

Impacts of Dam-orientated Water-Sediment Regulation Scheme on the Lower Reaches and Delta of the Yellow River, China: A review

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The Water-Sediment Regulation Scheme (WSRS), beginning in 2002, was an unprecedented engineering effort to manage the Yellow River with the aims to mitigate the siltation both in the lower river channel and within the Xiaolangdi Reservoir employing dam-regulated flood water. Ten years after its initial implementation, multi-disciplinary indicators allow us to offer a comprehensive review of this human intervention on a river-coastal system. The WSRS generally achieved its objective, including bed erosion in the lower reaches with increasing capacity for flood discharge and the mitigation of reservoir siltation. However, the WSRS presented unexpected disturbances on the delta and coastal system. Increasing grain size of suspended sediment and decreasing suspended sediment concentration at the river mouth resulted in a regime shift of sediment transport patterns that enhanced the disequilibrium of the delta. The WSRS induced an impulse delivery of nutrients and pollutants within a short period (~20 days), which together with the altered hydrological cycle, impacted the estuarine and coastal ecosystem. We expect that the sediment yield from the loess region will decrease due to soil-conservation practices, and the lower channel erosion will also decrease as the riverbed armors with coarser sediment. These, in combination with uncertain water discharge concomitant with climate change, increasing water demands and delta subsidence, will put the delta and coastal ocean at high environmental risks. In the context of global change, this work depicts a scenario of human impacts in the river basin that were transferred along the hydrological pathway to the coastal system and remotely transformed the different components of coastal environment. The synthesis review of the WSRS indicates that an integrated management of the river-coast continuum is crucially important for the sustainability of the whole river-delta system. The lessons learned from the WSRS in the Yellow River provide insights to the integrated management of large rivers worldwide.

Keywords: Water-sediment regulation, the Yellow River, Human activity, Delta morphology, Coastal ecosystem

Water: The Major Driver for Livelihood in Indian Sundarban Delta

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The estuarine islands within Indian Sundarban Delta are extremely vulnerable due to the changing climate, sudden shocks of cyclone & storm surge, prolonged erosion and regular inundation creates salinization and of course with increasing population. Around 4.6 million people living within the 19 blocks of Sundarban notified area are under constant threat of several events, affecting their traditional resource based economy and dependency on forest resources for their livelihood. Through time, this delta has been traditionally considered as a human centric terrestrial system in view of the developmental perspective. This diagnostic overview is instigating a paradigm shift towards considering this ecosystem as an aquatic system. Water within this delta, either excess or shortage, or, in terms of quality or quantity, is responsible to support or destroy the morphology, nature of water usage, and the profession of the people like agriculture, fishing etc. actually influence the livelihood of the people. Also, absence of implementable effective adaptation plan and disaster risk reduction mechanism is leading towards failed adaptation, loss in livelihood practices and tends to seasonal migration.

Keywords: Water, Livelihood, Indian Sundarban

Sediment facies and environment in distributary channels of the Mekong River delta, Vietnam

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The Mekong River delta is one of largest deltas in Asia, ranked world's third largest in delta plain area, and one of typical mixed wave- and tide-dominated deltas. River channels in the delta are strongly influenced by tides, up to Phnom Penh in Cambodia during the dry season. The coastal zone of the delta is strongly influenced by waves, resulting in the formation of beach ridges and alongshore sediment transport towards the Cape CaMau. Sediment sampling for sediment facies analysis and salinity survey were conducted in river channels in Vietnam from 2015 to 2016, and river morphology; channel depth, width, and sinuosity was analyzed.

The result shows clearly two main tracts in the river channels in Vietnam; an upstream, fluvial-dominated tract and a downstream, tide-dominated tract, and these tracts are divided into two subzones respectively. From upstream to downstream, the four subzones are identified: fluvial-dominated, tide-affected; fluvial-dominated, tide-influenced; tide-dominated, fluvial-influenced; and tide-dominated, fluvial-affected.

Tidally induced water-level changes affect the entire study area and extend into Cambodia. Salinity intrudes ~15 km upstream of the river mouth during the wet season, and ~50 km upstream during the dry season. Brackish water species of mangroves, mollusks, and diatoms, however, occur landward of these limits, suggesting that highly diluted brackish water may reach ~160 km upstream of the river mouth during the dry season. In the fluvial-dominated tract, channels are sinuous and show a seaward-deepening trend, whereas width is relatively constant. In the tide-dominated tract, channels are straight, and show seaward-widening and seaward-shallowing trends. Natural levees are present in the fluvial-dominated, tide-affected subzone, but are replaced by mangroves. In the fluvial-dominated tract, mud content is low, sand grain size fines seaward, and gravelly sand and sand are dominant facies. In the tide-dominated tract, mud content is high, sand grain size is constant, recycled sand is common, and tidal rhythmites are the dominant facies. Mud pebbles are common in sediments of a large part of the study area.

Keywords: distributary channel, tide-dominated delta, sediment facies, tidal river, backwater, tidal rhythmite

Southwest Mekong delta: the last piece of the delta evolution pazzle and its implications to recent shoreline erosion

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The Mekong delta, one of the largest deltas in the world, attracts increasing concerns about the coastal stability affected by the human-induced decrease in sediment supply. Serious erosion has been reported in the coast outlining the southwestern part of the delta, from the mouth of the Bassac River, through Bac Lieu and Camau Point, to Gulf of Thailand, where only muddy sediments are supplied by the southwestward longshore drift from the distributaries in the northeastern part. Little is known about the long-term coastal evolution of the southwest Mekong delta disproportionately to its large area (up to 40 % of the lower delta plain) as the effort has been focused on the distributary region. Here we report seven radiocarbon dated sediment cores and twenty optically-luminescence stimulated dates of beach ridges and intertidal mud flat deposits to constrain the position of shorelines at 2.4 ka, 1.4 ka, and 0.6 ka in the southwest Mekong delta. These shorelines have a similar shape with the modern shoreline and show the delta growth toward the SSW. The rate of the delta plain increment is estimated as 2 km²/y from 2.4 to 1.4 ka, 6 km²/y from 1.4 to 0.6 ka, and 8 km²/y from 0.6 ka to the present, respectively, which is much more significant than that in the distributary area, 0.5–2 km²/y. The increase in the rate after 1.4 ka may be related to the increased precipitation in the catchment as the palaeoenvironment reconstruction in Tibetan suggests a drier period of the weakened Indian summer monsoon during 2.4–1.4 ka. After 0.6 ka, the updrift part of the coast, from the Bassac River to Bac Lieu, has not prograded much, and the sediment accumulation has been concentrated around the Ca Mau Point, suggesting the increased exposure to the longshore drift in relation to the overall delta progradation. The accumulation trend after 0.6 ka also highlights the uniqueness of the modern shoreline that has been retreated almost entirely.

Keywords: coast, delta, monsoon

Relationship between sea-level change and incised-valley fill deposits at the Zengwen River, western Taiwan

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Eustatic sea-level change since around the Last Glacial Maximum (LGM) has been studied based on dated, shallow marine clastic sediment and corals. However, the sea-level change especially before 14 ka is still unclear due to the lack of data. This study focuses on incised-valley fill deposits at the Zengwen River, western Taiwan where tectonic subsidence has been dominant and huge fluvial sediment supply has occurred to clarify the sea-level change especially between the LGM and 14 ka. We obtained a new borehole core (NU-TN-1), 300 m long, near the river mouth in 2015. We performed sediment facies analysis, radiocarbon dating, measurement of grain size and electric conductivity (EC), and small macro- and microfossil analyses (mollusc shell, foraminifera, and ostracoda). Incised-valley fill deposits of the NU-TN-1 since the LGM are very thick, reaching 180 m, which is much larger than the amplitude of sea-level change, ~130 m. The core sediments can be divided into nine facies (A to I) in ascending order, and six of them (D to I) formed since around the LGM. Age–elevation plots of faces D to I were located below the estimated relative sea-level curve. Relatively slow accumulation rates of facies E between 17.5 and 15 ka may respond to slow sea-level rise. Facies F probably formed close to sea level contributes to reconstruct sea-level change between 14 and 12 ka. Retreat of the river mouth since the LGM might be very limited due to huge sediment supply.

Keywords: sea-level change, sediment supply, Last Glacial Maximum

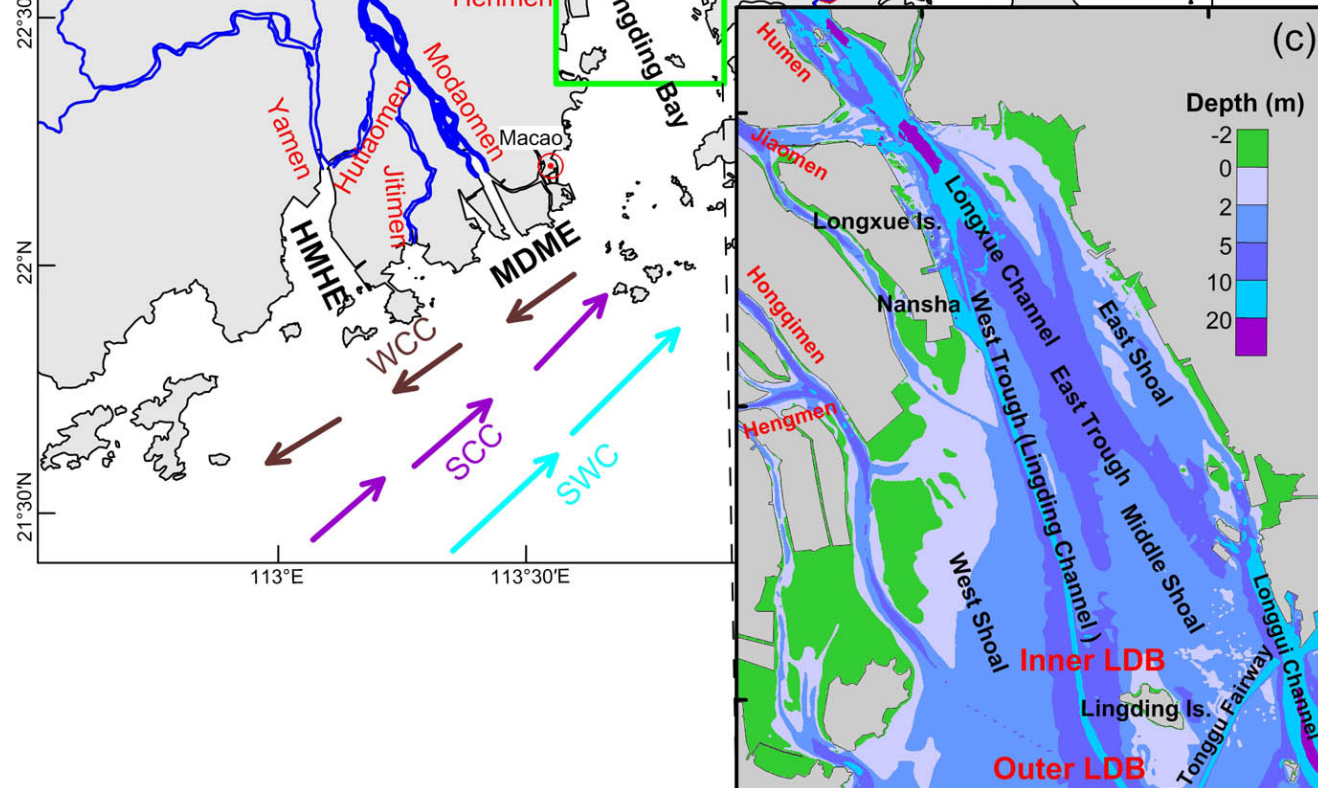
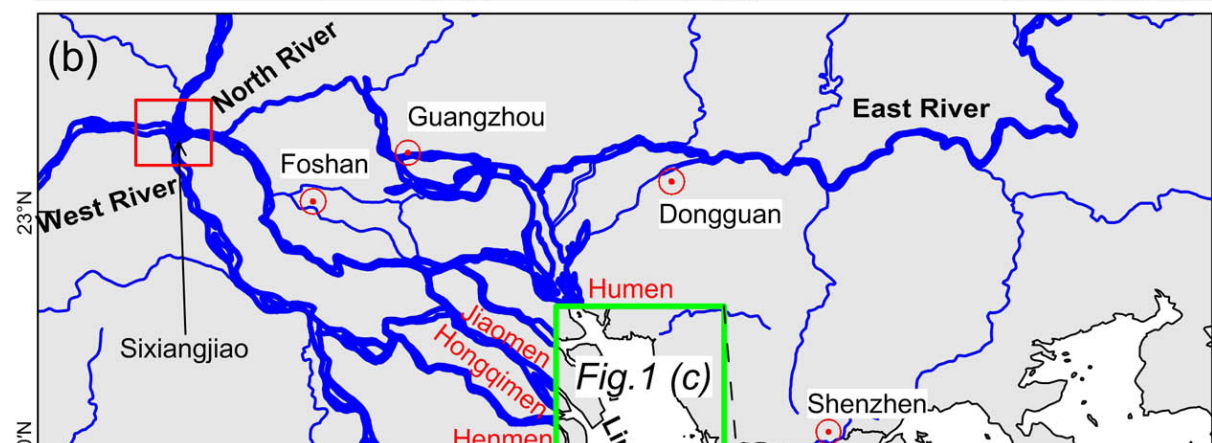
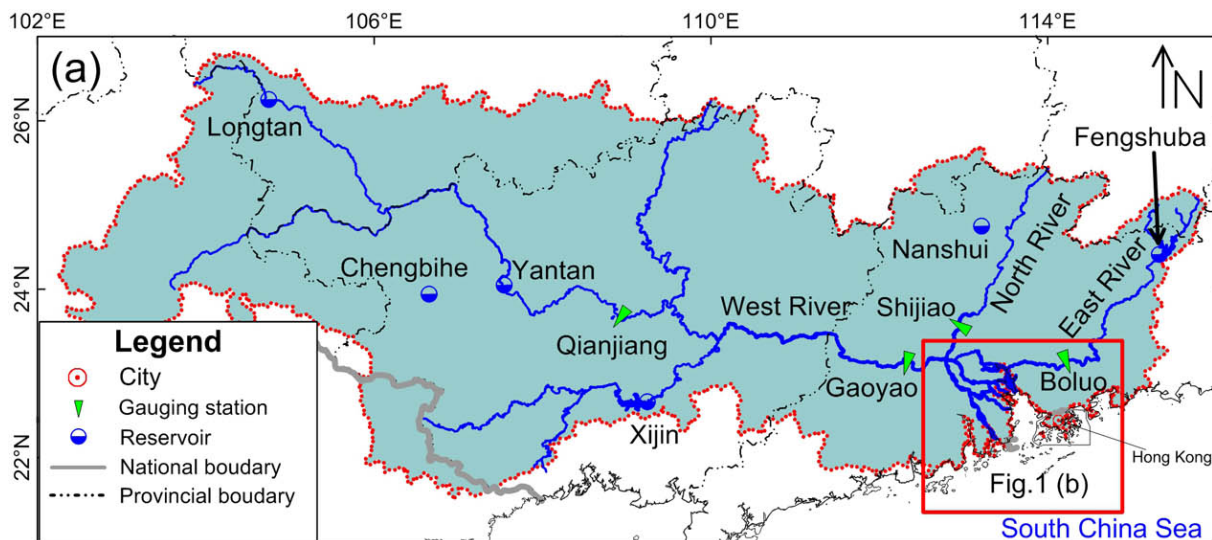
Impact of human activities on subaqueous topographic change in Lingding Bay of the Pearl River estuary, China during 1955–2013

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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% ($\sim 170\text{km}^2$), and the water volume of Lingding Bay decreased by $615 \times 10^6 \text{ m}^3$. This shows a net decrease of $11.2 \times 10^6 \text{ m}^3$ 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 $\pm 5 \text{ m/yr}$, 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



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 $\alpha = 1.5-2.5$ 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, Usulután, 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 microprobe 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 below 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 flank 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