# FIELD STUDIES OF SEDIMENT TRANSPORT IN THE NEARSHORE ENVIRONMENT

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## LONG-TERM GOALS

The long-term goals of this program are to improve the understanding of the processes and physical mechanisms responsible for beach morphology changes and patterns of erosion and deposition in the nearshore zone. We believe that studies of small-scale fluid-sediment interaction can provide the link between fluid forcing mechanisms and beach morphology change.

## SCIENTIFIC OBJECTIVES

Based on results from past efforts, we are presently concentrating on two aspects of surf zone dynamics. The specific objectives are:
1) to understand the processes of small-scale sediment transport with emphasis on the resuspension and vertical distribution of suspended sediment by turbulent forces generated in surface-wave breaking, and
2) to investigate the temporal dependence and spatial gradients of suspended sediment flux and their relationship to observed changes in nearshore morphology.

## APPROACH

The overall approach is to conduct detailed field studies of sea surface fluctuations, velocity, velocity fluctuations and suspended sediments within the surf zone to investigate the relationship between fluid forcing and sediment response. Specifically we place arrays of instruments in strategic locations in the nearshore zone and continually measure wave amplitudes, fluid velocity profiles, and suspended sediment profiles over extended time periods (days to weeks). Individual instrument arrays include electromagnetic current meters (at four elevations), a pressure transducer, and fiber optic backscatter sensors (at 19 elevations). Up to nine instrument arrays have been deployed in coherent cross-shore and longshore patterns.

## TASKS COMPLETED

During the past year two tasks have been completed. The first task is the completion of the Ph.D. dissertation “Influence of breaking waves on sediment concentration profiles and longshore sediment flux in the nearshore zone” by Ms. Andrea Ogston the graduate student working on this project. Second is participation in the Sandy Duck experiment being carried out at the U.S. Army Corps of Engineers Research Facility at Duck, North Carolina. Nine instrument arrays were deployed in September and will continue to collect data until November 1997.

## RESULTS

The Ph.D. dissertation by Ms. Ogston combines previous prototype-scale laboratory data and Duck `94 data to explore turbulent diffusion of sediment particles under broken and unbroken waves in the surf-zone. Results show that wave breaking has a major impact on suspending sediment throughout the water column. Under unbroken waves, suspended sediment profiles exhibit the influence turbulence generated by boundary shear in a nearbed region of 2-3 times the thickness of the wave boundary layer (2-3 $\delta$, typically 10-15 cm) above which very little sediment can be suspended. Under broken waves, the breaking-generated turbulence enables sediment to be suspended above the bottom boundary layer and is the major mechanism accounting for observed suspended sediment profiles. Turbulence intensity from breaking waves is scaled by breaker height and depth below the surface. Position across the surf zone relative to plunge point, appears to be of secondary importance. A procedure is presented for constructing vertical eddy coefficient profiles reflecting broken or unbroken wave conditions and using that profile to predict suspended sediment profiles and resulting longshore particle flux.
The Sandy Duck experiments are still underway so scientific results are not available at this time. the instruments at the 9 sites have been collecting almost continuous 16 Hz data since September 15, 1997 and have shown evidence of morphological change over the first month of deployment.

### IMPACT FOR SCIENCE

The results of this dissertation suggest some mechanisms that have important implications to our concept of surf zone sediment transport. Although a nearbed shear layer is observed throughout the surf zone (2-3 $\delta$), eddy diffusivity profiles (and thus the resulting sediment concentration profiles) under broken waves do not show correlation to turbulence estimated from wave characteristics. This implies that $K_s \neq f(kU_*z)$ where $U_*$ is at a location estimated from Johnsson friction factor in contrast to what is observed under unbroken waves. Rather, eddy diffusivity and concentration profiles are best correlated to the breaker height at the plunge point and relative elevation in the water column (i.e. sediment suspension dominated by turbulence generated at wave breaking which penetrates into the water column and is advected across the surf zone mixing particles upward as the turbulent bore progresses). Inclusion of turbulence generated by wave breaking in the surf zone can account for observed increases in longshore sand transport as much as 50% greater than predicted by present theories that use only turbulence generated by boundary shear flows.
The Sandy Duck experiment will provide an independent data set for testing of some of the concepts discussed above and will provide detailed longshore suspended sediment information to look at longshore coherence scales.

### TRANSITIONS ACCOMPLISHED AND EXPECTED

These results represent concepts and analytical techniques that have not been included in surf zone sediment transport models to date. It is expected that these results, which are based on Duck `94 data (limited spatial extent) will be compared to Sandy Duck results which are more extensive (extending across the surf zone). If these concepts and techniques are substantiated they should have a significant impact on future modeling of sediment transport in the surf zone.