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Sand transport measurements in Chioggia inlet, Venice lagoon – Comparison of two sites

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The magnitude of sand transport on the Adriatic shores of the Venice lagoon is evidenced by the presence of depositional features such as accreting beaches, sand bars, and ebb-tidal deltas. Volumetric analysis and currents modelling show that the main contribution to these features is littoral drift; however, the magnitude of sand transport across the inlets and its impact on the littoral cell remains highly unstudied. Modified Helley-Smith sediment traps were deployed to obtain direct measurements of sand in motion on two different sites along Chioggia inlet in 2006 and 2007 respectively. A vertical array of traps fitted with 63μm meshes was used to derive a profile of sediment concentration along the water column. Results show that transport on Chioggia inlet is supply dependent, with small amounts of fine sand sampled on site A (2006), and up to 10 times more material caught on site B (2007). Mean sediment diameter varied from 93 to 137μm in site A, and from 151 to 346μm in site B. The current Shield's parameter (θ) was obtained. Samples from site A, including those from the benthic layer, were above Shield's threshold for motion, whereas samples from site B behaved as expected with benthic and epi-benthic samples being at threshold conditions, and mid-water and surface samples moving in suspension. A profile of concentration was derived and compared to the Rouse profile. Sand concentration in suspension was simulated well by the Rouse exponent $\frac{W_s}{\beta \kappa U_*}$ = -0.53 (A) and -2.05 (B). β was evaluated as 0.97 (A) and 1.47 (B), showing to be grain size dependent. Two independent methods were used to evaluate the $\frac{W_s}{U_*}$ relation in order to test the robustness of the Rouse approach. $\frac{W_s}{U_*}$ obtained from direct measurements were 0.28 (A) and 0.84 (B),

and the values derived from the Rouse exponent $\frac{W_s}{U_*} = \frac{k}{m}$ were 0.36 (A) and 0.62 (B), providing a good correlation between both methods. Comparisons between modelled and measured bed-load transport, show that the model SHYFEM+Sedtrans05 over-predicts transport at site A, since it does not consider the existent limitation in sediment supply. However, the mass transport rate at the bed in site B is well represented by the model. Stochastic bed-load equations produced the best agreement with observations. Sediment and hydrodynamic characteristics of site B are particular of a reduced depositional area and do not represent conditions across the inlet. Calibrated transport predictions for site A compare well with global counterparts and thus allow the estimation of long term residual transport of sand between Venice lagoon and the northern Adriatic.