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

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## **The 3<sup>rd</sup> 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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# The 3<sup>rd</sup> Workshop on Sediment Dynamics of Muddy Coasts and Estuaries: an Introduction and Synthesis

## 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

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62 Oceanography, State Oceanic Administration, China. The Second Workshop was held in  
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64 Zhoushan, China, in October 2015 hosted by Ocean College, Zhejiang University. Based on  
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66 the success of the previous two workshops, the Third Workshop was held in Qingdao, China,  
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68 in November 2018, hosted by the Institute of Estuarine and Coastal Studies, Ocean  
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70 University of China in order to 1) review progress since the previous workshops; 2)  
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72 strengthen and expand the network of the coastal research community including young  
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74 scientists and encourage multi-disciplinary as well as international collaborations; and 3)  
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76 further identify new research themes (e.g., marine microplastics and debris) and formulate  
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78 current and future scientific questions and national/societal needs (e.g., coastal remediation  
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80 and restoration).  
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85 As a result of the Third Workshop, this special issue contains 18 papers with case studies of  
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87 muddy coasts in the Bohai, Yellow and East China Seas in China and other regions  
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89 worldwide. These papers represent the most recent advances in Chinese and international  
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91 estuarine and coastal sediment research in the following themes: 1) In-situ observations of  
92  
93 sediment dynamics in muddy coasts and estuaries and satellite remote sensing (Chang et al.,  
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95 2020; Duan et al., 2020; Li et al., 2020; Liu et al., 2020; Niu et al., 2020; Qiao et al., 2020; Z.  
96  
97 Wang et al., 2020a and Zhong et al., 2020); 2) Modelling of sediment transport and associated  
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99 sedimentary processes (Cruz and Noernberg, 2020; Tran and Strom, 2020; D. Wang et al.,  
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101 2020 and Xiao et al., 2020); 3) Fluid mud transport and process in bottom boundary layer  
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103 (Peng et al., 2020; Tang et al., 2020; Xue et al., 2020 and Xu et al., 2020), and 4) Blue bay  
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105 remediation action plan and coastal restoration (A. Wang et al., 2020 and Zhu et al., 2020).  
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107 The papers that address these themes are discussed in next section.  
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## 111 112 113 **2. Main themes in this SI** 114 115 116 117 118

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121 **Theme 1: In-situ observations of sediment dynamics in muddy coasts and estuaries and**  
122 **satellite remote sensing**  
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125 Zhong et al. (2020) investigated the sediment trapping in a typical coastal embayment using  
126 Weihai Bay, China, as an example. The study is based on observations of water depths,  
127 current profiles, wave parameters, near-bed flow velocities, turbidity, salinity and  
128 temperature. Shear stresses, residual currents and suspended sediment fluxes at the near-  
129 bottom were calculated. The authors concluded that, in the northern mouth, the temporal  
130 variability of suspended sediment concentration (SSC) was controlled by local resuspension,  
131 whereas in the southern mouth is due to the advection of a horizontal SSC gradient. The  
132 sediment trapping occurs mainly through the southern mouth and extends further landward  
133 through tidal pumping. The embayment tends to import fine sediments from the shelf at  
134 residual time scales. In two different papers, the suspended sediment in the continental  
135 shelves of China was investigated, using the method of remote sensing and in-situ  
136 measurements (Li et al., 2020 and Qiao et al., 2020). They provided a general pattern of  
137 suspended sediment concentration from the East China Sea to the Yellow Sea, with some  
138 discussion on the mechanisms of fine sediment transport from nearshore to the shelves. For  
139 example, Qiao et al. (2020) derived the spatiotemporal variations of SSC from MODIS  
140 during 2003-2018, and found that the wind is the controlling factor that affects the SSC in  
141 most areas in the Zhe-Min coast, especially in the spring and winter seasons. Their study  
142 concluded that the SSC anomaly exhibits opposite phases between the north and south parts  
143 of 28-29°N and between the landside and seaside of the front at the isobaths of 20 m to 40 m  
144 along the Zhe-Min Coast.  
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170 **Theme 2: Modelling of sediment transport and associated sedimentary processes**  
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172 D. Wang et al. (2020) investigated the data assimilation of multi-source SSC observations  
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180 into a three-dimensional suspended cohesive sediment transport model by the adjoint method  
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182 in the Bohai Sea. The authors found that except for the surface layer, assimilating only  
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184 satellite-retrieved SSCs can significantly improve the simulated SSCs in the middle and  
185  
186 bottom layers. Their results also showed that the model initial conditions are not only  
187  
188 important for SSC simulations, but also significant for data assimilation. Hydrodynamics in  
189  
190 estuaries provides a physical foundation for biogeochemical processes. The spatial and  
191  
192 temporal variabilities in the lateral circulation have wide implications for channel  
193  
194 morphology, sediment transport and the ecological environment. A fully calibrated three-  
195  
196 dimensional hydrodynamic model of the Sydney Harbour Estuary, Australia, was used to  
197  
198 determine the dominant forcing of regulating estuarine circulation in a sinuous channel under  
199  
200 conditions of low river discharge during dry weather (Xiao et al., 2020). The study found that  
201  
202 the channel bends induce vertical mixing as a result of the overturning of the density fields.  
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204 The lateral circulation redistributes the differential-advection-induced lateral shear of the  
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206 along-estuary momentum and is transferred to either reinforce or cancel the along-estuary  
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208 circulation. Thus the lateral bathymetry variability in a channel is shown to be the key factor  
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210 causing the intratidal asymmetries in along-estuary circulations.  
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### 217 **Theme 3: Fluid mud transport and process in bottom boundary layer**

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219 Based on the field observations off the Changjiang estuary, China, Peng et al. (2020) pointed  
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221 out that the flow structures within the bottom layer could be prominently influenced when the  
222  
223 gradient of SSC reaches a value in order of  $0.1 \text{ kg m}^{-4}$ . Moreover, modification of the flow  
224  
225 structure diminishes with the depth, and the drag coefficient reduction induced by sediment  
226  
227 stratification is depth-dependent. In another study, a series of entrainment and sedimentation  
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229 experiments was performed in an annular flume (Xu et al., 2020). The authors demonstrated  
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231 that the settling rate of fluid mud sample with higher salinity is enhanced and the gelling  
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239 concentration is reached at lower sediment concentration, causing different distributions of  
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241 sediment concentration for fluid mud under different flocculation states. On the basis of the  
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243 flume data, they also tested an existing model to suggest that the accurate prediction of the  
244  
245 entrainment rate of fluid mud requires the details of SSC and rheological properties of fluid  
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247 mud in the vertical direction.  
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#### 249 250 251 **Theme 4: Blue bay remediation action plan and coastal restoration**

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253 Wang et al. (2020) focused on the sedimentary processes in the subaqueous deltas of a typical  
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255 small mountainous river, Mingjiang, in the southern East China Sea based on a short  
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257 sediment core. They concluded that the increased sediment flux since 1960s delivered to the  
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259 sea by Minjiang was caused by the change of land use pattern and intensified soil erosion.  
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261 Then a decreased sedimentation rate in the river delta since the 1980s was resulted from the  
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263 reservoir construction. Their work provides data for assessing the impact of human activities  
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265 on the sedimentary environment in small estuaries. Zhu et al. (2020) studied management of  
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267 drainage pipes to optimize beach nourishment. The ‘salient’ landform is explored as a  
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269 feasible plan that considers beach nourishment and breakwater geometry of the drainage pipe  
270  
271 outlets. Using the XBeach simulations, the study found that the seaward convex breakwater  
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273 layout is the most effective option among three typical breakwater layouts (straight, landward  
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275 convex, and seaward convex), as it can accumulate the largest volume of sediment behind the  
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277 structure.  
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### 284 **3. Discussion and conclusions**

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286 One of the key debates during the Third Workshop amounted to a call for the urgent  
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288 development of a science-based indicator framework to evaluate the Blue Bay Remediation  
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290 Project (BBRP, Wang and Wang, 2018). The State Oceanic Administration of China  
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298 announced the start of a nation-wide coastal remediation project BBPP at the National  
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300 Maritime Work Conference in 2016. With the overall goals of pristine water, green coasts,  
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302 clean beaches, and beautiful bays and islands, the restoration of 66 Chinese bays will be  
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304 funded (about USD\$48-64 million for each bay), starting with 16 bays in 2016. This project  
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306 can be described as a milestone for China, as the coastal environment has never before  
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308 attracted such attention. Although there are some studies on evaluating coastal restoration  
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310 projects in China, they mostly presented only broad prescriptions and lacked specific  
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312 quantitative and qualitative indicators for environmental states and changes, and for  
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314 providing detailed information for project management. The Third Workshop has called for  
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316 development of an indicator framework that can be used as an effective assessment tool for  
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318 evaluating whether a project is on track or has been successful. A successful conclusion of  
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320 such a huge coastal remediation project in China may provide an example for the rest of the  
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322 world to follow.  
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328 There were only presentations on the theme of Microplastics transport and modelling  
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330 scheduled as a separate session during the Third Workshop. Unfortunately neither of these  
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332 presentations made it to publication in this SI. Marine plastic debris is critical environmental  
333  
334 issues affecting the world today. Numerical modelling is one of the key tools to understand  
335  
336 and estimate the sources, trajectories and fate of marine debris, especially microplastics. In  
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338 the session keynote speech entitled ‘Modelling the transport of microplastics in coastal and  
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340 marine environments: a new approach’, the presenter introduced the TrackMPD modelling  
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342 framework as a new approach for the transport of marine plastic debris (Jalón-Rojas et al.,  
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344 2019). TrackMPD fills the gaps of previous models by (1) considering a three-dimensional  
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346 approach, (2) providing compatibility with a variety of ocean models, and (3) including a  
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348 wide range of physical processes (advection, dispersion, wind age, sinking, settling, beaching  
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357 and re-floating) and MPD behaviour according to the particle dynamical properties, and the  
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359 fouling and degradation state.  
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364 There were in total more than 200 participants who represented 39 institutions mostly from  
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366 China, from multi-disciplinary fields. They include students and postdocs (42.5%), early- to  
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368 mid-career researchers (32.5%) and professorial and other senior scientists (25%). The  
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370 Workshop noted that there were significant representations from several emerging  
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372 Oceanography Schools in China such as Zhejiang University, Hohai University and Sun Yat-  
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374 sen University. This reflects an interesting trend that coastal and estuarine research has been  
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376 increasingly taken up by these non-traditional Oceanographic institutions over the past 15  
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378 years. The Third Workshop also attracted overseas scientists from University of Auckland,  
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380 New Zealand, UNSW Australia, Institution of coastal Research, HZG, Germany and  
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382 University of Hull, UK.  
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