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Analysis of tidal average saturated suspended sediment concentration of cohesive sediment in the Yangtze Estuary

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It is generally believed that sediment erosion and deposition can't occur simultaneously, which is also reflected in the classical Partheniades-Krone formulas used to calculate erosion and deposition flux. In this study, the erosion and deposition fluxes of cohesive sediment are integrated in the tidal period respectively, and when they are equal, the corresponding suspended cohesive sediment concentration is called 'tidal average saturated concentration of cohesive sediment'. Theoretical analysis of the factors affecting the saturated concentration indicates that a large erosion coefficient results in a high saturated concentration level. The corresponding critical erosion and deposition shear stresses (i.e., τ_e and τ_d) at saturated concentration have many possibilities. Therefore, it is understandable that good agreement of suspended sediment concentration between simulation and observation have been obtained by adjusting τ_e and τ_d in the previous numerical simulation calibration. According to the relative magnitude of τ_e and τ_d at saturated concentration, the erosion and deposition fluxes of cohesive sediment can be divided into four situations: weak erosion (i.e., $\tau_e > \tau_d$), intense erosion (i.e., $\tau_e < \tau_d$), intense deposition (i.e., $\tau_e < \tau_d$), and weak deposition (i.e., $\tau_e > \tau_d$). A two-dimensional numerical model is applied to calculate the temporal and spatial variation of the saturated concentration of cohesive sediment in the Yangtze Estuary. Simulation results shows the following findings. 1) The impact of the fraction of the kth size class in the surface (top) layer of bed material on erosion flux of non-uniform cohesive sediment is necessary to be considered. Otherwise, the calculated saturated concentration of cohesive sediment is greater than the measured. 2) The differences between saturated concentration and the field calculated/measured suspended sediment concentration can be applied to infer bed erosion/deposition characteristics to some extent, and compared it with the measured erosion/deposition result, which in turn verifies the values of τ_e and τ_d in the model. This finding provides insights for the following research on transport and diffusion of cohesive sediment in estuary and coastal areas.