Coastal sediment transport and erosion

Difficulties Of Sediment Transport Modeling In The Coastal Zone

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The ultimate purpose of sediment transport studies is the prediction of bottom relief in the zone of active wave effect accompanied by transport of significant sand volumes. The energetic longshore currents induced by the oblique wave approach, transport large amounts of sand lifted by waves from the sea bottom. This mass sediment transport and its variations finally determine the shore-line configuration and the location of accumulative and erosion areas on the underwater slope. Because of great practical significance, the problem of sediment transport has attracted much attention. When constructing theoretical models of suspended sediment mass transport by water flows, investigators have to face a number of difficulties. Modeling of the sediment transport is limited by the absence of clear physical mechanisms of sediment suspension. The main difficulties of the modeling are discussed in this report. Detailed measurement of mechanisms and time scales of sand suspension by irregular waves were carried out during field experiments at the Black, North and Mediterranean seas and in the largest wave channel GWK in Europe of the Hannover University. The processes which control the temporal variations in suspended sediment concentrations near the sand bottom have been examined by using field measurements of the suspended sand concentration and the horizontal current components. Measurements during experiments, revealed, that there were fluctuations of concentration in a broad band of frequencies near the bottom. Under the influence of unbroken waves with a typical group structure, the sand suspension occurred in the moments when the high wave groups passed. Consecutive sand suspending under the influence of every wave in those groups resulted in the formation of broad-concentration peaks. The peak-duration depended on the quantity of waves in the group; it was in the order of several tens of seconds. The fluctuations of the sand-concentrations, with the same period as the waves, occurred within these peaks. In this case the concentration spectrum of suspended sand is characterized by a local maximum at the frequency of the approaching waves and by a monotonous increase of the spectral density at the range of low frequencies, when they decrease. The latter can be explained by the fact that the spectrum of the envelope of the cross-shore currents is fairly wide and a local maximum is missing. In the breaking zone, where the group structure of waves degenerates because of energy dissipation, the concentration

fluctuations mainly take place in the infragravity wave band. Then, in some cases, significant values of the coherence between concentration and the cross-shore velocity of infragravity waves can be obtained. In these cases, the concentration spectra of the suspended sand have no local maxima and they are characterized by a monotonous increase of the spectral density when the frequency decreases. The observed regularities can be explained by the fact, that the intensity and time scales of sand suspending in the breaking zone depends on the turbulence, which is induced from the water surface under breaking waves. Analyses of the concentration chronograms and the velocity components have shown that the emergence of sharp concentration-peaks is restricted to the moments, when the turbulent fluctuation of the cross- and longshore velocity starts. The appearance of such a rise of the turbulent velocity fluctuation and of corresponding peaks of sand concentration usually is not timed to a definite phase of the approaching waves and has no periodicity. One of the difficulties of the suspension modeling is the problem to identify dependence between values of suspended sediment concentration and the form of wave spectrum. The form of wave spectrum greatly influences on the SSC values. With the same wave parameters the spectral steepness can alter the concentration by 2.5 times. The most effective way in the modeling developing is the determination of relations between the suspended sediment concentration and turbulent kinetic energy, between which there are statistically significant values of coherence. To obtain such dependencies, the further research in field and laboratory conditions of spatial-temporal variability of large-scale turbulence and sand suspension under irregular waves is necessary.