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DISCUSSION

Discussion of: Fucella, J.E. and Dolan, R., 1996. Magnitude of Subaerial Beach Disturbance During Northeast Storms. *Journal of Coastal Research*, 12(2), 420–429.

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FUCELLA and DOLAN (1996) revisit an interesting data set on subaerial beach change measured during 1963 and 1964 at Nags Head, North Carolina. They also make frequent reference to a paper by NICHOLLS and ORLANDO (1993) which outlines a new approach to measuring the maximum depth of disturbance on a subaerial beach during storms. They contrast the two methods used and make a number of comments on the approach of Nicholls and Orlando. This discussion considers the relative merits of the two approaches.

FUCELLA and DOLAN (1996) consider a 9-month data set of beach change comprising regular measurements of elevation change, depth of disturbance, grain size and wave parameters. This gives an excellent time series of beach change, but interestingly, no data is available for the most erosive event on 2 May 1964.

In contrast, NICHOLLS and ORLANDO (1993) focussed on developing a method to understand the *maximum* erosional response of beach profiles to large storms. This interest was partly based on the observation that during some storms which cause substantial subaerial erosion, the beach starts to recover during rather than after the storm (*e.g.*, BIRKEMEIER, 1979). This behaviour is in contrast with that reported widely in the published literature, including FUCELLA and DOLAN (1996) who describe recovery as a rapid post-storm process. Therefore, pre- and post-storm profiles may not indicate the full extent of erosion.

Therefore, we required an approach which would yield results under the most adverse conditions and without anyone present. The selected methodology utilized cross-shore lines of vertical aluminum columns, segmented at 3-cm intervals. Therefore, each column can 'break' at numerous locations and hence record the maximum depth of erosion/disturbance due to waves (see also NICHOLLS, 1989). Precise location after storms is facilitated by using a metal detector. The columns can also be rebuilt after being monitored so that repetitive measurements at the same column are possible.

To test the method, Nicholls and Orlando conducted a one-year field trial at the Field Research Facility (FRF) of the U.S. Army Engineer Waterways Experiment Station's, Coastal Engineering Research Center, located in Duck, North Carolina. The excellent data set of repetitive beach profiles at Duck (HOWD and BIRKEMEIER, 1987; LEE and BIRKEMEIER, 1993) indicated that the subaerial beach had shown a vertical range of nearly 3 metres over 10.5 years of measurements. To maximize the chances of survival for each column during the field trial given both large individual storms and the expected erosional tendency during the autumn/winter months, each column was installed as a 3 metre length (comprising 100 individual aluminium segments). The top of the column was established 30 cm below the beach surface to (1) avoid measuring changes due to minor events, and (2) minimize the possibility of accidental disturbance by treasure hunters using metal detectors.

The technique was successful in recording the depth of disturbance for all the significant erosional events during the trial. This included two major events: Tropical Storm Danielle (September 23 to 26 1992) and the December 1992 northeaster (December 10 to 14 1992) with maximum significant waves of 4.6 m and 9.5 secs and 4.7 m and 17.1 secs, respectively. Therefore, the segmented aluminium column approach is found to work effectively under all the observed wave conditions—column length can be designed to accommodate any likely profile change. It seems reasonable to conclude that the segmented columns would have yielded data for the 2 May 1964 northeaster.

FUCELLA and DOLAN (1996) also note that during large storms, the maximum vertical erosion tends towards some maximum value, regardless of erosional magnitude, but the horizontal erosion may extend substantial distances inland. This process can lead to serious property damage and losses, particularly if pile foundations are undermined by erosion (NICHOLLS *et al.*, 1995). The segmented column technique would provide high quality data on the maximum erosion under these conditions assuming that columns were installed in a line across the dune and into the backshore area. The column technique was developed with the possibility of such deployments in mind. Once a profile is instrumented with clamps, it seems reasonable to leave them for a number of years until a major erosional event occurs. Data from both extratropical storms (northeasters) and hurricane landfalls would be of interest.

Therefore, the column technique seems well suited to measuring maximum disturbance during major events when profile measurements are impossible and/or personnel are absent. For more intensive measurements during less intense storms as described by FUCELLA and DOLAN (1996), the column approach can still be utilized as an alternative to vertical columns of dyed sand. Similar measurements are reported for the December 1992 northeaster in NICHOLLS and ORLANDO (1993), although the frequency of surveying was limited by the extreme wave conditions. However, it is worth noting that each aluminium segment costs about 1 U.S. dollar.

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