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Sediment transport in the seine estuary

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First the physical forcings (tide, waves and river flow) of the macrotidal Seine estuary are reminded, as well as the main geometrical features. Then, the morphological evolution of the estuary since the XIXth century is presented : a strong reduction of intertidal areas is pointed out, and a general progradation of sediment deposits at the mouth is described : progressively the estuary tends to behave like a delta.
In a second section, the distribution of the surficial sediment is commented : in the upper estuary the bottom is mainly gravelled, but narrow muddy intertidal flats are observed on the sides and between small islands. Downstream in the channel, the sediment cover is sandy and rippled, and is proved to move upstream in some circumstances. At the mouth, fine sand is dominant, but cohesive sediment patches are more and more numerous, and muddy areas are in extension. An important feature is the seasonal variability of the fine sediment deposits, which depend on the wave and river flow regime.
The third part concerns the sediment transport. The upper and lower estuaries are considered separately. The former experiences periods of fine sediment accumulation followed by a mean flux in the downstream direction, but after the high river flow, inducing a phase-lag between the river input and the flux into the lower estuary. In addition, a significant part of the river input is trapped in the Rouen harbour. Interestingly, marine particles have been proved to move far upstream in the estuary, thanks to radioactive tracers.
Downstream, the movement of sand is commented, in relation with the tidal currents asymmetry, modified by submersible dykes built in the seventies. The potential role of dredging and sediment outfall is discussed. A deeper insight is given on the cohesive sediment movements and the turbidity maximum, by means of a validated numerical modelling. The respective roles of the fortnightly tidal cycle and the river regime are pointed out, but also the impact of waves : for instance, local measurements on intertidal flats showed that a single storm is likely to resuspend a sediment mass of the same order of magnitude as the one constituting the turbidity maximum. Fluid mud patterns have been observed mainly in two locations of the channel, and can be related either to the tide and river regime concerning the upper one, or to the wave regime for the other one. Lastly, attention is paid on the (cor)relation between waves and wind, with possible consequences on suspended sediment tracks following wave-induced resuspension.
Also, a regular monitoring of the estuarine water showed that the turbidity maximum and the associated fine sediment deposits moved downstream during the last 30 years, due to the engineering works in the lower estuary.
Last, computations of sediment budgets and fluxes are given in different locations of the estuary, and the relation with physical forcings is discussed.