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An integrated geochemical and hydrodynamic model for tidal coastal environments

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ABSTRACT

In this paper, the design, calibration, and application of an integrated geochemical-hydrodynamic model are described. The model is comprised of three parts: a hydrodynamic submodel that was adopted from a depth-averaged, semi-implicit hydrodynamic model, a geochemical submodel based on equilibrium partitioning of chemicals between aqueous and particulate phases, and a particle dynamic submodel that simulates the resuspension, transport and settling of suspended particulate matter (SPM). The integrated model was implemented in San Diego Bay (SDB), a heavily urbanized, semi-closed mesotidal embayment. A series of model calibrations were carried out based on the observations on salinity, polychlorinated biphenyls (PCBs) and SPM. Salinity calibrations indicated that only 15% of the precipitation in the drainage area of SDB could reach the bay, presumably due to dams in tributary rivers. Steady-state calibrations of PCBs based on fixed concentrations at known ‘hot spots’ have reproduced PCB concentrations observed in both dissolved and particulate phases. SPM calibrations showed that shipping-induced resuspension produce more SPM than natural processes. Based on the calibrated model, the annual transport of PCBs out of SDB was estimated to be 3.85 kg (3.5 kg and 0.35 kg in dissolved and particulate phases), much higher than the previous estimates based on steady-state assumptions. It was also found that only a small portion of the fine sediment exported from SDB was derived from riverine input. This model can be applied to studies of the transport and fate of other chemical species, and it is applicable other coastal areas. The integrated model offers a novel framework in which geochemical processes in coastal environments can be investigated on a truly dynamic basis.

Full Text

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