE CHANGES DURING THE PAST CENTURY

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ABSTRACT According to most specialists, during the past century, erosion has been prevalent on sandy shorelines around the World, while sectors of continuing progradation are very restricted. On the world scale the assumption that erosion on some sectors of sandy shorelines is balanced by deposition on other sectors has been shown to be incorrect. A brief analysis of the situation is made. Sectors of sandy shorelines that have advanced during the past century fall into one of the nine categories defined. In addition, nine factors are discussed in regard to sandy shoreline erosion. It is concluded that there is no single explanation to account for the modern prevalence of erosion on the world's sandy shorelines. Further investigations are needed to understand properly both the patterns and rates of changes on sandy shorelines.

RÉSUMÉ *Les tendances mondiales de l'évolution des rivages sableux au cours du siècle dernier*. De l'avis de la majorité des spécialistes, au cours du siècle dernier, l'érosion des rivages sableux a prévalu un peu partout dans le monde, alors que l'accumulation a été restreinte à quelques secteurs seulement. L'opinion générale affirmant qu'à l'échelle mondiale l'érosion est contrebalancée par l'accumulation se révèle inexacte. L'auteur analyse brièvement la situation. Il regroupe en neuf catégories les côtes sableuses accusant des gains et énonce neuf facteurs rendant compte de l'érosion des rivages sableux. Il n'existe pas de cause unique et simple expliquant la tendance récente à l'érosion des côtes sableuses dans le monde. Les données disponibles demeurant insuffisantes à une analyse adéquate de la situation, un effort doit être fait en ce sens.

INTRODUCTION

During the 22nd International Geographical Congress, held in Canada in 1972, a group of coastal geomorphologists met in Nova Scotia to discuss shoreline changes (McCANN, 1972). In the course of discussion it became clear that erosion was in progress on many sandy shorelines, while sectors of active progradation were difficult to find. A Working Group on the Dynamics of Shoreline Erosion, established during the Montréal congress to investigate this topic world-wide, produced a preliminary report for the succeeding I.G.C. in Moscow (BIRD, 1973, 1976). The project then continued as part of the work of the Commission on the Coastal Environment, which replaced the previous Working Group, and a final report was presented to the 24th I.G.C. in Tokyo in 1980 (BIRD, 1981).

The conclusion, based on reports from over 100 correspondents around the world's coasts, was that erosion has indeed become prevalent on sandy shorelines, and that sectors of continuing progradation are very restricted. During the past century most sandy shorelines have retreated steadily or intermittently; some have shown alternations of advance and retreat, the retreat usually exceeding the advance; and only a few have advanced steadily. Within Canada, this generalisation is applicable to the sandy shorelines that border the Gulf of St. Lawrence, especially in New Brunswick and along the north coast of Prince Edward Island, and even to the extensive sandy formations of the Magdalen Islands (DIONNE, 1980; DRAPEAU, 1980). Erosion is also predominant on sandy beaches along the intricate shoreline of British Columbia. On the world scale the assumption that erosion on some sandy shorelines is probably balanced by deposition on others, implicit in many texbooks on coastal geomorphology, has been shown to be incorrect. In particular, sandy barriers that have prograded earlier in Holocene times, (after the Holocene marine transgression [Fig. 1] established present sea level) in stages marked by successively-formed beach ridges and dunes, now commonly show truncation of their seaward margins, progradation having given place to erosion (Fig. 2). This reversal took place earlier on some sectors than others, but erosion is now prevalent. In analysing this situation it is convenient to consider first the limited sectors where sandy shorelines have prograded during the past century.

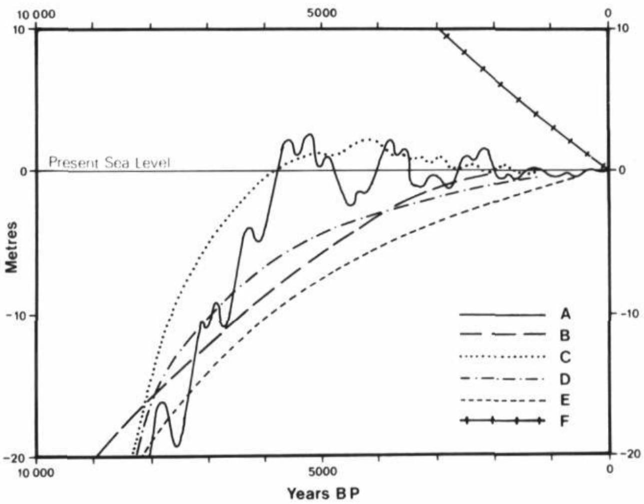

FIGURE 1. Holocene variations in World sea level; A, according to FAIRBRIDGE (1961); B, according to SHEPARD (1963); C, New Zealand; D, Southern England; E, New England; F, Arctic Canada (based on data in BLOOM, 1977).

Variations du niveau marin mondial au cours de l'Holocène: A, d'après FAIRBRIDGE (1961); B, d'après SHEPARD (1963); C, Nouvelle-Zélande; D, sud de l'Angleterre; E, Nouvelle-Angleterre; F, Arctique canadien; (d'après les données de BLOOM, 1977).

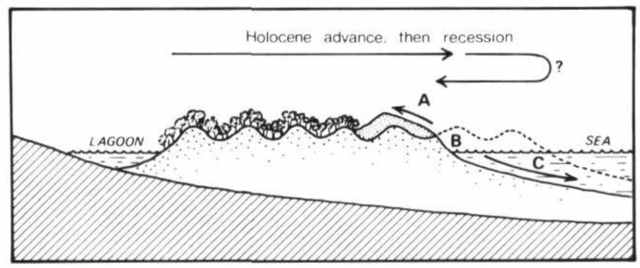

FIGURE 2. Transverse profiles of sandy barrier formations typically show Holocene progradation with successive ridge formation (to C) followed by late Holocene recession (C to B, often with dunes spilling inland, A).

Des coupes transversales de flèches d'avant-côte montrent d'une façon typique une progradation soulignée par la succession des cordons littoraux au début de l'Holocène (jusqu'à C), puis un recul à l'Holocène récent (C à B, avec souvent des dunes progressant vers l'intérieur, A).

PROGRADING SANDY SHORELINES

Sectors of sandy shorelines that have advanced during the past century fall into one or more of the following categories:

1) Close to mouths of rivers that are delivering sandy sediment to the sea (*e.g.* the Columbia River in north-western U.S.A., other rivers that are still building deltas, and streams that drain high hinterlands in humid environments, as in Japan and New Zealand).

2) Near cliffs where arenaceous rocks are being eroded to produce sandy material, as on the Makran coast of Pakistan.

3) Where sand dunes are being blown into the sea from the interior, as in south-east Qatar and on the Namibian coast.

4) Where sandy sediment is being carried in from reefs or shoals on the adjacent sea floor, a process that has been identified at Streaky Bay and Corner Inlet in S.E. Australia (BIRD, 1978), St. Vincent Island, Florida (STAPOR, 1971), the barrier islands of S.W. Jutland (BIRD, 1974), and the glacio-volcanic province of S.E. Iceland (BODÉRÉ, 1979). Such shoreward drifting can be aided by tectonic uplift as on the Island of Laesø in the Kattegat (BIRD, 1974), or by the shallowing of nearshore seas, as around the Caspian coasts, but it is evident in eastern Canada that continuing land uplift is no guarantee of sandy shoreline progradation.

5) Where sand from eroding beaches is being carried alongshore and deposited on accreting sectors, notably on spits, cuspate forelands, or barrier islands. The many examples of this include spits such as Cape Cod, the Pointe de la Coubre and Pointe d'Arcay in western France, the Darss foreland on the German Baltic coast, and the sandy capes of the Atlantic coast of the U.S.A. Sectors of local accretion explicable in this way are found on the sandy barrier islands of Kouchibouguac Bay in New Brunswick, and on Prince Edward Island (McCANN and BRYANT, 1972; OWENS, 1974).

6) Where longshore drift of sand is being intercepted by headlands, as on the California coast at Point Dume (SHEPARD and WANLESS, 1972), and at Apam, where a promontory traps sand drifting eastward along the Ghana coast (DEI, 1972).

7) Where longshore drift of sand is being intercepted by current outflow at the mouths of rivers and at tidal inlets, as at Barnegat Inlet, New Jersey (SHEPARD and WANLESS, 1972).

8) Where longshore drift of sand is being intercepted alongside artificial structures such as harbour breakwaters, as at Santa Barbara in California, and at the ports of Lagos in Nigeria, Durban in South Africa, Madras in India, and Sochi on the Soviet Black Sea coast. Accretion in the lee of an offshore breakwater is exemplified at Santa Monica, California, and a wrecked ship off Sukumi Cape on the Soviet Black Sea coast has induced similar local progradation.

9) Where sandy material is being dumped on the coast by man, usually with the intention of artificially creating or restoring a beach. Examples of this are seen at Atlantic City in the U.S.A., Bournemouth in England, and Mentone on the shores of Port Phillip Bay, Australia (BIRD, 1979). In most cases the sand has been dredged from the sea floor and carried in on barges or pumped

in through pipes, but on the Soviet Black Sea coast sand (and gravel) have been brought to the coast from hinterland quarries.

Of these nine situations, numbers 1 (fluvial supply), 4 (shoreward drifting from the sea floor), 5 (accretion fed by nearby beach erosion), and 8 (interception by breakwaters) are widely encountered, the others being relatively rare. With this as background, it is possible to examine the various factors responsible for the modern prevalence of sandy shoreline erosion.

SANDY SHORELINE EROSION

In assessing sandy shoreline erosion the following factors should be considered:

1) Fluvial sediment yields from many rivers have diminished as a consequence of dam construction and reservoir impoundment, and the onset of erosion on many deltas can be correlated with this. On the Nile delta, for example, sandy shoreline erosion attained 40 metres a year after the completion of the Aswan High Dam in 1964 (ORLOVA and ZENKOVICH, 1974). However, there are many sectors of sandy shoreline remote from such river mouths where erosion has become prevalent, and for these some other explanation is necessary.

2) Supply of beach material from cliff erosion has been much reduced, and often halted, by the building of sea walls designed to prevent further erosion. Beaches at Bournemouth in England and on the north-east coast of Port Phillip Bay in Australia became depleted after such sea walls cut off the supply of sand that previously maintained them.

3) There are many local examples of the onset of erosion downdrift of breakwaters that have intercepted the longshore drift of sand (see 6 above).

4) On some coasts, removal of sand from beaches for road-making and building use has initiated or accelerated shoreline erosion.

5) Beaches lose sediment by longshore drifting to other sectors of the coast, by leakage into the mouths of estuaries and embayments, tidal inlets or lagoon entrances, by removal of wind-blown sand to backshore dunes, and by overwash to backing lagoons and swamps. Where these losses are not compensated by the arrival of fresh sand, erosion ensues. Beaches are also depleted by the attrition of sands agitated and abraded by wave action, and as the sand grains become finer they are more easily removed by wind action or storm waves.

6) The supply of beach material from eroding cliffs diminishes as cliff erosion decelerates, for example when wave attack is reduced because of the widening of an inter-tidal shore platform during a prolonged stillstand of sea level. Beaches fed from such cliff erosion then diminish in volume, and may be eroded.

7) Coastal submergence (a rise of sea level, coastal land subsidence, or some combination of these) leads to recession of sandy shorelines. Bruun suggested that where such shorelines had previously attained a transverse profile of equilibrium a sea level rise would cause them to be eroded back as sand was transferred from the beach face to the adjacent sea floor (SCHWARTZ, 1967). This sequence has been identified around the Great Lakes during phases of rising water level (DUBOIS, 1976), and has contributed to the erosion in progress on submerging sandy shorelines along the Atlantic coast of the U.S.A. (FISHER and SCHWARTZ, 1980).

8) Shoreward drifting of sand from the sea floor is thought to have nourished many beaches and barriers during and since the world-wide Holocene marine transgression (Fig. 1), and is still continuing where nearshore shoals are present, but where losses from the beach system (5 above) are no longer compensated by the arrival of fresh sand, erosion has become prevalent (TANNER and STAPOR, 1972). It is now believed that this has been a major factor in the Holocene evolution of barrier coasts that first prograded, and now show shoreline recession (BIRD, 1976).

9) An increase in storminess in coastal waters could initiate or accelerate shoreline erosion, at least until a new transverse profile of equilibrium has been attained, adjusted to a more energetic environment. While some coasts show evidence of a response to increased storminess (THOM, 1978), this is unlikely to have been a sufficiently widespread phenomenon to explain the almost world-wide trend to sandy shoreline erosion.

CONCLUSION

It is now evident that no single explanation will account for the modern prevalence of erosion on the world's sandy shorelines. It is not simply the outcome of human activities, or a sea level rise, or an increase in storminess in coastal waters, or the 'maturing of the system' (*e.g.* the dwindling of sand supplies from the sea floor) during the Holocene still-stand. Each of these factors has contributed, to an extent which differs from place to place, to the erosion now seen on sandy shorelines; and there are some sectors where the interacting factors have resulted in continuing progradation. The task of ranking the relevant factors by apportioning their contribution to changes that have occurred on particular sectors requires further investigation, both of patterns and rates of change on sandy shorelines and of the process systems operative in coastal areas.

REFERENCES

BIRD, E.C.F. (1973): Documenting sandy shoreline changes, *Coastal Research Notes*, Vol. 3, No. 12, p. 1-3.

—— (1974): *Coastal changes in Denmark during the past two centuries*, Skrifter 8, Lab. for fysik geografi, Aarhus Univ.

—— (1976): *Shoreline changes during the past century*, (I.G.U. Working Group on the Dynamics of Shoreline Erosion, Melbourne.

—— (1978): The nature and source of beach materials on the Australian coast, *in Landform Evolution in Australasia*, Davis, J. L. and Williams, M.A.J. (eds), Canberra, p. 144-157.

—— (1979): Coastal processes *in Man and Environmental Processes*, Gregory, K.J. and Walling, D.E. (eds.), p. 82-101.

—— (1981): Recent changes on the world's sandy shorelines, *in Coastal Dynamics and Scientific Sites*, Bird, E.C.F. and Koike, K. (eds), Komazawa Univ., Tokyo, p. 5-30.

BLOOM, A.L. (1977): *Atlas of sea-level curves*, IGCP-Sea-level Project 61, 121 p.

BODÉRÉ, J.-C. (1979): Le rôle essentiel des débâcles glacio-volcaniques dans l'évolution récente des côtes sableuses en voie de progradation du sud-est de l'Islande, *in Les côtes Atlantiques de l'Europe*, Guilcher, A. (ed.), p. 55-64.

DEI, L.A. (1972): The central coastal plains of Ghana: a morphological and sedimentological study, *Zeitsh. Geomorph.*, Vol. 16, p. 415-431.

DIONNE, J.-C. (1980): *L'érosion des rives du Saint-Laurent: une menace sérieuse à l'environnement*, Québec, Environnement Canada, Ser. Terres, Rapp. interne, 9 p.

DRAPEAU, G. (1980): Shoreline evolution at the northern end of Iles-de-la-Madeleine, *Proc. Canadian Coastal Conference* (Burlington, Ont.), Ottawa, Nat. Res. Council — ACROSES Publ. No. 2, p. 294-308.

DUBOIS, R.N. (1976): Nearshore evidence in support of the Bruun rule on shore erosion, *J. Geol.*, Vol. 84, p. 485-491.

FAIRBRIDGE, R.W. (1961): Eustatic changes in sea level, *in Physics and Chemistry of the Earth*, vol. 4, L.C. Ahrens *et al.* (eds.), New York, Pergamon Press, p. 99-185.

FISHER, J.J. and SCHWARTZ, M.L. (1980): *Proceedings of the Per Bruun symposium*, Rhode Island, November 1979.

McCANN, S.B. (1972): *Coastal Commission Meeting Ca-5*, 22nd Inter. Geogr. Congress, Canada.

McCANN, S.B. and BRYANT, E.A. (1972): Beach changes and wave conditions, New Brunswick, *Proc. 13th Conf. on Coastal Engineering*, p. 1123-1142.

ORLOVA, G. and ZENKOVICH, V.P. (1974): Erosion on the shores of the Nile delta, *Geoforum*, Vol. 18, p. 68-72.

OWENS, E.H. (1974): A framework for the definition of coastal environments in the southern Gulf of St. Lawrence, *Geol. Surv. Can.*, Pap. 74-30, p. 47-76.

SCHWARTZ, M.L. (1967): The Bruun theory of sea level rise as a cause of shore erosion, *J. Geol.*, Vol. 75, p. 76-92.

SHEPARD, F.P. (1963): Thirty-five thousand years of sea-level, *in Essays in Marine Geology in Honor of K.O. EMERY*, Los Angeles, Univ. Southern California Press, p. 1-10.

SHEPARD, F.P. and WANLESS, H.R. (1972): *Our changing coastlines*, McGraw-Hill, New York, 579 p.

STAPOR, F. (1971): Sediment budgets on a compartmented low-to-moderate energy coast in northwest Florida, *Marine Geol.*, Vol. 10, M1-M7.

TANNER, W.F. and STAPOR, F. (1972): Accelerating crisis in beach erosion, *in International Geography 1972*, Adams, W.P. and Helleiner, F.M. (eds.), Univ. of Toronto Press, Vol. 2, p. 1020-1021.

THOM, B.G. (1978): Coastal sand deposition in southeast Australia during the Holocene, *in Landform Evolution in Australasia*, Jennings, J.N. and Williams, M.A.J. (eds.), p. 197-214.