Impact of human activities on subaqueous topographic change in Lingding Bay of the Pearl River estuary, China during 1955–2013

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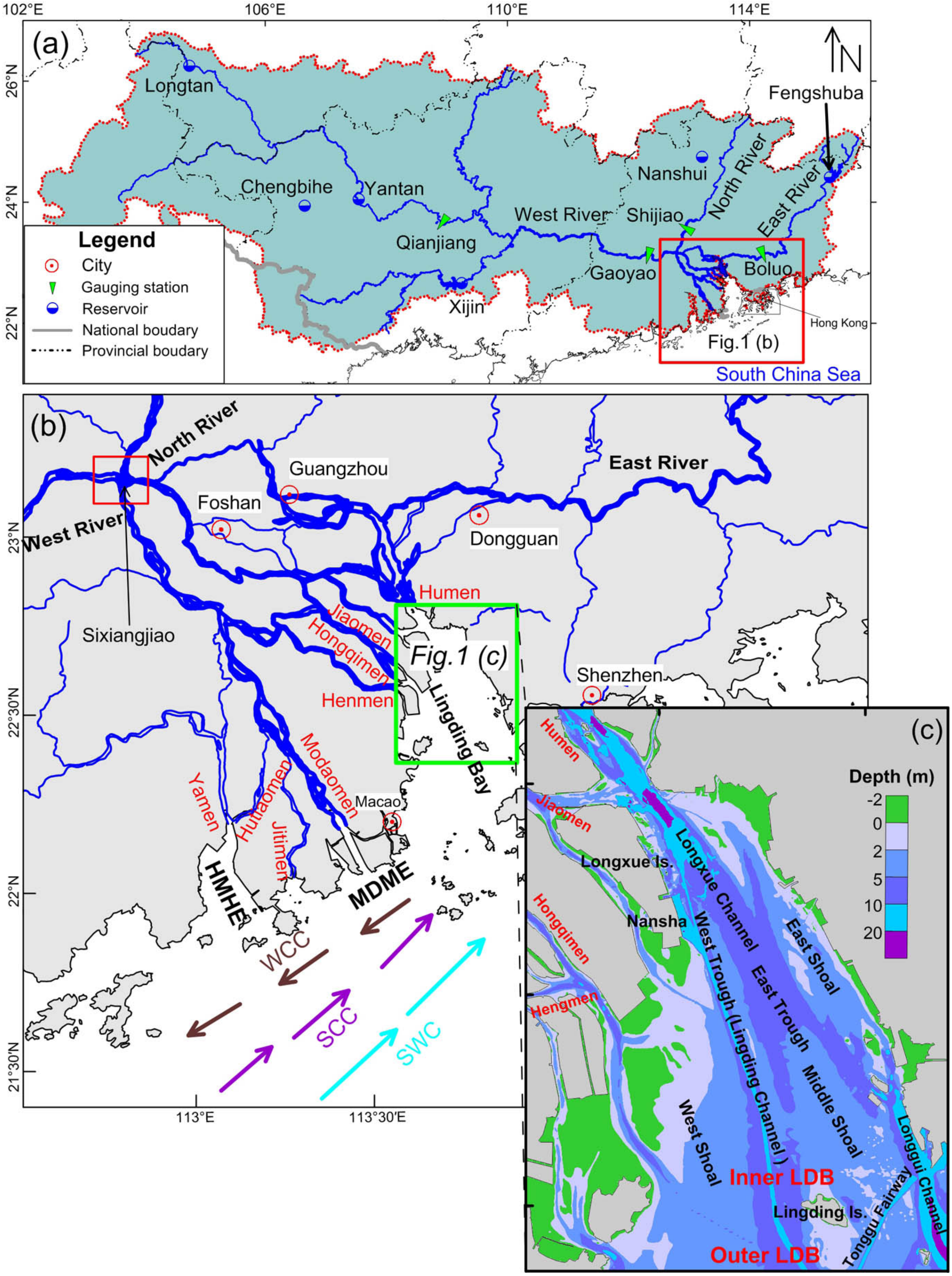
Estuaries have been the site of intensive human activities during the past century. The decadal time-scale evolution of subaqueous topography in estuaries enables us to understand the effects of human activities on estuaries. From 1955 to 2010, land reclamation decreased the area of Lingding Bay by 10% (~170km^2), and the water volume of Lingding Bay decreased by 615 $\times 10^6$ m^3. This shows a net decrease of 11.2 $\times 10^6$ m^3 a year, indicating that approximately 14.5 Mt/yr of sediment was deposited in Lingding Bay during that period. Before 1980, Lingding Bay was mainly governed by natural processes with slight net deposition, whereas after 1980 dredging in the bay and large port engineering projects changed the subaqueous topography by shallowing the shoals and deepening the troughs in the bay. Between 2012 and 2013, large-scale human activities including continuous dredging and a surge of sand excavation were found clearly with water depth changes of ±5 m/yr, far exceeding the magnitude of natural topographic evolution in Lingding Bay. Human activities such as reclamation, dredging, and navigation-channel projects remove about 8.4 Mt/yr of sediment from Lingding Bay, accounting for 29% of the sediment input to the bay, and these activities have increased recently.

Keywords: human activities, estuarine topography, Lingding Bay, Pearl River, evolution


(a)
Longtan
Chengbihe
Yantan
Qianjiang
Xijin
West River
Nanshui
Shijiao
North River
East River
Fengshuba
Gaoyao
Boluo
Hong Kong
Fig.1 (b)
South China Sea
Legend
City
Gauging station
Reservoir
National boudary
Provincial boudary
(b)
North River
West River
Guangzhou
Foshan
East River
Dongguan
Sixiangjiao
Humen
Jiaomen
Hongqimen
Henmen
Fig.1 (c)
Lingding Bay
Shenzhen
Macao
Modaomen
Hutiaomen
Yamen
Jitimen
HMHE
MDME
WCC
SCC
SWC
(c)
Depth (m)
Longxue Is.
Nansha
Longxue Channel
West Trough (Lingding Channel)
East Trough
East Shoal
Middle Shoal
West Shoal
Inner LDB
Outer LDB
Lingding Is.
Tonggu Fairway
Longgui Channel
Hengmen

Tidal and seasonal water-level variability in the Mekong River delta in Vietnam

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The interactions of tides and river flows in the Mekong River delta regions in Vietnam has been investigated by analysing the water-level datasets and by conducting numerical experiments with idealised settings. Tidal harmonic analyses of the observed water levels indicated a large seasonal change in tidal amplitudes. For example, the M2 tidal amplitude at Tan Chau near the Vietnam-Cambodian border was about a half of that at the river mouth in May whereas less than one-tenth in October. It was also found that seasonal changes in non-tidal water levels in the middle delta were caused not only by floods propagated from upstream but also by changes in sea levels along the deltaic coast. It was suggested that an intrusion of saline water from the sea is regulated by the spring-neap tidal cycle while the timing on the emergence of high-salinity water depends on the discharge rate of the river. These results suggest that it is important to take into account the effect of tides when evaluating the behavior of sediments in the lowest section of large rivers.

Keywords: Sea-level change, tides, Mekong River delta

Numerical model for the growth of distributary channel bifurcation on river delta

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We propose a numerical model to describe the growth of distributary channel networks on river deltas. The model uses the Laplace equation to describe shallow, unchannelized flow on the delta front and a moving boundary to describe the evolving channel network. The boundary element method is applied to solve the Laplace equation to obtain the outflow flux on the distributary boundary. Movement of the channel network boundary ($\mathbf{u} = (u_x, u_y)$) is a function of the outflow flux along the boundary (q). The relation $\mathbf{u} \sim q^{\alpha}$ with α=1.5-2.5 is consistent with common sediment transport formulae. The model produces emergent channel bifurcations which are similar to processes observed at the prograding Wax Lake Delta, Louisiana, USA. Furthermore, as α increases, the emergent width of distributary channels is reduced. Further comparisons with experiments and field data will be used to validate the numerical results. The model provides a new tool for investigating channel spacing and bifurcation dynamics in complex distributary channel networks.

Keywords: channel networks, channel bifurcation, river delta

Kinematic analogy between delta front and dune slip face progradation

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For both Gilbert lake deltas and Aeolian sand dunes, progradation involves the forward migration of curved surfaces of constant slope, equal to the granular angle of repose, driven by mass flux across the upstream shoreline or brink line. For three-dimensional delta fronts, it was recently shown that the progradation rate can be predicted from the mass flux using a simple curvature-dependent law. We will show that a similar law can be written for the slip faces of three-dimensional dunes. An important difference, however, is that whereas the delta shoreline is a plane curve deforming in the horizontal plane, the dune brink line is a space curve evolving in three-dimensional space. The mathematics must therefore be generalized to account for this greater freedom. We will illustrate the law for the example of isolated barchan dunes, for which we will apply the theory to laboratory experiments conducted in a deep, wide water channel.

Keywords: delta progradation, barchan dunes, morphodynamics

Scaling Relationships For Diffusive Boundary Layer Thickness And Diffusive Flux Based On In Situ Measurements In Coastal Seas

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In situ measurements of the diffusive boundary layer (DBL) and bottom boundary layer (BBL) under different dynamic and oxygen environments in three coastal seas are analyzed. Previous scaling methods for the DBL thickness (δ_{DBL}) are summarized. Three methods that lead to consistent dimensions at both sides of the derived relationships have all been rooted in the Batchelor length scale. The method representing the Batchelor length scale as a function of flow speed (*U*) is found to be the most appropriate for scaling δ_{DBL} when the law of wall applies. Diffusive flux is controlled by the dynamic-forced δ_{DBL} and the difference in oxygen concentration over the DBL (ΔC). Values of ΔC could be scaled using the oxygen concentration of the BBL (C_{BBL}) and the normalized benthic temperature. An effective method is developed for scaling the diffusive flux based on measurements of benthic temperature, salinity, *U*, C_{BBL}, and the estimation of bottom roughness. The scaling of δ_{DBL} based mainly on *U* and the scaling of diffusive flux well fit data from the three sites, despite their distinct differences in dynamic and oxygen environments.

Keywords: Diffusive Boundary Layer, Bottom Boundary Layer, Diffusive Flux, Sediment-water Interface

Influence of environmental changes followed by huge eruption on human activities in the lower Lempa River, El Salvador, Central America

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Not only destructive volcanic disaster but also environmental change caused by volcanic eruption can influence human activities. Sometimes it is difficult to understand human response, however, in the case that it occurred in the area unaffected by destructive volcanic phenomena. Geomorphological and sedimentological approach is valuable for clarifying environmental change and considering the human response for the change.
In the lower Lempa River, Usulutan, El Salvador, including the area surrounding a lagoon called Jiquilisco Bay, there are many archaeological sites in the Preclassic Period (ca. B.C. 2500 - A.D.250) and the Early Classic Period (ca. A.D. 250-600), except in a coastal sandbar called San Juan del Gozo Peninsula which extends ca. 40 km to the southeast enclosing Jiquilisco Bay. Ceramic pottery for salt production has been discovered in some sites, so that, this area is considered to have been a big center of salt production. On the other hand, because archaeological sites in the Late Classic Period (ca. A.D.600-900) are quite few in the area, considerable population decrease is assumed to have occur before the Late Classic Period. While gigantic eruption occurred in the 4th to 6th century during the Early Classic period at Ilopango Caldera which located ca. 50 km northwest of the Lempa River Delta has been considered to affect this area, destructive phenomena such as pyroclastic flow did not reach to the area, although only the moderate influence by the deposition of fall-out fine ash called "TBJ" (ca. 30 cm thick) was supposed. Recently, the present coastal sandbar was clarified to be formed after the eruption on the basis of the stratigraphic relationship among the geomorphological units and the TBJ tephra, and Jiquilisco Bay was smaller than the present before the eruption, enclosed by old sandbar that was located inland and remains as linearly ranging small islands inside of the present lagoon. This fact suggests that environmental change by the formation of offshore sandbar would give any influence on human activities.
In this study, organic fine-grained sediment under the mangrove forest was collected by hand auger in the coast of Jiquilisco Bay to demonstrate environmental change in the lagoon. Organic material and intercalated sandy sediment were sampled from the boring core for radiocarbon dating and chemical analysis, respectively, to clarify depositional date at the sampling level in the core.
In the northern coast of Jiquilisco Bay, 1.9 to more than 3.3 m organic fine-grained sediment is accumulated intercalating ca. 13 cm to 56 cm fine sand layer in the middle. The bottom of the organic fine-grained sediment exhibits radiocarbon dates as ca. 2,000 to 3,500 yrBP. The intercalated fine sand layer contains volcanic glass at the bottom, and the chemical composition of the volcanic glass was illustrated to be coincident with that of the TBJ tephra by electron microprove analysis (JEOL JXA-8800RL in Dep. Earth & Environmental Sci., Hirosaki Univ.). The radiocarbon dates as the 5th to 6th and the 9th to 11th centuries were obtained almost just bellow the bottom and almost just above the top of the fine sand layer, respectively. In the southern coast of Jiquilisco Bay along San Juan del Gozo Peninsula, 1.9 to 2.5 m organic fine-grained sediments are accumulated, but no fine sand layer is found to be intercalated. The bottom of the organic fine-grained sediments exhibits the radiocarbon dates of the 8th to 10th century. These data indicate that mangrove forest in the north coast was already formed around 2,000 yrBP at the latest, and had been devastated for several hundred years since the Ilopango eruption. It also suggests that the present coastal sandbar had been formed in the 8th to 10th century, and since then

mangrove forest has rehabited in the north area of the lagoon and has also habited in the southern area offshore of the old sandbar.
Devastation of mangrove forest was possible to be caused by the inflow and outflow of sandy sediment for several hundred years after the eruption as well as the ash fall at the eruption, because mangrove trees can live only in the height between average sea level and mean high-tide level and is so vulnerable to such the change of surface level by the deposition and erosion of sand. Salt production needs a great amount of wood, so that, it was probable to be terminated by the devastation of mangrove forest in Jiquilisco Bay for the several hundred years, if the people had exhausted wood of forest in land and have been dependent on mangrove forest as the fuel resource until the Early Classic Period.

Keywords: TBJ tephra, Ilopango Caldera, Jiquilisco, mangrove, salt production

Modern sediment accumulation and sedimentary structure of the modern Yellow River delta

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Since 1976 the Yellow River channel has been located on the east side of delta complex and has built out a broad sedimentary lobe. In 2012, extensive bathymetric and high resolution seismic profiles, vibrocores in the survey lines and surface sediments were collected off the Yellow River delta and in Laizhou Bay. This study examines the sedimentation and morphology in the modern Yellow River delta and in Laizhou Bay, based on analyses of radionuclides (^{137}Cs, ^{210}Pb, ^{134}Cs), sediment structure and texture, surface sediment distribution pattern, and the morphological change between 1976 and 2012. Bathymetric profiles, especially the S-N profiles, reveal the present morphology of the delta front which exceed previous estimated boundary, and this also validate on basis of analysis of ^{137}Cs in cores. The ^{137}Cs onset depths corresponding to the depths of lithological changes and morphological changes indicate that it can be a proxy to track the dispersal of Yellow River-derived sediments in the study area. Synthesis of bathymetry, seismic profiles, ^{137}Cs profiles and surface sediment pattern show that a depocenter occurs in the south frank of the Yellow River delta (morphologically a spit) in west of Laizhou Bay. The deposition probably results from the headland eddy that formed with the morphological change. ^{210}Pb profiles only in shelf area provide reliable accumulation rates, while ^{137}Cs profiles show the depositional thickness in the whole area. Morphological changes along with ^{137}Cs profiles of cores were used to establish the present sedimentary frame of the delta front slope and sediment dispersal in the west of Laizhou Bay.

Keywords: Yellow River (Huanghe), sedimentation rate, delta lobe

