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REPLY

Roger N. Dubois

Department of Geography, University of Maryland, Baltimore County, Baltimore, MD 21228, U.S.A.

Reply to Discussion by Per Bruun (1993) on the paper by Dubois, R. N., 1992. A re-evaluation of Bruun's rule and supporting evidence. *Journal of Coastal Research*, 8(3), 618–628.

In 1962 Bruun proposed a theory that linked rising sea level with shoreline erosion. Given an equilibrium shore profile, he reasoned that a rise in sea level would perturb coastal processes so as to cause shore erosion and offshore deposition, thereby elevating the offshore bottom in proportion to the rise in sea level in order to re-establish an equilibrium profile (Figure 1). The sediment volume eroded from the shore would be equal to that deposited in the offshore. This explanation of how a shore profile should respond to rising sea level is now known as "Bruun's rule" (SCHWARTZ, 1967). There are, however, major concerns about Bruun's rule, and BRUUN (1993) raises two of them in his discussion. The first has to do with identifying the submarine zone where aggradation takes place while the second deals with the coastal processes responsible for readjusting a shore profile back to its equilibrium form following a rise in sea level. Clearly, both of these concerns are interrelated.

In regard to the first concern, BRUUN (1962) used the term nearshore to describe the shore bottom profile that would be affected by a rise in sea level. As defined by SWIFT (1982) and employed by BRUUN (1962), the nearshore extends seaward from the high tide line to about a depth of 18–20 m where coastal processes cease to cause deposition; the subaerial portion of the shore profile extends landward to the dune crest (BRUUN, 1988). As further explained by SWIFT (1982), the nearshore includes the shoreface, an overall concave-skyward profile, followed by the inner shelf or ramp where the bottom profile becomes planar with a gentle seaward-dipping slope. In his 1962 article, Bruun used the word "shelf" to describe the area where accretion should occur, and contrary to what Bruun (1993) has just written, he did used the term "ramp" in a 1988 publication to describe the accretationary zone (Figure 1). Several investigators have interpreted Bruun's rule as a model that depicts the transference of bottom sediments from the shoreface to the inner shelf or ramp in response to rising sea levels (KING, 1972, p. 465; SWIFT, 1975; NIEDORODA *et al.*, 1985; COMMITTEE on ENGINEERING IMPLICATIONS of CHANGES in RELATIVE MEAN SEA LEVEL, 1987, p. 53; KRAFT *et al.*, 1987; WILLIAMS and MEISBURGER, 1987; DUBOIS, 1990). DEAN (1987) and EVERTS (1987) have offered a slightly different interpretation of Bruun's rule; they believed that if the rule is correct then sediments eroded from the upper shoreface might be deposited on the shoreface base, thereby creating a new ramp segment.

With respect to the second concern regarding the process responsible for causing the shoreface to transgress and for the ramp to accrete, Bruun wrote:

> The material needed to raise the bottom is assumed to come from the corresponding shore area by movement of material by transversal (rip) currents and by diffusion currents (Bruun, 1962, p. 129).

Once again, contrary to what BRUUN (1993) has just written, he did invoke currents as a prime process responsible for the readjustment of a shore profile following a rise in sea level. Others have suggested that downwelling currents are responsible for the transport of sediments from the shoreface to the ramp (SWIFT, 1975; NIEDORODA *et al.*, 1985).

The term "nearshore" has another definition. Following KOMAR (1976, p. 13) and BIRD (1984, p. 1), DUBOIS (1992) used the term to describe the zone between the foreshore and the position of breaking waves. The seaward end of the nearshore

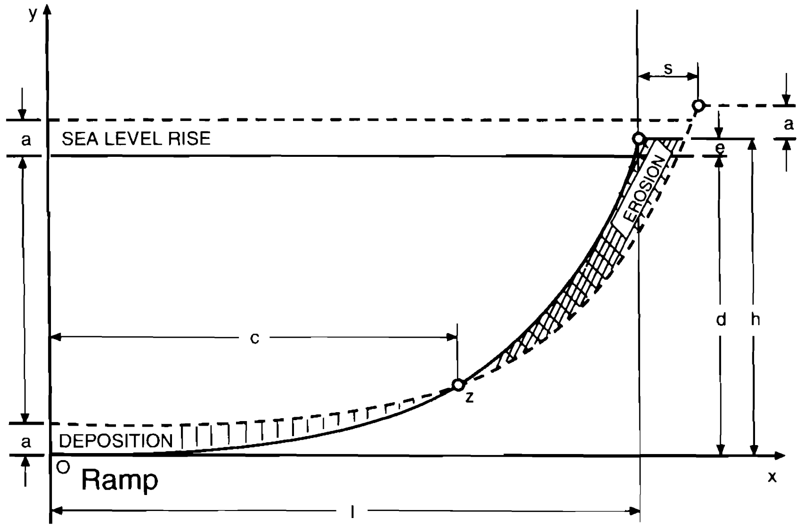

Figure 1. The above diagram is a duplication of Figure 1 in Bruun (1988).

extends to depths ranging from 4 to 10 m (HALLERMEIER, 1981). The nearshore in this definition is the landward portion of the shoreface (DUBOIS, 1992: Figure 1). In the remainder of this discussion, the term nearshore will have the meaning just defined.

DUBOIS (1990; 1992: Figures 6 and 7) postulated that when sea level rises along barrier islands wave action causes the shoreface to transgress while the ramp is abandoned by wave action, although downwelling currents can cause accretion along portions of a ramp. Bruun's rule might be more suitably applied to the beach-nearshore zone; during times of rising sea level, sediment is lost from the beach and gained in the nearshore (DUBOIS, 1992). DEAN and MAURMEYER (1983) and BIRD (1984, pp. 138–139) have also applied Bruun's rule to the beach-nearshore zone. Storm waves erode a beach and deposit sediments in the nearshore; however, not all sediments are returned to the beach by swells during fair-weather conditions. A sediment layer equal in thickness to the rise in sea level remains on the nearshore bottom (DUBOIS, 1992).

It has been just over three decades since BRUUN (1962) first presented his theory, and as can be seen from the preceding discussion, there is still no general agreement as to how a shoreface-ramp profile along barrier islands or other coastlines should respond to rising sea levels. Although we have a reasonable understanding of the dynamics involved in causing the subaerial portion of barriers to transgress in the face of rising sea levels, the same can not be said of the dynamics responsible for the readjustment of a shoreface and ramp. Clearly more research is needed. In the opinion of this writer, there is no other problem facing the community of coastal scientists and engineers that is as important as this one. Sea level is rising around the world at an average rate of 2.4 mm/yr (PELTIER and TUSHINGHAM, 1989) and in all probability will continue to do so for some time in the future. Yet, we cannot fully explain how a submarine shore profile will respond, nor can we predict with a reasonable degree of confidence the rate of beach erosion caused by rising sea level. Surely results from wave basin research could cast some light on this problem. Hopefully, an institution or agency, such as the U.S. Army Corps of Engineers at Vicksburg, Mississippi, will in the near future undertake such research and fill in this crucial gap of knowledge.

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