Estuarine ecohydrology modeling: what works and within what limits?

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There is a practical need for models to assess the impact on estuarine ecosystems of development proposals throughout the river catchment and the effectiveness of remedial measures. Such models must link the catchment and all the human activities within it with the estuary and the coastal seas. Also they must link models of the water circulation with sediment dynamics model and with ecology models. This is because water transports waterborne matter, because sediment provides habitats, affects turbidity and thus Photosynthetically Active Radiation, and it absorbs nutrients, and because all these processes affect the estuarine ecology. Several such models have been proposed and are reviewed. Water circulation models are the most advanced and have been extensively proven. There are still problems with those models when tackling estuarine fronts and river plumes in that they do not work well for estuarine fronts, and this is important for the ecology because such fronts are used by fish larvae in their strategy to recruit. Models of the sediment dynamics are still empirical for sand but they are better developed for mud; nevertheless, none can be reliably used without extensive field data. Fine sediment dynamics models must integrate the feedbacks between the physics and the biology; for instance, the mud dynamics themselves are closely dependent on the biology through its role in floc formation and substrate stabilization/destabilization by the benthic fauna and flora. To be of practical use, models of the ecology need to be kept 'simple', i.e. restricted to the essential processes. These models require extensive field data for verification and in such cases the models appear reliable. When such data are unavailable, which is the case for many estuaries, model verification is only qualitative. Estuarine ecohydrology modeling is thus possible and practical for systems where the food web structure basically stays unchanged, provided suitable field data are available. Examples are provided for the Guadiana Estuary in Portugal, Darwin Harbour in Australia, Wami Estuary in Tanzania, Chilika lagoon in India and Laizhou Bay in China. As no two estuaries are the same, by and large this modeling is still an art more than a formal science and for each estuary the modeler needs to work closely with the physical oceanographer and the ecologist.

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