

Field Studies of Sediment Transport in the Nearshore Environment

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LONG-TERM GOALS

Small-scale fluid-sediment interactions are the link between large-scale hydrodynamic forcing and beach morphology change. Changes in morphology are the cumulative result of many small-scale sediment movements integrated over time and space. The long-range goal of this research is to understand the process of small-scale sediment transport with emphasis on the resuspension and vertical distribution of suspended sediment by turbulence. Spatial gradients of fluxes of suspended sediment ultimately lead to changes in nearshore morphology.

OBJECTIVES

We wish to evaluate the role of wave-breaking in suspending and transporting sediment in the surf zone. In general, models used to predict sediment suspension include only boundary shear relationships (e.g., boundary shear stress, τ_b) in their calculations. The influence of wave breaking is not well understood, so the challenge has been to measure wave breaking kinematics, to parameterize breaking characteristics in terms of eddy diffusivity, and to develop an eddy diffusivity profile for the surf zone that includes bottom boundary shear and wave breaking characteristics.

APPROACH

During FY98 we participated in the SANDYDUCK experiments carried out at the USACOE Field Research Facility at Duck, NC. Eight vertical arrays of current meters, optical backscatterance sensors, and a pressure transducer were placed in a cross-pattern across the surf zone and shore parallel (in the longshore trough) during the two-month experiment. Instruments were operated over 22 hours per day and all data were transmitted to shore for logging. Key individuals participating in this work included Dr Reginald Beach (ONR), Dr Rob Holman and scientists and technicians from Oregon State University, Dr Daniel Conley (SUNY Stony Brook), and Dr Andrea Ogston (University of Washington).

WORK COMPLETED

Two tasks were completed during the year. The first task was the completion of a Ph.D. dissertation by Andrea S. Ogston. Her studies combined observations of breaking wave kinematics measured in an artificial wave basin and suspended sediment and velocity observations from the DUCK94 experiments to develop an eddy diffusivity profile. The dissertation is titled "Influence of Breaking Waves on Sediment Concentration Profiles and Longshore Sediment Flux in the nearshore Zone"

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(completed in December 1997). The second task was our participation in the SANDYDUCK experiment during the period September to November 1997.

RESULTS

Breaking wave dissertation. A simple one-dimensional model was created to examine the impact of the eddy diffusivity profile developed using turbulence estimates in a prototype wave basin on suspended sediment and longshore sediment flux. Under unbroken waves the eddy diffusivity profile in the upper water column is low and its magnitude is not critical because such small amounts of sediment are suspended above the wave boundary layer. Under broken waves the eddy coefficient profile in the upper water column increases dramatically with elevation and is related to wave height and depth below the surface (Fig. 1a). Results show that without the influence of wave breaking there is no mechanism to transfer sediment high into the water column and both the suspended sediment concentration profile and the longshore sediment flux profile are significantly underpredicted when compared to observations (Fig. 1b and c, respectively). These results have important implications for understanding and modeling sediment transport in the shelf zone. They provide a consistent method for parameterizing eddy diffusion profiles in the nearshore zone which includes the effects of breaking waves. When applied to a sediment transport model, estimates of sediment concentration profiles and longshore particle flux are more accurately predicted than when wave breaking effects are not included.

SANDYDUCK. The data set from SANDYDUCK has just recently become available for analysis. Our plans are to use the SANDYDUCK data set which spans the surf zone over a wide range of climatic conditions to evaluate and expand the model results of Ogston (1998). Analysis will begin later in the year.

IMPACT

The initial work of Ogston (1998) sets a method for estimating suspended sediment concentration profiles in the surf zone using easily obtained parameters (e.g., z , h , H). This method incorporates the effects of broken waves and provides improved estimates of sediment concentration profiles and longshore sand transport. Improved methods of predicting longshore sand transport will impact our ability to predict effects of waves and currents on beach erosion and sand transport in the surf zone.

PUBLICATIONS

Ogston, A.S. (1997) Influence of breaking waves on sediment concentration profiles and longshore sediment flux in the nearshore zone. Ph.D. Dissertation, University of Washington, Seattle, WA.

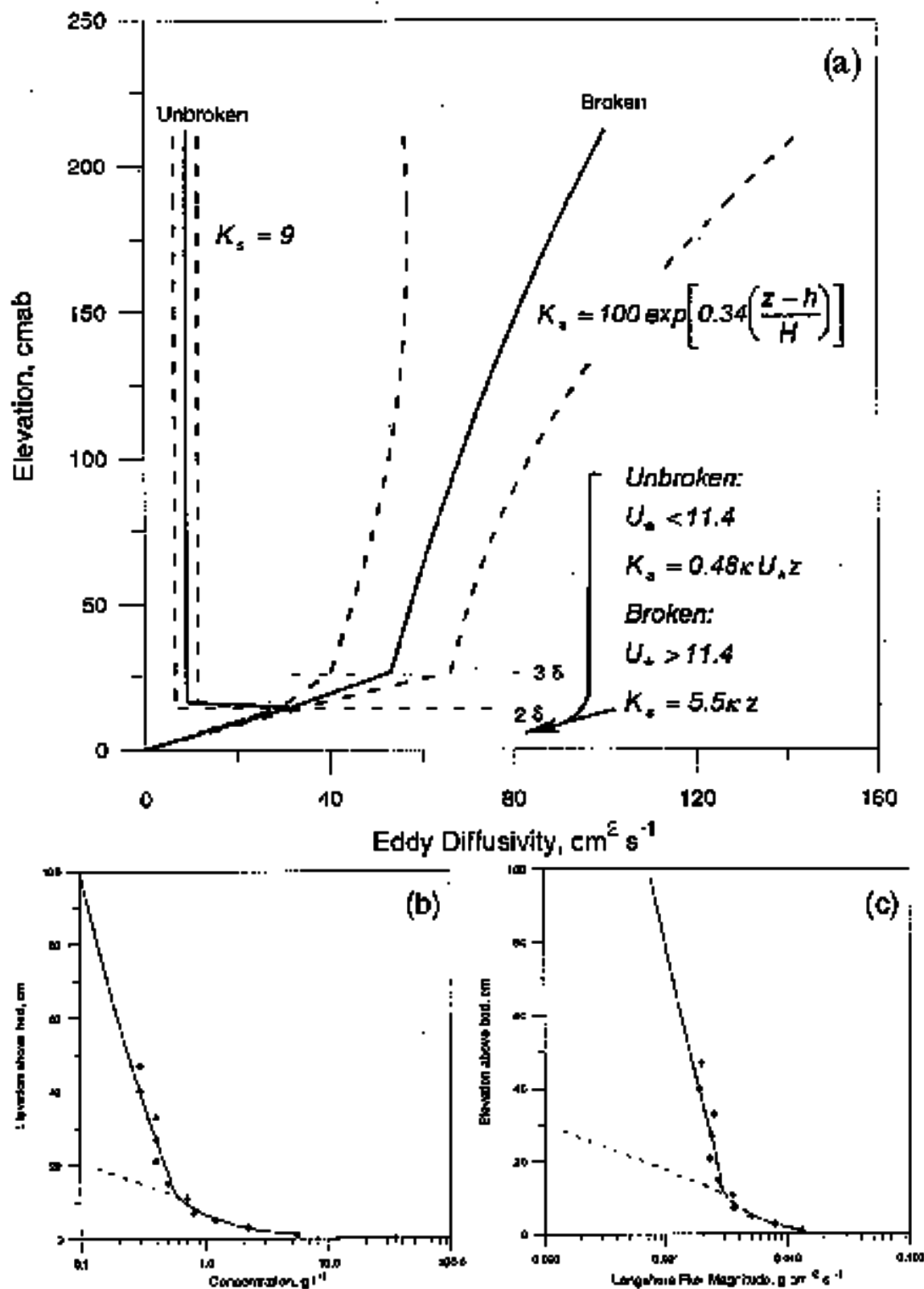


FIGURE 1. Conceptual diagram of the eddy diffusivity profile formulated from the wave basin and DUCK94 data (a) measured (crosses) and predicted suspended sediment concentration (b) and long shore sediment flux (c) profiles using eddy diffusivity with (solid line) and without (dashed line) wave breaking approximations.