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Editorial

Mechanisms of sediment retention in estuaries

Estuaries are the primary receiver and retainer of sediment delivered to the coast by rivers. Their geomorphologic and dynamic characteristics as well as their prevailing biological conditions are essential to define the capability of each estuary to retain sediments within the system. Whether the accommodation space available and the amount of sediment received are enough to permit the evolution of the estuary in phase with long-term sea level trends or anthropogenic modifications requires an in-depth analysis of the unique conditions present.

Many estuaries are out of equilibrium given 20th century boundary conditions. The sediment load delivered to estuaries has often change through land use (Syvitski and Milliman, 2007) and from restrictions to offshore sediment sources. Estuaries and wetlands often respond quickly to reductions in sedimentary flux, decreasing their potential to withstand the expected eustatic sea level rise (Nicholls, 2004). Subtidal regions similarly respond to changes in the estuarine sediment budget; a point seldom considered when coastal wetlands are investigated.

Estuaries, including their wetlands, are controlled by hydrodynamic, atmospheric and biogeochemical factors that act upon the original geomorphology by transporting sediment from one place to another (Perillo et al., 2007). Over time, cumulative changes grow from the microscale to the macroscale perceived by humanity, sometimes passing across some irrecoverable threshold (van de Koppel et al., 2009), inducing a change in "state."

Global climatic changes will affect most coastal environments as they are buffers between the continent and sea. How fast estuaries will respond to changes in 21st century boundary conditions remains a matter of debate. Estuaries exist from the interplay between continental delivery and marine dissipation forces. Ocean energy may carry offshore or littoral sediment into an estuary, as well as disperse material from within the estuary into the coastal ocean. If sediment delivery overwhelms dispersal energy, the estuary will accumulate sediment and eventually convert to a delta. Sediment deposits are therefore viewed as a proxy to the health and long-term viability of an estuary. Pollutants tend to attach to sediment particles and thus follow their fate. Thus to track or predict the behavior of pollutants, one also needs to be able to monitor and model the various sediment retention mechanisms within an estuary.

Estuaries are presently adjusting to changes in mean sea level and to modifications in the water and sediment discharge by rivers and groundwater. The Intergovernmental Panel on Climate Change (IPCC) projects that mean sea level will rise 21–71 cm by 2070, with a best estimate of 44 cm averaged globally (Bindoff et al., 2007) in response to ocean volume expansion. Importantly, many coastal wetlands are subsiding much faster than mean sea level is rising under the influence of human activities (Syvitski et al., 2009), resulting in the inland migration and deepening of the basin which may provide greater accommodation space for sediment trapping. This is exacerbated by the marked decrease in sediment delivery to the coast due to the construction of dams (Syvistki et al., 2005).

There are various scales from seasonal to millennia that are superimposed on the evolution of the mechanisms of sediment retention in estuaries, which impact the way estuaries will evolve. Mature estuaries may have natural cycles, tens to hundred of years in duration, that alternate between periods of prevailing deposition and erosion for the whole system following climatic cycles (e.g. ENSO, NAO, NPO).

The present Special Issue is dedicated to the Mechanism of Sediment Retention in Estuaries Working Group 122, under the auspices of the Scientific Committee on Ocean Research (SCOR), the Land–Ocean Interaction in the Coastal Zone (LOICZ), and the International Association for the Physical Sciences of the Oceans (IAPSO). The articles herein, and those previously published have led to the following determinations:

- Estuaries are being seriously affected by climatic and human impacts, as manifested by changes in the level of sediment input from the land and sometimes from the sea, and through sediment redistribution within the estuary;
- Some estuaries are starved of riverine sediment due to dams; others are enriched in sediment input such as through land clearing; others are sinking due to excess groundwater extraction;
- The role of relative sea level has not been adequately addressed in our interpretation of an estuary's vulnerability;
- Increased storminess and a rise in sea level from climate change, partially or wholly man-made, may further destabilize an estuary;
- Some estuaries are changing from exporter to importer and vice-versa due to human impacts;
- Present numerical models are not capable of predicting estuarine evolution over long periods (hundreds to thousands of years), as there remain many problems in defining and quantifying the conditions at the open boundaries. The future may be to advance toward coupling models operating across different spatial and temporal scales. Behind each model lies commonly used concepts like tidal pumping and scour and settling lags that require further improvements;
- The use of sediment core dating for estimating estuarine sediment accumulation rates and their temporal and spatial changes is important for the proper assessment of the sedimentological and morphological state of estuaries. Such

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accumulation estimates will also be useful in the process of assessing the results from numerical models being used to monitor changes;
- Other aspect like analyzing the estuaries in reaches rather as a whole system has not been properly considered, given our partial understanding of the various processes occurring in them.

Most of the papers review the varied sediment trapping mechanism due to the action of currents and waves over tidal flats and marshes, and their interaction with the associated estuary as well. Biological–physical interaction processes play a major role affecting water circulation. However, biology can be either a mechanism to trap and preserve sediment in the estuaries but on the other hand bioturbation put sediment in a position to be readily available for transport. Tidal wetlands are considered one of the primary systems that retain sediments in estuaries; their survival depends entirely on their efficiency in storing the material being supplied but also to develop systems that prevent erosion.

As Co-Chairs of the SCOR–LOICZ working group, we offer this compilation as examples of the diversity of scenarios and to the challenge in our understanding of these endangered coastal environments. The short-term evolution of estuaries deserves our immediate attention. On behalf of all the members of the WG, we thank SCOR, LOICZ and IAPSO for their guidance and support.

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