The 3rd workshop on sediment dynamics of muddy coasts and estuaries: An introduction and synthesis

Xiao Hua Wang, Fei Chai, Lulu Qiao, Isabel Jalón-Rojas, Houjie Wang, Ya Ping Wang

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Corresponding Author	Xiao Hua Wang
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The 3rd Workshop on Sediment Dynamics of Muddy Coasts and Estuaries: an Introduction and Synthesis

Highlights

The workshop series on sediment dynamics of muddy coasts and estuaries focused on international frontier issues and major social needs, such as land-sea interactions, estuarine and coastal monitoring, numerical simulation, sediment transport and its biogeochemical effects. The Third Workshop was held in Qingdao, China, in November 2018, hosted by the Institute of Estuarine and Coastal Studies, Ocean University of China. As a result of the Third Workshop, this special issue contains 18 papers with case studies of muddy coasts in the Bohai, Yellow and East China Seas in China and other regions worldwide.

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Abstract

The workshop series on sediment dynamics of muddy coasts and estuaries focused on international frontier issues and major social needs, such as land-sea interactions, estuarine and coastal monitoring, numerical simulation, sediment transport and its biogeochemical effects. The Third Workshop was held in Qingdao, China, in November 2018, hosted by the Institute of Estuarine and Coastal Studies, Ocean University of China. As a result of the Third Workshop, this special issue contains 18 papers with case studies of muddy coasts in the Bohai, Yellow and East China Seas in China and other regions worldwide. These papers represent the most recent advances in Chinese and international estuarine and coastal sediment research in the topics including 1) In-situ observations of sediment dynamics in muddy coasts and estuaries and satellite remote sensing; 2) Modelling of sediment transport and associated sedimentary processes; 3) Fluid mud transport and process in bottom boundary layer, and 4) Blue bay remediation action plan and coastal restoration.

Keywords: Sediment dynamics; Muddy coasts; Estuaries; Synthesis; Workshop

1. Introduction

The workshop series on sediment dynamics of muddy coasts and estuaries focused on international frontier issues and major social needs, such as land-sea interactions, estuarine and coastal monitoring, numerical simulation, sediment transport and its biogeochemical effects. The First Workshop was held in Guilin, China, in September 2009 and was hosted by the State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of

Oceanography, State Oceanic Administration, China. The Second Workshop was held in Zhoushan, China, in October 2015 hosted by Ocean College, Zhejiang University. Based on the success of the previous two workshops, the Third Workshop was held in Qingdao, China, in November 2018, hosted by the Institute of Estuarine and Coastal Studies, Ocean University of China in order to 1) review progress since the previous workshops; 2) strengthen and expand the network of the coastal research community including young scientists and encourage multi-disciplinary as well as international collaborations; and 3) further identify new research themes (e.g., marine microplastics and debris) and formulate current and future scientific questions and national/societal needs (e.g., coastal remediation and restoration).

As a result of the Third Workshop, this special issue contains 18 papers with case studies of muddy coasts in the Bohai, Yellow and East China Seas in China and other regions worldwide. These papers represent the most recent advances in Chinese and international estuarine and coastal sediment research in the following themes: 1) In-situ observations of sediment dynamics in muddy coasts and estuaries and satellite remote sensing (Chang et al., 2020; Duan et al., 2020; Li et al., 2020; Liu et al., 2020; Niu et al., 2020; Qiao et al., 2020; Z. Wang et al., 2020a and Zhong et al, 2020); 2) Modelling of sediment transport and associated sedimentary processes (Cruz and Noernberg, 2020; Tran and Strom, 2020; D. Wang et al., 2020 and Xiao et al., 2020); 3) Fluid mud transport and process in bottom boundary layer (Peng et al., 2020; Tang et al., 2020; Xue et al., 2020 and Xu et al., 2020), and 4) Blue bay remediation action plan and coastal restoration (A. Wang et al., 2020 and Zhu et al., 2020). The papers that address these themes are discussed in next section.

2. Main themes in this SI

Theme 1: In-situ observations of sediment dynamics in muddy coasts and estuaries and satellite remote sensing

Zhong et al. (2020) investigated the sediment trapping in a typical coastal embayment using Weihai Bay, China, as an example. The study is based on observations of water depths, current profiles, wave parameters, near-bed flow velocities, turbidity, salinity and temperature. Shear stresses, residual currents and suspended sediment fluxes at the near-bottom were calculated. The authors concluded that, in the northern mouth, the temporal variability of suspended sediment concentration (SSC) was controlled by local resuspension, whereas in the southern mouth is due to the advection of a horizontal SSC gradient. The sediment trapping occurs mainly through the southern mouth and extends further landward through tidal pumping. The embayment tends to import fine sediments from the shelf at residual time scales. In two different papers, the suspended sediment in the continental shelves of China was investigated, using the method of remote sensing and in-situ measurements (Li et al., 2020 and Qiao et al., 2020). They provided a general pattern of suspended sediment concentration from the East China Sea to the Yellow Sea, with some discussion on the mechanisms of fine sediment transport from nearshore to the shelves. For example, Qiao et al. (2020) derived the spatiotemporal variations of SSC from MODIS during 2003-2018, and found that the wind is the controlling factor that affects the SSC in most areas in the Zhe-Min coast, especially in the spring and winter seasons. Their study concluded that the SSC anomaly exhibits opposite phases between the north and south parts of 28-29°N and between the landside and seaside of the front at the isobaths of 20 m to 40 m along the Zhe-Min Coast.

Theme 2: Modelling of sediment transport and associated sedimentary processes

D. Wang et al. (2020) investigated the data assimilation of multi-source SSC observations

into a three-dimensional suspended cohesive sediment transport model by the adjoint method in the Bohai Sea. The authors found that except for the surface layer, assimilating only satellite-retrieved SSCs can significantly improve the simulated SSCs in the middle and bottom layers. Their results also showed that the model initial conditions are not only important for SSC simulations, but also significant for data assimilation. Hydrodynamics in estuaries provides a physical foundation for biogeochemical processes. The spatial and temporal variabilities in the lateral circulation have wide implications for channel morphology, sediment transport and the ecological environment. A fully calibrated three-dimensional hydrodynamic model of the Sydney Harbour Estuary, Australia, was used to determine the dominant forcing of regulating estuarine circulation in a sinuous channel under conditions of low river discharge during dry weather (Xiao et al., 2020). The study found that the channel bends induce vertical mixing as a result of the overturning of the density fields. The lateral circulation redistributes the differential-advection-induced lateral shear of the along-estuary momentum and is transferred to either reinforce or cancel the along-estuary circulation. Thus the lateral bathymetry variability in a channel is shown to be the key factor causing the intratidal asymmetries in along-estuary circulations.

Theme 3: Fluid mud transport and process in bottom boundary layer

Based on the field observations off the Changjiang estuary, China, Peng et al. (2020) pointed out that the flow structures within the bottom layer could be prominently influenced when the gradient of SSC reaches a value in order of 0.1 kg m^{-4}. Moreover, modification of the flow structure diminishes with the depth, and the drag coefficient reduction induced by sediment stratification is depth-dependent. In another study, a series of entrainment and sedimentation experiments was performed in an annular flume (Xu et al., 2020). The authors demonstrated that the settling rate of fluid mud sample with higher salinity is enhanced and the gelling

concentration is reached at lower sediment concentration, causing different distributions of sediment concentration for fluid mud under different flocculation states. On the basis of the flume data, they also tested an existing model to suggest that the accurate prediction of the entrainment rate of fluid mud requires the details of SSC and rheological properties of fluid mud in the vertical direction.

Theme 4: Blue bay remediation action plan and coastal restoration

Wang et al. (2020) focused on the sedimentary processes in the subaqueous deltas of a typical small mountainous river, Mingjiang, in the southern East China Sea based on a short sediment core. They concluded that the increased sediment flux since 1960s delivered to the sea by Minjiang was caused by the change of land use pattern and intensified soil erosion. Then a decreased sedimentation rate in the river delta since the 1980s was resulted from the reservoir construction. Their work provides data for assessing the impact of human activities on the sedimentary environment in small estuaries. Zhu et al. (2020) studied management of drainage pipes to optimize beach nourishment. The 'salient' landform is explored as a feasible plan that considers beach nourishment and breakwater geometry of the drainage pipe outlets. Using the XBeach simulations, the study found that the seaward convex breakwater layout is the most effective option among three typical breakwater layouts (straight, landward convex, and seaward convex), as it can accumulate the largest volume of sediment behind the structure.

3. Discussion and conclusions

One of the key debates during the Third Workshop amounted to a call for the urgent development of a science-based indicator framework to evaluate the Blue Bay Remediation Project (BBRP, Wang and Wang, 2018). The State Oceanic Administration of China

announced the start of a nation-wide coastal remediation project BBPP at the National Maritime Work Conference in 2016. With the overall goals of pristine water, green coasts, clean beaches, and beautiful bays and islands, the restoration of 66 Chinese bays will be funded (about USD$48-64 million for each bay), starting with 16 bays in 2016. This project can be described as a milestone for China, as the coastal environment has never before attracted such attention. Although there are some studies on evaluating coastal restoration projects in China, they mostly presented only broad prescriptions and lacked specific quantitative and qualitative indicators for environmental states and changes, and for providing detailed information for project management. The Third Workshop has called for development of an indicator framework that can be used as an effective assessment tool for evaluating whether a project is on track or has been successful. A successful conclusion of such a huge coastal remediation project in China may provide an example for the rest of the world to follow.

There were only presentations on the theme of Microplastics transport and modelling scheduled as a separate session during the Third Workshop. Unfortunately neither of these presentations made it to publication in this SI. Marine plastic debris is critical environmental issues affecting the world today. Numerical modelling is one of the key tools to understand and estimate the sources, trajectories and fate of marine debris, especially microplastics. In the session keynote speech entitled ‘Modelling the transport of microplastics in coastal and marine environments: a new approach’, the presenter introduced the TrackMPD modelling framework as a new approach for the transport of marine plastic debris (Jalón-Rojas et al., 2019). TrackMPD fills the gaps of previous models by (1) considering a three-dimensional approach, (2) providing compatibility with a variety of ocean models, and (3) including a wide range of physical processes (advection, dispersion, wind age, sinking, settling, beaching

and re-floating) and MPD behaviour according to the particle dynamical properties, and the fouling and degradation state.

There were in total more than 200 participants who represented 39 institutions mostly from China, from multi-disciplinary fields. They include students and postdocs (42.5%), early- to mid-career researchers (32.5%) and professorial and other senior scientists (25%). The Workshop noted that there were significant representations from several emerging Oceanography Schools in China such as Zhejiang University, Hohai University and Sun Yat-sen University. This reflects an interesting trend that coastal and estuarine research has been increasingly taken up by these non-traditional Oceanographic institutions over the past 15 years. The Third Workshop also attracted overseas scientists from University of Auckland, New Zealand, UNSW Australia, Institution of coastal Research, HZG, Germany and University of Hull, UK.

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Xiao Hua Wang*
The Sino-Australian Research Centre for Coastal Management, UNSW Canberra, Canberra, ACT, 2600, Australia

Fei Chai
State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, China

Lulu Qiao
Institute of Estuarine and Coastal Zone, Ocean University of China

Isabel Jalón-Rojas
UMR 5805 EPOC, Centre National de la Recherche Scientifique, Pessac, France
The Sino-Australian Research Centre for Coastal Management, UNSW Canberra, Canberra, ACT, 2600, Australia

Houjie Wang
College of Marine Geosciences, Ocean University of China

Ya Ping Wang
State Key Laboratory of Estuarine and Coastal Research, East China Normal University

*Corresponding author.
E-mail address: x.h.wang@unsw.edu.au (X.H. Wang)