THE USE OF HELLY-SMITH SAND TRAPS TO MEASURE SAND IN SUSPENSION IN A TIDAL INLET

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Paper topic: Beach morphodynamics and sediment transport

1. Introduction

The evolution of a lagoon or an estuary is governed by the net flux of the material passing through its inlet (Amos et. al, 2010). In order to predict the morphological changes of an inlet, the hydrodynamics must be known, and more specifically, the suspended sediment transport rate with time. The main objective of this presentation is to define the vertical distribution of sand in suspension over a range of tidal conditions. There are two methods that can be used to measure sediment transport in suspension (Van Rijn, 2007). The first is a direct method which is based on either time-averaged or depth-integrated sediment transport at a certain point. The second is the indirect method, which is based on separate time-averaged velocity and sediment concentrations simultaneous measured (Villatoro et. al, 2010). There are different instruments available to measure sediment transport in suspension ranging from simple samplers to more complicated optical or acoustical sensors, which are subject to limitations. This study elected to use a modified Helley-Smith sand sampler, as described below.

2. Methodology and data collection

A modified version of the Helley-Smith sampler (Helley and Smith, 1971) was used to measure the vertical distribution of sand in the water column due to its easy handling whilst providing sand samples from suspension large enough for further analysis. The sand traps consist of a nozzle, a sample bag and frame as shown in Figure 1. The sample bag is constructed of 60 micron mesh made of polyester.

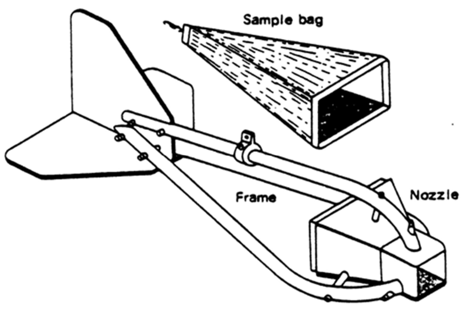

Figure 1: Sketch of Helley-Smith sand sampler showing the nozzle and sample bag (from Helley and Smith, 1971)

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The sand traps were deployed hourly from a stationary boat for a period of 10 to 15 minutes to collect at least eight profiles to cover a complete tidal cycle at four levels (surface, middle, epi-benthic, and benthic). The sand samples so derived are used to determine the sand concentration as a function of elevation in the benthic boundary layer.

Data collection was carried out in June, 2011, in Oka estuary, Spain, at three different locations in the vicinity of the main tidal inlet. The first survey location, Station 1, was inside the estuary (wave sheltered), Station 2 was at the inlet mouth (tide dominated), and Station 3 was in the wave exposed ebb delta. The three locations varied in grain size and flow conditions.

3. Results

The sand concentration increased drastically with water depth for Station 1. The grain size also increased towards the bed; a reflection of greater settling rates. This shows that the greater sand movement occurs in the lower part of the water column. The sand concentration appears higher on the flood than the ebb suggesting a landward net movement over the survey period.

At the inlet mouth (Station 2) the material is classified as fine-medium sand in the lower water column and fine sand in the upper column. The sand concentration increased drastically towards the bed as well as with current velocity. As well, the ebb tide sand concentration was ten times the value during the flood tide. This suggests that the amount of sand leaving the inlet is much more than the sand entering the inlet, which explains the formation of the ebb tidal delta.

The grain size increased with depth through the water column at Station 3. The sand closest to the bed is three times the size of the sand further up in the water column. The sand varies from fine to coarse with water depth. There is a gradient in sand concentration throughout the water column as well as over the tidal cycle. The sand concentration during the ebb tide is greater than the flood tide by an order of magnitude. The three stations differ considerably in vertical concentration gradients and residual sand transport which will be discussed further in this presentation.

References

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