PRINCIPLES OF SEDIMENT TRANSPORT

IN

RIVERS, ESTUARIES AND COASTAL SEAS

PART II: Supplement (update) 2006

by

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Other publications:

Principles of Fluid Flow and Surface Waves in Rivers, Estuaries, Seas and Oceans by Leo C. van Rijn, 1990

Principles of Coastal Morphology, by Leo C. van Rijn, 1998

Principles of Sedimentation and Erosion Engineering in Rivers, Estuaries, Seas and Oceans by Leo C. van Rijn, 2005

Manual of Sediment Transport Measurements (update 2006)

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PREFACE

This 2006-update reflects the scientific and engineering progress of sediment transport processes in rivers, estuaries and coastal seas in the period between 1993 and 2006. Since 1993 many papers have been produced in the field of sediment transport. Most papers can be classified as refinements of existing theories; some papers are aimed at exploring new ideas and directions. Focus points are: initiation of motion, bed forms and associated bed roughness, sediment transport in steady flow (river flow) and in combined steady and oscillatory flow (coastal transport).

Initiation of motion of fine sediment particles down to the silt range has been studied by various researchers (Chapter 4), as the fine sediment range is not well covered by the classic experimental results of Shields. In addition, the effect of cohesive material on the critical bed-shear stress of the sand particles has been an important research topic, which is of crucial importance for the sediment transport processes in estuaries.
Bed forms also is a continuous research topic (see Chapter 5), because of its importance for the effective bed roughness (see Chapter 6), particularly in estuaries and coastal seas where it is hardly feasible to measure the water surface slope. The generation of wave-induced ripples in coastal seas has got much attention by many researchers analyzing both theoretical and experimental (field) results. The author has for the first time tried to combine all available data into a predictive method for (apparent) bed roughness, which is a basic input parameter for sediment transport. Verification of the apparent bed roughness concept in conditions with currents plus waves remains of vital importance and should be a focus point in future research. The availability of new research facilities such as the large-scale coastal basin at Vicksburg (USA) will help to improve our knowledge of coastal flows and transport.

Research on sand transport in steady flow conditions (river flow) has been focussed on the high-shear stress regime with sheet flow transport. Furthermore, the effects of slope and mixed beds on the initiation and movement of sediment particles have got new attention (see Chapter 7). Various researchers have shown that the dispersive stress concept of Bagnold can be used to derive simple expressions for the sheet flow characteristics which ultimately leads to a Meyer-Peter Mueller type of bed-load transport formula for the upper regime. The deterministic Bagnold approach accurately predicts the onset of avalanching for realistic values of the dynamic friction coefficient. Bed-load transport at low flows near initiation of motion is problematic because of the stochastic nature of the particle movement. Experimental research shows particle movement and transport for bed-shear stresses smaller than 20% of the critical bed-shear stress according to Shields. The studies of sediment suspensions have mainly focussed on the effect of the sediments on the mixing properties of the system. Sediment suspensions of relatively high concentrations often behave as stratified suspensions in which turbulence damping in the near-bed region plays a crucial role affecting the effective roughness of the flow system. Different results have been obtained for flat bed and non-flat bed conditions, emphasizing the importance of bed forms. For very fine sediments (see Chapter 11) it has been shown that the flow becomes saturated due to collapse of turbulence depending on the Richardson number. Fine sediments can be transported at very large quantities (up to 1000 kg/m^3) as a result of the presence of hindered settling processes reducing the effective settling velocity to very small values (0.1 mm/s). These phenomena have been observed and reported for the Yellow River in China.

Sediment transport studies in coastal flows (see Chapters 8 and 9) still suffer from a tremendous lack of reliable field data, particularly for the deeper shoreface region. Most of the attention has been focussed on the sand transport processes in the shallow surf and swash zones with emphasis on phenomena such as phase lags between instantaneous concentrations and velocities in rippled bed conditions and enhanced bed-shear stresses in conditions with asymmetric waves. Although our knowledge of sand transport processes in the rippled bed regime has increased considerably due to various experimental studies in wave tunnels in Scotland and in The Netherlands, much work remains to be done on this topic which is of great importance for the morphological modelling of beaches and related problems (erosion, nourishment, impact of structures).

Finally, the knowledge on instruments for measuring particle size, settling velocity and sediment transport has been updated focussing on the recent boost of new electronic equipment based on optical and acoustical techniques (see Chapter 13).