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Editorial: Hydrodynamics and water environment characteristics in coastal areas under the influences of climate change and human activities

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Editorial on the Research Topic
Hydrodynamics and water environment characteristics in coastal areas under the influences of climate change and human activities

The global apprehension regarding the effects of climate change and human activities on coastal regions has been extensively documented. Researchers worldwide have investigated the precise repercussions on extreme water level, coastal structures, coastal evolution, sediment, water exchange, and water quality (e.g., Weatherdon et al., 2016; Almar et al., 2021; Pan et al., 2022). However, the impact of climate change and human activities is systematic and intricate, and it is evident that more investigation is needed to further understand its ramifications. This Research Topic aims to provide a comprehensive understanding of the effects of climate change and human activities on coastal areas, specifically in terms of storm surge, coastal hydrodynamics, coastline evolution, river plume, and related topics.

The intensities of storm surges are highly likely to increase in the context of global climate change (IPCC, 2021), posing significant threats to coastal structures such as sea levees (e.g., Pan et al., 2020). Wu et al. conducted a comparative analysis of the performances of parametric wind models through numerical simulations of waves induced by tropical cyclones in the East China Sea. The study found that the asymmetric wind model exhibited superior performance in this region. Pan et al. used a numerical study scheme to investigate the effects of increasing maximum wind speed of tropical cyclones on the return periods of water levels in the Yangtze River Delta. The numerical study scheme involved 154 storm surges under historical and enhanced scenarios. It was found that the inner areas of the estuaries were more sensitive to the increasing maximum wind speed of tropical cyclones than the outer areas in terms of extreme water levels and corresponding return periods. Zhou et al. examined the combined effects of wave and surge overtopping on sea levees and proposed an empirical distribution to describe the distribution of normal stress on the levee induced by the combined wave and surge overtopping.

Coastal hydrodynamics can be significantly affected by both climate change and human activities. Wu et al. conducted a numerical simulation study to investigate the impact of Bohai Sea coastline changes on hydrodynamics and water exchange. The results indicated that coastline changes had a more significant effect on the semi-diurnal tide amplitude than the diurnal tide amplitude, causing a shift of the amphidromic point towards the offshore direction. Similarly, Zhang et al. used a numerical simulation approach to explore the hydrodynamic and sedimentary effects of tidal flat reclamation on adjacent areas. The study found that reclamation led to a decrease in intertidal area, a shift of the M4 shallow water tidal line towards the shore, a weakening of the flood tide advantage, and a reduction in suspended sediment concentration. However, the impact on net sediment transport was limited. Moreover, the construction of guide dikes in the estuarine area interfered with suspended sediment circulation and strengthened landward sediment transport. Kwak and Cho employed a three-dimensional numerical model to investigate water exchange between two neighboring bays, considering factors such as river flow, wind stress, sea surface heat flux, and tides. The study showed that river flow was the primary factor influencing water exchange between the bays during the summer. Wang et al. studied the effects of river runoff on coastal water quality after heavy rainfall, taking into account a complex coastline with two artificial islands. It is found that dissolved inorganic nitrogen (DIN) and nitrate-nitrogen (NO_3-N) concentrations in the study area remained high after the flooding process, while ammonium-nitrogen (NH_4-N) and orthophosphate (PO_4-P) showed a response with an ephemeral correspondence with the flooding process. Concentration recovery took approximately 5.5 days for DIN and NO_3-N and only approximately 1 day for NH_4-N and PO_4-P. Luo et al. used a numerical model to investigate the impacts of human activities on the coastal hydrodynamics surround Liyashan oyster reefs, based on which the impacts on oyster reefs were discussed.

Coastlines and tidal flats are experiencing a general eroding trend due to sea level rise and human activities. In Gao et al., the authors utilized field data and remote sensing images to investigate the impacts of climate change and sea level rise on the evolution of the coastline in the Shandong Peninsula between 2007 and 2020. They found that the coastline retreat was primarily driven by sea level rise due to global climate change. In Zhang et al., the authors used four phases of Sentinel-2 multispectral images and field data to investigate the spatial and temporal distributions of tidal flat surface sediment in the Doulonggang tidal flat in Jiangsu Province, China. Their study demonstrated that the sediment composition of the tidal flat coarsened over time, with an increase in sand content and a decrease in clay and silt contents. Shen et al. surveyed the sedimentation of cohesive sediments at the subtidal flat based on an 11-day field study at the subtidal region of the Hengsha Shoal adjacent to the turbidity maximum zone of the Yangtze Estuary. They concluded that the deposition process of cohesive sediments could be better explained by the simultaneous deposition paradigm compared to the exclusive deposition paradigm based on the direct data-model comparison of the bed level changes. Fu et al. utilized the coastal erosion vulnerability index (CVI) method to investigate the coastal erosion vulnerability of typical coasts on Hainan Island. Their study found that coral reef coasts were the least vulnerable areas to coastal erosion, while estuary coasts were identified as the most vulnerable areas.

The phenomenon of river plume and its associated effects on salinity have garnered significant attention in estuarine studies. In Xu et al., the movement characteristics of the river plume were analyzed using the particle image velocimetry (PIV) technique and the dye tracing method. The results revealed that the horizontal velocity of the plume could be effectively described by a 1/2 Gaussian distribution curve. It was also found that the turbulent kinetic energy increased with an increase in flow rate or density difference. In Matsoukis et al., the impact of river flow regimes on river delta salinization was explored using an idealized model. The study revealed that the magnitude of peak flow, time of occurrence, and the length of a hydrograph's tails could be vital parameters affecting stratification, freshwater residence, and renewal times. Cho et al. analyzed the variation in salinity gradient along the entire Sumjin River estuary and its effect on the exchange flow over fortnightly tidal cycles using observations and numerical model experiments. The study demonstrated the significance of salinity gradient variation in estuarine dynamics and its impact on water exchange.

The flow structure and sediment transport in estuaries can be impacted by aquatic vegetation. In Wu et al., laboratory experiments were conducted to study the effects of submerged vegetation with different flexibility on the flow structure and turbulence characteristics under unidirectional flow. Based on the experimental results, a turbulent kinetic energy model (TKE model) was established, which can be used to predict the turbulent kinetic energy and its shear production term within the vegetation canopy. Lou et al. proposed an improved model for incipient sediment suspension considering the effect of cylinder density to simulate the bottom sediment flux in the flow with cylinders. It is proved that the proposed model is capable of simulating sediment suspension under both unidirectional and combined wave–current flows reasonably well with the average the coefficients of determination and model skills greater than 0.8 and 0.64.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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