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Field measurements and laboratory calibrations of supended sediment concentration in tidal bores

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Tidal bores provide a significant influence on sediment erosion and deposition in estuarine systems. Evolution of suspended sediment concentration close to the channel bed and in the water column during the passage of several tidal bores is proposed thanks to extensive field data acquisitions and laboratory calibrations. An Acoustic Doppler Velocimeter (ADV) was used to measure longitudinal, vertical flow velocities and turbulence features. Suspended Sediment Concentration (SSC) evolution was monitored using an Argus Surface Meter (144 OBS sensors) and direct water sampling at different elevations above the channel bed. The ASM has been calibrated in laboratory using a recirculating water column with natural sediment. ASM did provide at least accurate informations of relative evolution of the SSC in the water column, with a temporal and spatial resolution which is difficult to achieve with usual systems. A water sampling system was deployed in association with the ASM, and provided absolute references of the SSC to the relative measurements of the optical system. The sampling tubes were positioned at 0, 20, 40 and 60 cm above the channel bed. Water was sampled simultaneously at the four elevations every 2 seconds. The sampling started a few seconds before the passage of the tidal bore, and lasted for at least 40 minutes. Finally 800 samples per tidal bore were collected and processed at the laboratory. To characterize the influence of various parameters on the ADV measurements, a laboratory protocol was also defined. We mainly considered suspended sediment concentration and turbulence intensities. The tests were conducted in a tank of 500 l. The turbulence was created by a rotating steel grid driven by a linear motor with a dimmer in order to adjust the turbulence rate. Ten levels of turbulence and 8 levels of sediment concentration were tested. In the field, the highest sediment concentration was recorded at the channel bed a few seconds just after the passage of the bore front. This important sediment resuspension is due to a highly sheared flow during the bore passage, resulting in a 10 cm thick fluid mud layer with concentration values up to 50 g/L, travelling on the channel bed as the bore is propagating. Few minutes after the bore passage, an upward advection of suspended sediment was observed, that resulted in the homogenization of the water column concentration up to 15g/L. The development of a tidal bore results in very high sediment fluxes initiated by the bore front and impact on the bottom, of the order of 10 to 40 times higher than sediment fluxes without tidal bore.