JSPS and CCOP/GSJ/AIST Joint Seminar on Monitoring and Evaluating Coastal Erosion in Deltas

Program and Abstracts

Hosted by the Institute of Marine Environment and Resources, VAST

Venue: Navy Guest House, Haiphong, Vietnam
Dates: November 24 (Wednesday) to 29 (Monday), 2010

Edited by Yoshiki Saito, Geological Survey of Japan, AIST

Organizers

JSPS Asia-Africa Science Platform program "Mega-Delta Watching in Asia: Networking and Capacity Building"

CCOP Project DelSEA-II "Integrated Geological Assessment for Deltas in Southeast and East Asia"

Institute of Marine Environment and Resources (IMER), Vietnam Academy of Science and Technology (VAST)

Geological Survey of Japan/AIST, Japan

Conveners:

Yoshiki Saito (Geological Survey of Japan, AIST), leader of MDW and DelSEA-II project

Tran Duc Thanh (IMER, VAST)

Niran Chaimanee (CCOP Technical Secretariat)

Accommodation

Hai Phong on Nov 23–26: Navy Guest House. Address: 27C Dien Bien Phu Street, Hai Phong City. Phone number: 84 0313 842856

Quan Lam Beach on Nov 27: Sai Gon Hotel. Address: Giao Thuy District, Nam Dinh Province. Tel: 84 03503747612.

Hanoi on Nov 28: Army Hotel. Address: 33C Phạm Ngũ Lão, Hanoi, Tel: 84.4 3825 28 96

JSPS Asia-Africa Science Platform program "Mega-Delta Watching in Asia: Networking and Capacity Building"

(1 April 2008 – 31 March 2011: 3 years)

http://unit.aist.go.jp/igg/sed-rg/JSPS/MDW_Eng.html

For the purpose of networking and capacity building of researchers on mega-deltas in Asia, a 3-years project entitled "Mega-Delta Watching in Asia: Networking and Capacity Building (MDW Project)" has started from April 2008, supported by JSPS Asia-Afirica Science Platform Program. Through collaborative study and seminars, particularly among participating core institutes in Japan, China, Vietnam and Thailand, monitoring methods and analyses of the annual to decadal changes of deltas are focused in the MDW Project. Those who are interested in this project can participate in open annual-seminars. The first open annual seminar was held in Shanghai and Qingdao on 26 October to 3 November 2008 with about 100 participants. The second seminar was held in Bangkok, Thailand on December 1 to 6, 2009.

Coordinators of the MDW project: Mega-delta watching in Asia

Chief Coordinator: Yoshiki Saito, IGG, Geological Survey of Japan, AIST

China Coordinator: Zuosheng Yang, Ocean University of China

Vietnam Coordinator: Tran Duc Thanh, Institute of Marine Environment and Resources, VAST

Thailand Coordinator: Thanawat Jarupongsakul, Chulalongkorn University

CCOP project:

Integrated Geological Assessment for Deltas in Southeast and East Asia (DelSEA-II Project)

http://unit.aist.go.jp/igg/sed-rg/ADP/ADP_E/a_ccop_en.html

(1 April 2008 – 31 March 2012: 4 years)

The purposes are to foster exchange of modern knowledge on deltas, quaternary geology, sequence stratigraphy, and geological coastal management and to enhance joint study for better understanding of deltaic coasts and geological assessment for coastal management, through scientific meetings to be held annually with excursions to the Asian coasts and additional lecture courses & short training courses.

Leader: Dr. Yoshiki Saito of IGG, Geological Survey of Japan, AIST.

CCOP webpage: http://www.ccop.or.th/

JSPS and CCOP/GSJ/AIST Joint Seminar on
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Venue: Navy Guest House, Haiphong, Vietnam
Dates: November 24 (Wednesday) to 29 (Monday), 2010

Program of Scientific Sessions

Day 1: November 24 (Wednesday)

Evening: registration at the Navy Guest House, Haiphong, Vietnam

Day 2: November 25 (Thursday)

At Meeting room of the Navy Guest House, Haiphong, Vietnam

0830–0900: registration

0900–0930: Opening of the Seminar

CCOP Technical Secretariat, Project leader, Host Institute

0930–1000: Yoshiki SAITO, Deltaic Coasts and the Present Crisis

1000–1030: Keynote, Colin D. Woodroffe

Coastal erosion along the margin of the Ganges-Brahmaputra delta, Bay of Bengal

1030–1050: Coffee break

1050–1120: Keynote, Houjie WANG, Recent changes in sediment delivery by the Huanghe (Yellow River) to the sea: Causes and implications for delta morphology

1120–1140: Liangyong ZHOU, Onshore and offshore morphologic changes in the abandoned Huanghe (Yellow River) delta in Jiangsu, China

1140–1200: Jeungsu YOUN, Seasonal variations of Hwasun and Hyeojae beach sediments in the southwest coast of Jeju Island, Korea

1200–1220: Raymond Lee Yamai, Status of PNG in coastal Delta Erosion, Monitoring and Evaluation

1220–1330: Lunch

1330–1400: Keynote, Thanawat JARUPONGSAKUL, Coastal erosion and protection in the Chao Phraya delta, Thailand

1400–1420: Siraprapa CHATPRASERT, Climate change adaptation and mitigation in the Upper Gulf of Thailand

1420–1440: Phalsambon Neak, Coasts in Cambodia

1440–1500: Kumala Hardjawidjaksana, Coastal Erosion in Old Distributaries Channel of Cipunegara Delta and its Surroundings, North Java, Indonesia

1500–1520: Coffee break

1520–1540: Jong-Gyu HAN, Inundation Potential Assessment based on a Precise Elevation Model and its application to Adaptive Planning for Sustainable Coastal Zone Management

1540–1600: Leopoldo T. Virtucio, Coastal Change along the Coast of Northwestern Luzon, Philippines

1600–1620: Wan SaifulbahriI Bin Wan Mohammad, Groundwater quality of Holocene and Pleistocene aquifers in the delta-plain of Pekan, Pahang, Malaysia

1620–1640: Bui Cong Que, Some features of geological structure and the geological disasters in the coastal area of Vietnam

1640–1700: Joao Edmundo dos Reis, Removal of sediment in a landslide-dominated mountain-belt: Timor-Leste

1830–2030: Dinner

Day 3: November 26 (Friday)

At Meeting room of the Navy Guest House, Haiphong, Vietnam

0830–0900: Keynote, Karl STATTEGGER, Deglacial sea-level rise and evolution of the Mekong Delta

0900–0930: Keynote, Yu SAITOH, Unraveling the supply and transport of beach sand by multiple use of grain-size, geochemistry, and strontium isotope: a case study in the south coast of Sendai Bay, northeast Japan

0930–0950: Yong YIN, The sedimentary environment of Xiyang tidal channel since the Late Pleistocene, South Yellow Sea coast, East China

0950–1010: Jian LIU, Subaqueous deltaic formation of the Old Yellow River (AD 1128–1855) on the western South Yellow Sea

1010–1030: Junko Komatsubara, Sedimentary Processes of the latest Pleistocene to Holocene incised-valley fills under Tokyo area, central Japan

1030–1050: Coffee break

1050–1110: Ayako FUNABIKI, Sequences Stratigraphic model of the late Pleistocene-Holocene incised valley fill sediments, in the Echigo Plain, central Japan

1110–1130: Jeungsu YOUN, Rare earth element geochemistry and Sr-Nd isotope composition of shelf sediments in the northern East China Sea

1130–1150: Ta Thi THOANG, Preliminary assessment on intrinsic compression of the Red River delta soft clay

1150–1210: Yasuo MAEDA, Holocene sea-level changes reconstructed from paleo shoreline indicators from Philippines coast

1210–1330: Lunch

1330–1400: Keynote, Klaus Schwarzer, The influence of tropical rainfall on sediment redeposition in mangrove environments – examples from Can Gio, SE-Vietnam.

1400–1430: Keynote, Katsuto UEHARA, Seasonal variability of sea levels and waves in the Red and the Mekong river deltas

1430–1450: NGUYEN Van Lap, Coastal landform changes at the active delta plain in the Mekong River Delta, Vietnam

1450–1510: TA Thi Kim Oanh, Coastline changes in the last 100 years at the Ca Mau deltaic margin, Mekong River Delta, Vietnam

1510–1530: Coffee break

1530–1550: Tran Duc THANH, Coastal Erosion in Cat Hai Island and Solution for Coastal Protection

1550–1610: Nguyen Van Thao, Study on effect of upland reservoirs to morphological change of coastal Red river delta by using remote sensing data

1610–1630: Vu Duy VINH, Seasonal variation of hydrodynamics and suspended sediment dynamics in the coastal zone of Red River Delta

1630–1650: Tran Anh TU, Hydro-dynamic Process and Erosion-Accretion in the Coastal Zone of Haiphong

1650–1710: Dang Hoai NHON, Sedimentation in tidal flats of Hai Phong coastal area

1710–1740: Excursion outline by Nguyen Van Thao, Doan Dinh Lam, and Ayako Funabiki

1830–2030: Dinner

Abstract only

Shafi Noor ISLAM, Coastal Mangrove Wetland Ecosystems Management in Red River Delta, Vietnam

S.K. Sarkar, Polycyclic aromatic hydrocarbons (PAHs) in core sediments from Sundarban Mangrove Wetland, Ganges River Delta, India and their ecotoxicological significance

Shilpa SINGH, Evolution of mangrove vegetation in Mahanadi Delta, India: A palynological assessment

Sobhanlal BONNERJEE, The Sundarbans: A delta with unique character and unique problems

Day 4: November 27 (Saturday)

Excursion to a mangrove coast, river mouth, and serious coastal erosion area of the Red river delta.

Day 5: November 28 (Sunday)

Excursion to Holocene notches in Ninh Binh (stay in Hanoi)

Day 6: November 29 (Monday)

Morning: Excursion in and around Hanoi to see the old capital and river-bank system

Deltaic Coasts and the Present Crisis

Yoshiki SAITO

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River deltas are one of the principal coastal landforms, and they are important areas for humans both ecologically and economically. Deltaic coasts are affected by changes both on the land (in both the drainage basin and the delta itself) and in the ocean. Sea-level rises and tsunamis are typical examples of ocean phenomena that may severely affect coastal zones. Decreases in sediment and water discharge caused by dam construction, sand dredging in river channels, and water usage in drainage basins are typical examples of changes on land that also impact deltaic coasts. Excess groundwater pumping in deltaic plains also causes land subsidence, resulting in coastal erosion.

Asian coasts are characterized by large-river deltas, called "*megadeltas*" in the IPCC Fourth Assessment Report 2007. The IPCC reported that megadeltas are one of most vulnerable areas in the world with respect to global climate change. They are not only expected to be vulnerable in the future, but they are also currently experiencing serious environmental problems. Moreover, similar problems have been recognized in smaller deltas along the coasts of small mountainous islands in Southeast and East Asia. Three ongoing global phenomena characterize the present delta crisis: shrinking deltas, sinking deltas, and ecosystem collapse. Shrinking and sinking deltas are caused mainly by a decrease in the amount of sediment supplied by rivers to deltas and deltaic coasts, as well as by a relative rise in sea level, either eustatic or caused by land subsidence due to isostatic effects, tectonic activity, sediment compaction, sediment reduction, or extraction of subsurface resources (groundwater, oil, or gas). Ecosystem collapse generally refers to the loss of wetlands (e.g., mangroves, tidal flats, and salt marshes), which is caused by human activities such as land reclamation and deforestation. These three phenomena are interlinked, as are their causes, which can be primarily attributed to human activities.

The purpose of this joint meeting is to exchange and share current knowledge, information, and ideas on deltas and to help coastal researchers and policy makers interact to better understand deltas and create measures to alleviate the present crisis.

Relevant references

Saito, Y., Chaimanee, N., Jarupongsakul, T., Syvitski, J.P.M. (2007) Shrinking megadeltas in Asia: Sea-level rise and sediment reduction impacts from a case study of the Chao Phraya delta. *LOICZ Imprint*, no. 2007/2, p. 3–9.

Syvitski, J.P.M., Kettner, A.K., Overeem, I., Hutton, E.W.H., Hannon, M.T., Brakenridge, G.R., Day, J., Vörösmarty, C., Saito, Y., Giosan, L., Nicholls, R.J. (2009) Sinking deltas due to human activities. *Nature Geoscience*, vol. 2, no. 10, pp. 681–686, DOI: 10.1038/ngeo629

Woodroffe, C.D., Nicholls, R.J., Saito, Y., Chen, Z., Goodbred, S.L. (2006) Landscape variability and the response of Asian megadeltas to environmental change. *In* Harvey, N. (ed.), *Global Change and Integrated Coastal Management: the Asia-Pacific Region*. Coastal Systems and Continental Margins, Vol. 10. Springer, pp. 277–314.

Coastal erosion along the margin of the Ganges-Brahmaputra delta, Bay of Bengal

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The delta plain of the Ganges-Brahmaputra-Meghna (GBM) Rivers, draining into the Bay of Bengal, receives the most concentrated sediment delivery in the world. It comprises the active, river-dominated mouth of the Meghna. To the west, the abandoned Ganges deltaic plain, is covered by the Sundarbans mangrove forest system, which is tide-dominated. The delta plain of the Ganges-Brahmaputra-Meghna is particularly low-lying, and has been recognised as especially vulnerable in the face of sea-level rise. Preliminary estimates indicate that the population of the Holocene plains exceeded 129 million people in 2000, and is likely to be more than 166 million in 2015. Initial assessments of the vulnerability of the GBM delta plain emphasised inundation of those low-lying coastal areas considered to be below the 1 or 2 m contour. Such a view was proposed by Broadus, who estimated that a 1 m rise of sea level would cover 7% of the habitable land, involving 5% of the population, resulting in a 5% decrease of GDP. The concept of simple translation of the shoreline landwards as the sea rises, however, does not capture the more complex changes considered likely by Brammer who indicated that sedimentation would occur within the mangrove-lined tidal channels of the Sundarbans, but foreshadowed significant alteration to flooding regimes. In a recent GIS modelling simulation of the Sundarbans, based on a series of GPS survey points, rapid disappearance of extensive tiger habitat has been proposed in response to sea-level rise within the range projected by the IPCC.

Our studies compare satellite imagery from 1989 with that acquired in 2009. Satellite imagery was checked for georectification, and shoreline position was captured using a band ratio method. Rates of shoreline erosion and accretion were derived using the Digital Shoreline Analysis System (DSAS) extension in ArcGIS, with transects set at 50m intervals. The broad pattern of change varies along the coast. The Sundarbans of Bangladesh shows erosion along much of its seaward margin. 88% of transects were eroding, although rates of accretion at local sites often exceeded rates of erosion. This pattern extends a similar study of the coast of west Bengal by Mukherjee (2007), which showed consistent changes in the tapering tidal channels of the western Sundarbans coast. Similarly, vast areas of Barguna, Patuakhali, Bhola, Manpura Island and Hatiya Island have been eroding more rapidly than accreting. High rates of change were detected over this period in the region at the mouth of the Meghna; in particular, the islands of Hatiya and Sandweep and the coastline of Noakhali zilla, where accretion was recorded as high as 633 m/yr. By contrast, there was less rapid erosion and accretion along the eastern coast of Bangladesh. The coastal zone of Cox's Bazaar showed minimum change compare to the rest of Bangladesh, but a small section of the Cox's Bazaar coast, covering Moheshkhali upazilla, did show rapid accretion. These trends are explored in the context of the longer term dynamics of the coasts of the Bay of Bengal.

Recent changes in sediment delivery by the Huanghe (Yellow River) to the sea: Causes and implications for delta morphology

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Over the past 60 years, climate change and human activities in the Huanghe (Yellow River) basin have changed the river system. In particular, construction of large reservoirs and soil-conservation practices within the river basin have reduced sediment flux to the sea by about 90% and increased the grain size of suspended sediment delivered to the sea (a current median grain size of 30 μm versus 18 μm before). Scouring of the channel in the lower reaches has added a new sediment source to those in the loess regions of the middle reaches. Before construction of the Xiaolangdi Reservoir at the downstream end of the middle reaches, the suspended sediment concentration (SSC) at Lijin Station, the last hydrographic station before the river enters the sea, was high enough (>35 kg/m^3) in the flood season to offset the density contrast between freshwater and ambient seawater. Thus, hyperpycnal flows developed along the subaqueous slope at the river mouth during the flood season. Observations from two cruises near the mouth of the Yellow River, one before and one after operation of the Xiaolangdi Reservoir began, suggest that buoyant hypopycnal plumes, rather than hyperpycnal plumes, have occurred at the river mouth since the dramatic changes in the concentration and grain size of suspended sediment discharged to the sea. The rapid decrease of sediment discharge to the sea and the increase of grain size of suspended sediments not only changed the sediment dispersal pattern at the river mouth but also modified the shoreline and subaqueous slope. The effects of climate change and human activities in the river basin have been transferred along the hydrological pathway to the estuary and delta, and they have changed estuarine sediment dynamics and delta morphology.

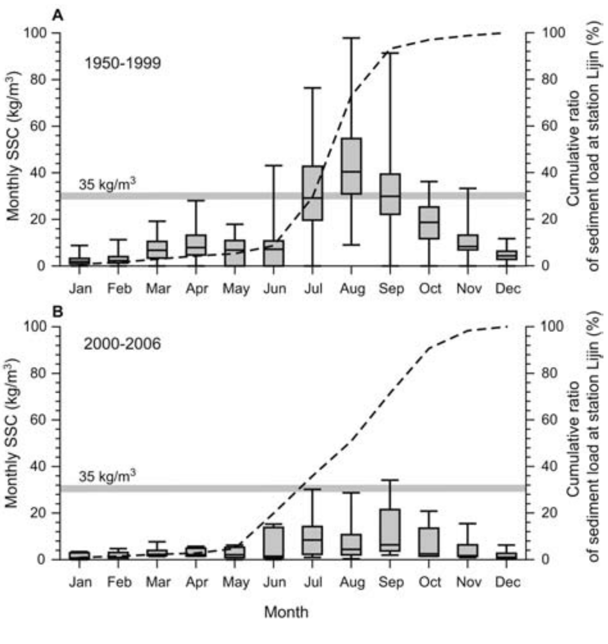

Figure 1 Monthly SSC values (box plots) and cumulative ratios of the monthly sediment load (dashed lines) to the annual sediment load at Lijin Station, Yellow River, during (A) 1950–1999 and (B) 2000–2006.

Onshore and offshore morphologic changes in the abandoned Huanghe (Yellow River) delta in Jiangsu, China

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Erosion occurs in the onshore and offshore seabed in the abandoned Yellow River Delta in Jiangsu Province, so it is better to understand the coastal erosion by integrating the two aspects: (1) repeated profiles of beaches/tidal flats, and (2) seabed sonar images and bathymetry in the offshore zone.

The erosional delta coast can be divided into strong-erosional coast and mild-erosion to stable coast, based on the presence of erosion features and beach profile features. In the strong-erosional coast, erosion features (such as scarps, muddy pebbles, etc.) are widespread without vegetation surviving. Whereas, in the mild-erosional to stable coast, vegetation can grow and no scarps / muddy pebbles occur. Beach profile features are different in the two types of coasts. Reworked coarser, soft sediment (<1m in thickness, very fine sand) covers on clayed silt delta sediment in the strong-erosion coast, while hard fine sand (>1m in thickness) is on the mild-erosional to stable coast. The shape of profiles in strong erosional coast is concave, often with a changing bar in difference seasons; but they tend to be a straight line in stable coast. Wave processes dominate in the strong erosional coast and shape the profiles.

Sidescan sonar images and bathymetric data show the erosion in offshore area (8 – 18 m in depth). There are various erosional structures in subaqueous delta, including pocks, scarps, residual high sites, linear deposits, etc. It suggests that the seabed has been eroded 1 – 4 m during the period from 1980 to 2008 by comparing bathymetric data. Nevertheless, the typical bathymetric line normal to the coastline is concave, and several erosion channels were found. Linear structures in sonar images and erosion channels are parallel to the main tidal currents direction, which indicate that the strong tidal currents (up to 2.7 knots in surface) play an important role in the erosional subaqueous delta.

Although different dynamic factors influence the erosion onshore and offshore, the two processes link together in the whole system. The erosion offshore may cause the serious retreat of the coastline, and /or the contour lines, if dykes have protected the coastline. Our results show that offshore erosion zone extend to the south of the Sheyang River mouth, which is regarded as accretional coast. This indicates that the accretional coast may face erosion due to strong morphologic changes offshore.

Seasonal variations of Hwasun and Hyeojae beach sediments in the southwest coast of Jeju Island, Korea

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The Hwasun and Hyeojae beaches, the major coastal beaches in the southwest of Jeju Island, have been studied through size analysis and using an experimental extension pole and sediment trap in the beach profile, in order to understand their textural characteristics, migration patterns, and seasonal change in beach geometry. The Hwasun beach is composed of coarse sands, 717m in total length. The foreshore slope and width are 7.2°, 79.5m in summer and 8.3°, 73.7m in winter, respectively, which shows the common seasonal cycles of beach profiles. The Hyeojae beach consisting mostly shell fragments (av. 92.7%) is 1,050m long, 6.2°~7.1° steep and 92.5~98.8m wide, respectively. The suspended load drift concentrations in the studied beaches showed 7.6 ㎎/ℓ during the period of summer and 34.4 ㎎/ℓ in winter, and those of fine-grained sediments are derived mostly from the marine of southwest and/or northwestward directions. The typical beach transformation of the Hwasun beach is resulting from construction of jetties in the east side that built up the sand inside the jetties, whereas the erosion is occurring on the west side of beach. The berm sides of sand in the Hyeojae beach drift into the dune side during the period of stormy winter season.

Status of PNG in coastal Delta Erosion, Monitoring and Evaluation

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Delta erosion is a significant coastal erosion hazard that poses a problem for those who live near the coast and for marine organisms living along the coast in bays, estuaries and shallow waters.

Coastal Delta erosion is now becoming a concern due to the threat of sea level rise, the impact of mining tailings being dumped into the river systems, logging and population pressures.

In PNG, the National Development priorities of developing natural resources, tourism and the need for money prevails over coastal delta erosion. Coastal delta erosion is not taken into account as seriously as it should since the consequences are not so immediate and seen to pose danger on the livelihood of the communities or the lack of data on the impacts of delta erosion. The Office of Climate change in PNG is highly polictised office since its inception in 2006 within the Ministry of Environment and Conservation. It has been brought into disrepute by numerous court battles by individuals, retrenchment of officers and at one time the abolishment by the NEC in 2009 which really defeats/undermines its establishment and purpose.

However, my Department of Mineral Policy & Geohazards Management which is the remnant of the former Department of Mining (Decommissioned via NEC Decision 164/2004) has a vision through its strategic and corporate plan to develop mineral policy and legislative framework and the state of the art geohazards Management system. Its mission is to improve the quality of life and safety of our people through effective mineral policy and reduction of geologic risks. This goes to say that we at the Department can develop effective policies to manage the coastal geohazards for the country. In addition, through applied research the Department aims to improve the capability to monitor assess and where possible predict hazards in PNG. There is a need for studies and monitoring to be done on the effects of coastal delta erosion to ensure that coastal erosion is alerted to relevant authorities. Lack of fundamental data on the erosion of coastal deltas handicaps the ability to predict the time course and severity of the consequences of the local environmental change for the deltaic environment in PNG. The physical processes responsible for coastal erosion on deltas/shoreline are complex and difficult to measure and complicated by the influence of many tidal inlets and sedimentation from various human activities. However, understanding the relative contributions of processes causing coastal erosion is important to mitigation of delta erosion and its effects on communities, environment and infrastructures.

Our hope is with improved reliable data, a comprehensive technical analysis carried out on one of the major deltas in the country on the problem of coastal delta erosion will provide the policy managers an effective buffer against the usual arguments put forward by resource developers that regulatory decisions are arbitrary or subjective. In general, the stronger the technical justification for permit decisions the greater is the political acceptability of controversial decision.

To take prominence in this situation, exposure and experiences in geosciences seminars and workshops is a positive step in an endeavor to networking and capacity building needs and to foster exchange of modern knowledge on deltas erosion, measures of protection and mitigation.

We need to employ strategies aimed at strengthening human resources and institutional capacities. One of the best ways to acquire knowledge and skills is through in service training and active participation in Seminars. We may digest and gain valuable techniques and skills employed elsewhere to sustainably develop our delta. This paper highlights our status in PNG and significance in us participating in this seminar.

Coastal erosion and protection in the Chao Phraya delta, Thailand

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The coast at the head of the Chao Phraya delta which is approximately 120 kilometer long, is comprised of 5 provinces: Samut Songkham; Samut Sakhon; Bangkok; Samut Prakan; and Chacheongsao. The coastal zone in these areas contains sediments from the four major rivers and forms a soft muddy shore in the Chao Phraya delta. The results of the study reveal that there are many evidences of coastal erosion along the Chao Phraya delta. Very severe erosion with rates of more than 25 m. per year occurs on the west coast of the Chao Phraya river mouth. High erosion with rate between 10–25 m. per year occurs on the both side of the river mouth. The shoreline at the head of delta has suffered from the attack by wave and tide with the maximum eroded distance of 1 kilometer from 1967 to 2009 on the west coast of the Chao Phraya river mouth.

The pilot study at Khunsamut Chin has provided fruitful results. Monitoring of the sea floor at the pilot site before and after construction of the breakwater shows: 1) considerable erosion of 2–3 cm/month in the intertidal zone before construction; 2) sediment accumulation of 7–10 cm/month landward of the coastal barrier after construction; and 3) continued erosion seaward of barrier. The monitoring data is supported by physical and numerical simulations that show: 1) high wave energy, which potentially cause erosion, decreases landward of the barrier during the period July 2007 to March 2008, which illustrates the effectiveness of the KSC 49A2 for preventing erosion as well as for trapping sediment transported by wave and tidal currents; and 2) that the configuration of the breakwater in relation to the local wave climate may influence its effectiveness. Both observed wave data at the pilot study site and flume experiments showed the effectiveness of the system’s capability for reducing wave energy of 40–80%.

Climate change adaptation and mitigation in the Upper Gulf of Thailand

Siraprapa CHATPRASERT

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This work presents some results obtained from a study on climate change adaptation and mitigation related to geological aspect in the Upper Gulf of Thailand. Since global warming has drawn strong people's attention worldwide. It is likely that the global warming has contributed significantly to the observed sea-level rise, through thermal expansion of seawater and widespread loss of land ice. The sea-level rise would impose serious impacts on the natural system and human society in the coastal zone such as inundation and beach erosion. Moreover, the relative rise of sea level and subsidence of coastal area will cause a land lost to sea and changes in coastal morphology that may occur over time through processes of scouring and sedimentation. However, there are huge uncertainties still remain over the magnitude and rate of sea-level rise in the Gulf of Thailand, which usually based on the regional scale studies through tectonic and geologic processes.

The studies to determine the rates of vertical land movement at tide gauges have been carried out using new geodetic techniques such as Continuous Global Positioning System (CGPS) and microgravity technique with the aim of eventually removing the land movement signals from the sea level records. However, long term data collecting needed for accurate movement trend prediction. In order to estimate the venerability area of flood due to sea-level rise, the detail topographic mapping along coastal zone using LIDAR have been carried out. The land subsidence assessment using Precise Point Positioning surveying technique was conducted in coastal zone. Then, the venerability area of flood due to sea-level rise in coastal zone such as Samut Prakran province and Chacheangsao provinces were assessed based on land subsidence data, sea level rise data, detail topographic map, and land use data. Finally, the training on the climate change protection for youth in order to promote information to gain local people's understanding on climate change adaptation and preparedness.

Coasts in Cambodia

Phalsambon Neak

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Introduction

The coastal area of Cambodia was along coast between Vietnam and Thailand. The coastline of kingdom of Cambodia there are four Provinces (Koh Kong, Sihanoukvill, Kam Pot, Kep Province). Along the coastline and riverbank mangroves are abundant. Apart from the above, there are many places where mangroves grow adjacent to evergreen forest and mudflat area.

The research has found that some part of the seabed in Koh Kong, have coral reef and sea grasses. Aquatic organisms can be found around Koh Chhlam Island in Kiri Sakor and nearby Phnom Koh Rong. The coastal zone consists of land, shoreline and offshore area.The winds in the Cambodia, the south-west from may to September, The northeast monsoon from November to March (Figure 1). The observation of winds in Cambodia is very rare

Figure1. Coastal in Cambodia

River

The coastal area in Cambodia has found the river drain westward from the Cardamon Montains, and have relatively limited catchments. The river that low into the Gulf of Thailand are relatively small with water levels changing according to the volume of rainfall. The rivers in the coastal area are generally short and have their source in hills of about 500 to 600 meters altitude. They flow between hills and fall in cascades before reaching the plain located 15 to 20 kilometers from the sea. In the deltas areas, the rivers divide into many estuaries where the level of turbidity is usually high and where there are several mash area covered by mangrove forest (Figure 2). There are many streams located in the coastal area, which usually dries up in the dry season, the low-lying rivers become saline.

Figure 2. Mangroves forest on the coastline

Coastal erosion

The coastal erosion can be monitored by topographic, geology, hydrographic maps of direct observation. The research on coastal erosion of the small River mouth shows erosion of the coastlines. Koh Pao smaller river mouth in Mondul Seima district Ka´duoch smaller river mouth in Mondulseima district Trapang Roung smaller river mourh in Koh Kong district Ou Chamyeam river mouth in Mondul Sei-ma district Ta Kai Stream in Koh Kong district Bam Bek Stream in Smach Meanchey district Chi Phat river mouth in Thma Bang district Chhay smaller stream in Sre Ambel district Sam Roung stream in kampong Seila district. The Provincial Department of land management, Urbanization and Construction has provided the existing the information. In addition, there are no possibilities for the respon- sible officials to conduct survey in the area. The coastal erosion often takes place in the rainy season, as there is heavy rainfall, causing a rapid flow from the upland and causing landslides of riverbanks.

Figure 3.Accomulation of sand in deltas

Otres river lagoon Inlet. Otres river mouth 5km from Sihanoukvill port, has active and spits on the side, Usually it moves in northwest direction.

Figure 4. Coastal erosion along Sihanukvill

Prek Tuk Chhou River Mouth. Prek Tuk Chhou River Mouth on tributaries of the Prek Kampot river then to the sea.

Prek kep River Mouth. Prek kep River Mouth has eroded on the shoreline by wave to reach the sea, usually it more in southeast direction and it cut by waves, eroded the shoreline.

The southeast Otres Coast. The southeast end along Sihanukvill, have been eroded and partly accreted upcoast on the shoreline . and not show document of accreted the coastal erosion (Figure 4, 5).

Figure 5. Coastal erosion in Ou Tres

Depletion of sediment Influx

Tum Nup Rolok Dam.Tum nup Rolok Dam near Sihanoukvill port was built 1972-1973 to protect the strong waves to transport sediment supply on longshore. The construction of embankment to the coastlines to protect of sediments and cause erosion down-coast and landfiff this area (in Kep City). Some where the construction embankment obstruct eroded down coast in Prek kampot River, shoreline Kep city. (Figure 6)

The plant of electic stoeung Chhay, The plant of electric Stoeung Chhay (Kampot province, Koh Santepheap Newspaper) has built sice 2007-2010, and the plant of Stoeung Ta Tay (Koh Kong Provice, Koh Santhepheap Newspaper) the present is under construction, These plants are the main causes of sediment supply depletion in the coastal line.

Current, the document on infrastructures of coastal erosion in deltas not yet prepared. The government, have been built for safety first as resort, hotel and port, etc. especially on capital town. However, most processes that are responsible have not been investigated at present time. Addition the seriousness of the problem can be seen in the loss of the developed land area to the sea.

Figure 6. Embankment on shoreline, Kep City

Conclusion

Protective measures: The arts and science of beach erosion control and shore protection measures have been greatly advanced by geologists, hydrologists. Several types of onshore and offshore have been built. The consideration and final selection of any particular type of structure and design depends on several factors including coastal geomorphology. These structures dissipate wave energy by diffraction and change the direction of near shore currents, thus providing the barriers for sand deposition. Even though eroding action by continues in front of the breakwater, the effect is much less because of the deeper water condition there. The embayment, which is created between the breakwaters and the coastlines serves as a sedimentation basin where sand, silt and clay can deposit and plant growth can revive.

Coastal Erosion in Old Distributaries Channel of Cipunegara Delta and its Surroundings, North Java, Indonesia

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Geologically, in the northern coast of Java which is extended eastward from Sunda Strait to Surabaya, is a part of the extensive coastal lowland belt mainly built up from unconsolidated clay and sand. This material derived from fluviatile (flood plain and channel deposits) and marine sediments (beach and beach ridge; mangrove swamp; near shore; and shallow marine deposits deposits), which are deposited since 6000 years ago with some beach ridges widening to a deltaic plain.

The problem and interesting phenomena in this area is mainly comes from the geological aspect and human pressure to the environment. The coastal environments under study here are on the land and the marine side. Rapid development along the northern coast of Java is currently need a coastal zone management plans. As the fastest growing of the city coastal area in the northern coast of the island requires land resources. Land requirement will be increasing in the future, and an integrated study of coastal zone and marine geohazard should be done.

Recently a case study in the Cipunegara Delta and its surroundings has been done in relation to coastal erosion and its environments. The Cipunegara has a catchment of about 1,450 square kilometres, with mountainous headwater regions, carrying relics of a natural deciduous rain forest and extensive tea plantations; a hilly central catchments with teak forest, rubber plantations, and cultivated land; and a broad coastal plain bearing irrigated ricefields. The river meanders across this plain, branching near Tegallurung, where the main stream runs northwards and a major distributary, the Pancer, flows to the north-east. Based on an aerial photographs taken in 1946, shows that further advance on the Pancer delta, and continued smoothing of the former delta lobe to the west, its confirmed this sequence with reference to the pattern of beach ridges truncated on the eastern shores of Ciasem Bay and the 1976 Landsat pictures show that a new delta has been built out to the north-east. This delta is formed after the new northeast channel built in 1960 to avoid flooding in the region by the river. Along the coast of Cipunegara delta, the mangrove fringe (mainly Rhizophora) has persisted on advancing sectors but elsewhere has been eroded or displaced by the construction of fishponds. There has been widespread removal of mangroves, in the course of constructing tambak (brackishwater fishponds) in this area starting 1990s, and lack of sedimentation in places these are being eroded such as shown along the coast of Pondok Bali to the Muara Pancer Wetan. The others factor which are influence to this area are subsidence as shown in the seismic reflection profile and sea level fluctuation with ranges between 9-15 mm/year (based on tide analysis and altimetry satellite data/TOPEX/Poseidon and JAS-1). Earth.google 2009's image shows that the newly build northeast delta has advance more to Java Sea and developed 5400 m since 1960 from the Dutch coast 1942, it means at least 108 m/year advance.

In order reconstruct an updated shoreline migration history at annual scale in the Cipunegara delta and its surroundings, we have recently compiled and calculated the available data which shows that it is a dynamic area where the shoreline accretion and abrasion can be found in some places. It is due to the changing of river channels and lacking of sediment distributed to the sea.

Based on the coastline mapping during the survey in Mei 2010, the coastal erosion occurs along the coast of Patimban village to the Tanjungpura village since 1942 to 2010, and the coastline retreat is about

680 m long in Trungtum village and 530 m in Mangsetan river mouth, therefore the average of erosion is 10 m/year in that area. To the west of Cipunegara delta, coastal erosion occurs in Pondok Bali is about 310 meter and in Legoksempring bay-Ujung Pamanukan (old distributaries channel) is about 780 m since 1942 to 2007, therefore the average of erosion is 4,7 m/year in Pondok Bali and 10.2 m/year in Legoksempring.

Coastal characteristic of the study area can be divided into two types such as sandy beach and muddy beach. The sandy beach type can be found in the eastern part of the study area and in Pondok Bali. This is a typically of erosion shoreline with mud deposit of flood plain is found in some places. The muddy beach type can be found along the Cipunegara delta with mangrove growth well and act as an accretion shoreline. The sea bottom sediments distribution in this area is also divided into two types such as muddy sediment which can be found almost in the whole of map and sandy mud is only found in some places. The bathymetric data shows that the sea bottom morphology is relatively low angle close to the river mouth of Cipunegara with some places is nearly flat with the depth ranges between 2.5 m to 20 m.

Keywords: muddy coast; shoreline erosion; shoreline accretion; sea level fluctuation; bathymetry, Cipunegara delta; Pondok Bali

Inundation Potential Assessment based on a Precise Elevation Model and its application to Adaptive Planning for Sustainable Coastal Zone Management

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As global warming continues, meteorologic events become more abrupt and disastrous, which results in large amount of socioeconomic damages. Especially, the inundation caused by storm surge is a major problem in many coastal urban areas of south Korea. Airborne LiDAR survey data were acquired in an urbanized coastal area in order to quantitatively assess inundation potential driven by a severe storm (typhoon). The studied area, the Haeundae beach resort, is located in a metropolitan city of ca. 3.5-million population in the southeastern part of Korean peninsula. Based on the acquired data a one-meter-grid digital elevation model (DEM) was made and spatial extent and pattern of inundation were investigated by applying previously reported storm surge heights. With the assumption of a super (Class 5) storm approx. 600,000 m^2 is revealed to be vulnerable to surge-driven inundation, which could result in significant loss of life and property in the urban area. Considering the base level change of ca. 0.6 m induced by projected sea level rise to 2100 the scale of inundation area could be increased by 28% horizontally. The result implies major sea wall renovation to cope with future impacts of amplified surges, which, at present, protects the urban area against direct seawater invasion.

Coastal Change along the Coast of Northwestern Luzon, Philippines

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The coastal areas are generally considered as the most dynamic and productive sites in terms of living and non-living resources. These areas are also regarded as the most complex habitat system and the most susceptible to both natural and man-induced hazards such as flooding, coastal erosion, siltation, pollution and other coastal geoenvironmental problems. Field study and data gathering were carried out in the coastal and nearshore areas along the coast of Northwestern Luzon, Philippines in order to observe and determine the extent of the coastal changes. Results of the study have been disseminated to the various coastal communities through Information, Education and Communication campaigns.

Groundwater quality of Holocene and Pleistocene aquifers in the delta-plain of Pekan, Pahang, Malaysia

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The Pekan coastal plain in which the Pahang river delta is located is made up of a thick sequence of unconsolidated sedimentary sequence. Deep drilling programmes were carried out in the area show that unconsolidated sequence was deposited during two major periods of sedimentation that took place in two different setting. The lower sequence which has been interpreted to have been deposited during the Pleistocene period consists of entirely continental sediment. The sea-level rise during the early Holocene period has resulted in deposition of a series of marine sediments at the top of the sequence. As part of the groundwater monitoring programme the study has been carried out to identify the cause of increasing in salinity of the fresh water in Pleistocene aquifer. This monitoring has been carried out since 2003 to determine the characteristic and behavior of the Holocene and Pleistocene aquifers in aspect of its chemical changes due to large amounts of pumping activities in the area. There is obvious change in chloride concentration and significant lowering of the groundwater level especially at the eel breeding farm in Tanjung Batu and public water work in Nenasi, Pekan, Pahang. In Tanjung Batu area, chloride concentration has exceeded WHO standard for drinking water. This study indicates that there is a serious problem of saline water intrusion in the area.

Some features of geological structure and the geological disasters in the coastal area of Vietnam

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Coastline of Vietnam has a length of more 3200 km stretching on the form of letter S from the North to the South crosses many structures with the rocks of a different geological ages and physical properties. The geotectonic activity and affect of sea – land interaction process along coastal area are the reasons of the observed geological disasters as the earthquake, volcanic activity, tsunami hazards, landslide, coastal erosion, sedimentation, flooding, sand dune moving and salt-water intrusion.

In the Red River and Mekong River deltas, where developed a big thickness of friable and weak Cenozoic sediments and crossing active tectonic fault systems it is recorded most high seismic hazard and strong coastal erosion as well as sedimentation. Along river systems in dry season salt water intrusion from the sea develops to 30–40km inland, and in rainy season flooding water raises to 5–8m height.

In the coastal areas of central and south central Vietnam, where developed the structures of the central Vietnam Mesozoic folded systems and Indochina geomassif, the relatively high seismic and tsunami hazards are recorded as well as volcanic activity have been observed for last time. In relation to high slope and complicated structure of coastline terrain there developed intensive coastal erosion, sedimentation sand dune moving as well flood and storm surges along coastal area. Especially there frequently recorded landslides in a time of strong rainy and floods. Besides, the landslide hazard increased due to relatively high seismic and volcanic activities, recorded in the same area.

Removal of sediment in a landslide-dominated mountain-belt: Timor-Leste

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Mass movements such as landslides and debris flows are important agents of erosion in steep mountains, and are significant landform processes in Timor-Leste. The dominant triggers are earthquakes and high-intensity precipitation events, thus, the study of the role of landslides in the erosion of young compressional orogens, such as Timor, provides an insight into the dynamic coupling between tectonics, surface erosion processes, and climate.

The contribution of landslides to the sediment flux of this part of the Timor orogen was also investigated. Size distribution of landslides in Timor-Leste was mapped using aerial photograph interpretation (API) of one set of detailed aerial photographs acquired in 2001. The distribution exhibits a very clear power law trend. An estimate denudation rate due to landsliding of X mm yr^{-1} was calculated for the country using this relationship.

A recent landslide in the Quelicai district, occurring in May 2010, appears to have been triggered by preceding days of high precipitation. The landslide flowed in a north-east direction and covered an area of 0.22573 km^2. The majority of movement occurred over two days and destroyed rice paddies, houses and gardens. The landslide appears to have been deep seated extending below the soil and colluvial layers into the competent bedrock below. Exposure of scarps around the slide gave direct viewing of the underlying bedrock structure; a series of weak mudstones overlain by weathered volcanic and volcanic sands. The volcanic bedrock appears to have preferentially separated along previous fault planes.

The internal structure of the landslide shows steep debris flows near the head of the slide followed by large translocational/rotational blocks. These blocks have created a series of midslope benches with backward tilting and internal scarps. Some areas within the landslide have remained relatively intact with some vegetation near to growth position. Large alluvial areas and sag ponds are present due to large amounts of drainage across the site. These drainage systems transport sediment from the new landslide into the local river systems.

Deglacial sea-level rise and evolution of the Mekong Delta

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The coastal zone of South Vietnam was severely impacted by major changes in the Mekong river-mouth systemcial sea-level lowstand onward. First reorganisation by deglacial flooding of the lowstand delta and incised lower Mekong valley provided landward migrating estuarine conditions in the valley depression. Flooding can be traced from the middle shelf 13300 cal yr ago until the maximum transgression reached the region of south-eastern Cambodia around 8500 years ago following meltwater pulse 1C over a distance of 500 km. Second reorganisation started with the onset of the modern Mekong delta 8200 years ago during the final phase of the deglacial sea level rise when sea level stood alongshore a few metres below the modern one. At that time a bay-head delta initiated near Phnom Penh/Cambodia at the landward apex of a big shallow-marine embayment. The delta prograded rapidly after the mid-Holocene sea-level highstand 6000 years ago over a distance of 300 km and reached the modern shoreline 1000 years ago in the eastern and central parts of the delta. Camau Peninsula in the southwest emerged during the last millennium due to monsoon-driven southwestward directed longshore sediment transport. Wave influence increased together with slower delta-progradation during the last 3000 years by heavier exposure to the open sea.

Third reorganisation takes place at present as response to far outgrowing, delta-switching, sea-level rise and intensive human use. River discharge was switching from the eastern distributaries to the Bassac River. Thereby a major sediment plume is escaping at this river mouth and moves alongshore to the SW, enveloping then Camau Peninsula and the western border of the subaerial Mekong Delta. East of Camau Peninsula we observe frequently shoreline erosion. From the interplay of the prevailing south-westward directed sediment transport and shoreward directed wave action a very pronounced delta-front configuration with steep slopes of seaward dipping clinoforms has evolved. Remarkable is the shift of the prodelta depocenter away from the Bassac-River mouth in downdrift direction towards and around Camau-Peninsula as the result of wind-induced alongshore currents and wave action. Intense sand mining activities in the deltaic channels as well as the construction of reservoirs in the upper reaches of the Mekong River could be envisaged as direct man-made contributions to delta-deterioration. The combination of (1) reduced sediment transport, (2) delta subsidence, and (3) sea-level rise may result in substantial coastal erosion with land-loss of more than 30% in the densely populated delta plain during this century.

Unraveling the supply and transport of beach sand by multiple use of grain-size, geochemistry, and strontium isotope: a case study in the south coast of Sendai Bay, northeast Japan

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Beach erosion is recently becoming a serious issue in many coasts of the world. Various anthropogenic factors including decrease of sediment supply from rivers due to dam construction, blocking of littoral sand transport by coastal construction such as jetty and groin, and sea-level rise caused by global warming are supposed to be affecting multiply. Understanding of the broad-based circumstance of supply and transport of coastal sediment is essential in appropriate countermeasure development. South coast of Sendai bay, which is also subject to the recent beach erosion, is an typical temperate open-ocean beach coast facing to the Pacific Ocean, stretching 40 km north-south. Pattern of sand supply and transport in this coast was revealed by the multiple consideration of grain size, geochemistry and strontium isotopic ratio.

Strontium isotope ratio, $^{87}Sr/^{86}Sr$, and chemical composition of medium-sand sized light mineral (MSLM) fraction of beach sand and river sediment were used to trace the sand transport in the coast. Strontium isotope ratio is widely used as the tracer of natural materials such as groundwater and eolian dust because $^{87}Sr/^{86}Sr$, the ratio of radiogenic ^{87}Sr, which arises from beta disintegration of ^{87}Rb having a half-life of 466 billion years, to stable ^{86}Sr, of sediment and water significantly varies with geology of the provenance or drainage basin. Although the Sr isotope ratio of sand also depends on the geology of the provenance, even though they share origin, the ratios of sand particles of different mineral species typically differ each other because of the difference of initial content of rubidium. The aim of restricting the analytical object to light minerals (quartz and feldspars) is to suppress such mineralogical variation. In addition, light minerals are important because of their higher mobility and thus susceptibility to coastal processes than heavier minerals. On the other hand, medium sand is the dominant grain size of beach sand in the south coast of Sendai Bay.

Three major rivers, the Abukuma, the Natori, and the Nanakita river, enters the Pacific Ocean at the southern coast of Sendai Bay. This coast is divided into three part for descriptive purpose, 1) Watari-Yamamoto coast, southern 15 km interval of the Abukuma river mouth, 2) Iwanuma coast, 15 km interval between mouths of the Abukuma and Natori river, and 3) Sendai coast, northern 10 km interval from the Natori river mouth to the Nanakita River mouth of the northern margin. The Abukuma River of 5400 km^2 of drainage area is a order of magnitude larger than the others.

Results of geochemical and isotopic analysis indicate that the contribution of the Natori and Nanakita River as the sand source to the coast is rather minor than the Abukuma River. Concentration of several elements and $^{87}Sr/^{86}Sr$ in the MSLM fraction discontinuously change across the Abukuma River mouth. Na, K, Pb, and Ba of MSLM are rather higher and closer to those of the Abukuma River sand in Iwanuma and Sendai coast than in Watari-Yamamoto coast. Those of the Natori and Nanakita river sediment are rather low and close to the value of Watari-Yamamoto coast except Na. $^{87}Sr/^{86}Sr$ of MSLM increases northward from 0.7053–0.7055 in Watari-Yamamoto through 0.7057–0.7059 in Iwanuma to 0.7058–0.7062 in Sendai. The value of the Abukuma River sediment is 0.7060 and close to those in Sendai coast, while those of the Natori and Nanakita river, which are spatially closer to Sendai coast, are rather low ranging from 0.7045 to 0.7050 (Figure 1). Such discrepancy in chemical and isotopic values between the Natori and Nanakita River and the neighboring coast suggest rather minor contribution of these rivers to beach sand supply.

Dominant direction of littoral sand transport is suggested north by the spatial distribution of grain-size composition of beach sand. Although little spatial trend is observed in median grain size, which ranges from

1.1 to 1.4 f, standard deviation, which decreases northward from the Abukuma River mouth, suggest the dominance of northward flow near the coast (McLaren and Bowles, 1985). Selective accretion of sand to the southern side of jetties commonly observed in this area also supports the northward direction of the net sediment transport. About 20-m width of beach had been lost from 1964 to 1999 in the southern 5-km interval of Iwanuma coast (Ministry of Land, Infrastructure, Transport and Tourism, 2009). Blocking sand movement by the jetties immediate south of the Abukuma River mouth, which had largely extended offshore in around 1970, may be responsible for the loss. Discontinuous change of geochemical and isotopic composition across the Abukuma River mouth may reflect the influence of the obstruction.

The Abukuma River and the coastal cliffs of the southern margin consisting of the Neogene sedimentary rocks emerge as possible major sources of beach sand in the south coast of the Sendai Bay considering the minor contribution of the Natori and Nanakita rivers and the northward dominance of sand transport. Northward increase of the Abukuma River sediment from 20 to 45 % in Watari-Yamamoto coast is shown by comparing K and $^{87}Sr/^{86}Sr$ of sand in each sampling point with the mixing line derived assigning the Abukuma river sand and sand in pocket beach confined between cliffs of southern end of Watari-Yamamoto coast as the two endmembers. In the north of the Abukuma River mouth, the contribution of the Abukuma River to the beach sand is suggested to exceed 50 %, reaching to 90 % in Sendai coast, although the actual K-$^{87}Sr/^{86}Sr$ of samples fits less well with the mixing line.

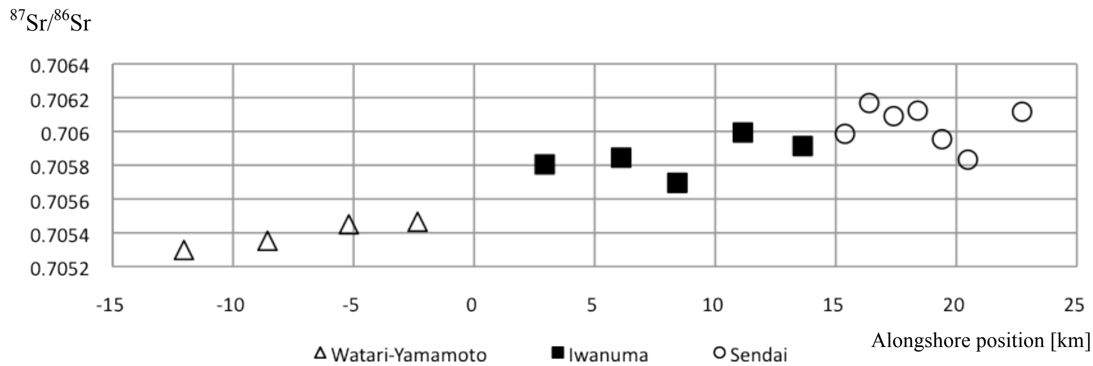

Figure 1. Spatial variation of $^{87}Sr/^{86}Sr$ in the south coast of Sendai Bay. Horizontal axis is the northward-positive alongshore position with the zero at the mouth of the Abukuma River.

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The sedimentary environment of Xiyang tidal channel since the Late Pleistocene, South Yellow Sea coast, East China

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A large radial tidal sand ridge system (RTSRS) has developed under a complex tidal current field along the eastern coast of China between the Yangtze River delta to the south and the abandoned Yellow River delta to the north. A large tidal channel named Xiyang lies on the north of RTSRS. It has a north-open trumpet shape, with width of 12–25 km and length of 80km. The maximum water depth reaches to 20 m.

A core, 36.1m long was drilled (33°15.84′ N，120°53.761′ E) in Xiyang tidal channel, aimed to revel the history of sedimentary environment. Seven sedimentary facies have been distinguished on the basis of lithology, sedimentary structures, grain size, and fossils contained: 1) *tidal channel lag deposit.* The top 10cm of the core comprise this facies. It consists of silt, intercalated with thin clay layer and shows flaser bedding; 2) *inter-subtidal*. The core between 0.1m and 15.6m comprises this facies. Rhythmic couplets between silt/fine sand and clay/silty clay dominated the facies. Wavy beddings and lenticular beddings as well as small ripple beddings are common; 3) *shell Bed.* This facies occurs between 15.8–16.1m down core depth. It consists of yellowish brown shell fragments, with small amount of clay. The sediments show massive structure. The molluscan fossils show a mixed brackish and fresh water environment. 4) *lagoon*. This facies occurs between15.6–20.5m down core depth. It consists of olive grey and dark grey clay, intercalated with shell fragments and peat. No bedding has been found in this facies; 5) *flooding plain*. This facies, composed of silty clay intercalated with clay silt occurs between 20.5 and 21.8m down core depth. Horizontal laminations and small ripple beddings are common in this interval. Caliche nodules indicate probable exposure during deposition; 6) *littoral swamp basin.* This facies was found between 21.8–26.8m in core Xiyang, which is composed of varicolored hard clay and clay silt. Horizontal laminae and small ripple beddings have been observed; 7) *coastal barrier or coastal bar*. This facies occurs between 26.8–36.1m. The deposits are mainly composed of massive brown fine sand and sandy silt. Subtle horizontal and cross beddings have been found in the middle of this interval. The average grain size is 3.86Φ.

During the late Pleistocene period (after ca. 40 ka), the study area experienced coastal barrier to flooding plain and finally exposure under the background of sea-level decline. At the beginning of Holocene, with the Holocene transgression, a littoral lagoon dominated the area. The increased tidal currents reworked the underlying sediments during middle Holocene period and as a result, tidal ridge-channel system developed. During the late Holocene, the tidal ridges were cut and eroded partly. Xiyang tidal channel formed under this period. When the Yellow River delivered to South Yellow Sea coast during 1128 and 1855 AD, the channel was filled. After it switched to Bohai Bay, the sediments were cut and the channel encountered tidal erosion. As a result, the channel bottom became expansion and relief.

Key words: tidal channel, sedimentary facies, Xiyang

Subaqueous deltaic formation of the Old Yellow River (AD 1128–1855) on the western South Yellow Sea

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A comprehensive geological survey was made in the western South Yellow Sea, including measurement of 4100 km of high-resolution seismic profiles, surficial sampling at 626 sites, core drilling, and collection of piston cores, to document the sedimentary characteristics of the study area. Seismic profiles revealed a compound-clinoform geometry that consists of a subaerial/subaqueous delta couplet. Both the nearshore subaerial and the offshore subaqueous deltas are up to 15 m thick, and they are separated by a concave terrain ranging from 7 to 35 km in length. The nearshore delta extends about 30 km away from the present shoreline, whereas the offshore subaqueous delta reaches a maximum distance of more than 150 km from the shoreline. The delta couplet is dominated by silt and characterized by high concentrations of CaO and smectite, suggesting that the delta sediments are predominantly derived from the Yellow River. The distal part of the offshore delta was dated as less than 500 years old, consistent with a logical explanation that the delta couplet was formed by the Old Yellow River discharging into the western South Yellow Sea from AD 1128 to 1855. The ^{210}Pb measurements of piston cores indicate that the foreset beds of the offshore delta have high accumulation rates compared to the topset beds and those in the surrounding shallow-sea areas. The energetic tidal current field in the western South Yellow Sea is interpreted to be responsible for the subaqueous deltaic formation.

Sedimentary Processes of the latest Pleistocene to Holocene incised-valley fills under Tokyo area, central Japan

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Sedimentary processes of narrow incised-valley fills under the lowlands spreading in Tokyo area, one of the most populated areas in Japan, has been studied in recent decades. These valleys were incised at the Last Glacial Maximum, and filled with marine/nonmarine sediments during the following sea-level rise from the latest Pleistocene to Holocene.

The lowlands around Tokyo city are divided into the Arakawa, Nakagawa and Tokyo lowlands. Our target is the Arakawa Lowland, which is 5 km wide, 60 km long and had received a great amount of sediment supply due to a large drainage area until 6 or 4 ka. We took four sediment cores in the lowland, three are along the axis and one is in the tributary valley. Sedimentary environments are reconstructed based on sedimentary facies, fossil assemblages and chemical element analysis (CNS), and depositional ages are determined by radiocarbon dating.

Paleoenvironmental transition and sequence stratigraphic units are interpreted based on the result of core analysis, 14C dating and geological sections deduced from 3-dimensional model of the valley fills.

Along the valley axis, on the basal sequence boundary incised at the Last Glacial Maximum, first gravelly- and later sandy-fluvial deposits had onlapped upstream from 12 to 9 ka. The fluvial deposits were slightly truncated as a transgression progressed around 9–8.4 ka and resulted in a ravinement surface diagonal to the time line, followed by muddy deposits of an inner bay. Though the sea level was still rising at 8 ka, a delta began prograding downstream in this area. At the Holocene highstand, salt-marsh mud covered the deltaplain in the valley axis. The valley was almost filled and became land area around 5 ka.

On the other hand, in the tributary valley, an inner bay and a salt marsh environments continued until the valley was almost filled, instead of delta progradation due to a small sediment supply. Therefore poorly-sorted muddy sediments predominates. The Nakagawa Lowland, located east to the Arakawa Lowland, the sedimentation rate was much lower, possibly due to the smaller drainage area.

Sequences Stratigraphic model of the late Pleistocene-Holocene incised valley fill sediments, in the Echigo Plain, central Japan

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The Echigo Plain faced on the Japan Sea coast is a sedimentary basin governed by subsidence of the Echigo Plain Western Margin Fault Zone. The incised valley under the Echigo Plain is filled with the sediment of the Shinano and Agano Rivers as the sea level rose during the last deglacial. The thickness of the sediment is up to 160 m. The plain is still interseismically subsiding at a rate of about 3mm/yr.

We reconstructed sequence stratigraphic model based on more than 10,000 borehole logs. The stratigraphy of the Echigo plain is composed of the lower alluvial unit, the middle brackish-marine unit, and the upper alluvial unit. The lower alluvial unit is the Late Pleistocene to Holocene alluvial sediments. The middle brackish-marine unit changes from inner bay or offshore to transgressive barrier-lagoon sediments. The upper alluvial sediment is composed of the modern floodplain, channel, lagoon, and marsh sediments.

The base of the lower alluvial unit indicates the NNE-directed incised valley of the Old Shinano River during the Last Glacial Maximum. We recognized two marine flooding surfaces in the middle brackish-marine unit; The first flooding surface is at around 9 cal kyr BP, when the sea level rose rapidly. The sedimentary environment changed from tidal marsh to inner bay or offshore. This change is recognized as the ravienment surface in some borehole data. The second marine flooding surface appeared at 8－7 cal kyr BP with the maximum expansion of the brackish water into the lagoon area. This age corresponds to the maximum flooding surface of the Echigo Plain in the previous studies (e.g. Omura et al., 2006).

Two marine flooding surfaces decline to the Old Shinano River thalweg, showing the subsidence effect that is controlled by the Echigo Plain Western Margin Fault Zone.

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Rare earth element geochemistry and Sr-Nd isotope composition of shelf sediments in the northern East China Sea

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The sediment geochemistry, including REE and Sr-Nd isotope composition of the shelf sediments around the Jeju Island have been carried out in order to understand the provenance and hydrolic sorting. The total Al_2O_3, Fe_2O_3, K_2O, MgO, and MnO contents and REE concentration of the fine sediments are higher than those of the coarse sediments. The higher Zr/Th and Zr/Yb ratios in coarse sediments relative to fine-grained detritus indicates sedimentary sorting. Grain size influence the REE concentrations of the study area sediment significantly. The＜63 ㎛ fraction of the sediment has higher REE concentration and different REE patterns when compared with those in bulk samples, due to the presence of REE-enrich heavy minerals. The UCC-normalized REE distribution patterns of the northern East China Sea sediments are much similar to the Huanghe sediment, though LREEs are slightly enriched due to contribution of heavy minerals. The Eu/Eu* ratios ranged from 0.594~0.665(0.631) is similar to the Yangtze River sediment.

The $^{87}Sr/^{86}Sr$ and εNd values from the Shandong peninsula mud wedge sediment samples which are supposed to be derived from the Huanghe River ranged from 0.722 to 0.725 and –13.1 to –13.5, respectively, whereas the Yangtze River's submerged delta sediment samples have difference isotopic composition with lower Sr ratios($^{87}Sr/^{86}Sr$=0.712 to 0.717) and high εNd values(εNd=-10.1 to –11.2). It may suggesting the distribution pattern of $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ values as a new tracer to discriminate the provenance of shelf sediments in the study area. The most of ε Nd values and $^{87}Sr/^{86}Sr$ ratios of sediment samples in the southwestern part of Jeju Island are similar values(($^{87}Sr/^{86}Sr$=0.715 to 0.722; εNd=-9.9 to –11.4) to those of the Yangtze River's submerged delta sediment averages, suggesting that fine-grained Yangtze sediments can reach nearshore area of Jeju Island.

Preliminary assessment on intrinsic compression of the Red River delta soft clay

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Geotechnical characterization of the Red River delta clay deposits is important as they are most widespread distributed in the urban and industrial areas that have lot of infrastructure development projects going on. In this paper we present the results of a study on intrinsic compression of the Red River clay, which can be helpful to geotechnical engineers and other geoscientists in understanding the natural compression of these clay deposits.

Holocene sea-level changes reconstructed from paleo shoreline indicators from Philippines coast

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Philippines consisted with more than 7,000 islands. They have uplifted indicators of past shorelines including uplifted corals and tidal notches. They are mainly formed at the sea level. Reconstructing past sea level is based mainly on the heights of retreat point of a notches and ages provided from corals attached to the notch floor. However determining exact timing of formation of notches is always difficult since there are lags between formations of notches and corals.

We have, therefore, been applying the methods only using a few Oysters species living at the intertidal environment and the oysters that we employs are *Saccostres circumsuta* (Gould, 1850), *S. malabonensis* (Fastino, 1850), *S. echinata* (Quay & Gaimard, 1835), *S. mordax* (Gould, 1850), *Crassostrea bilineata* (Rording, 1798). They are typically found at sites such as marine caves and the coast sheltered by the island where wave actions cannot reached, and at brackish water area.

We have reconstructed Holocene paleo sea-level at Tinabanan, Buyayawon, Siargao, Palawan, Paraoir, Currimao in Philippines and found that there were 3 periods when sea-level were higher than the present during the Holocene, respectively 7.5–6 ka (0–1 m), 6–4 k (2–3 m) and 3–1 ka (ca 1 m).

The influence of tropical rainfall on sediment redeposition in mangrove environments: examples from Can Gio, SE-Vietnam

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Mangroves have their widest extent along tropical muddy coasts in lowland deltas where sediment supply allows progression of the coastline. In the presence of mangroves usually less erosion occurs whilst expansion takes place at particular coastal types with mangrove existence, i.e. at river mouths and in sheltered areas. These environments can keep pace with a sea level rise of up to 4.5 mm/year (GILMAN, 2004) and are growing due to an increase in tidal flooding (ANTHONY, 2004) and sediment supply. Additionally they undergo a rapid and accelerated alteration due to the response to climate change, resulting in eustatic sea level rise and changes of global temperature, storm frequency and intensity, prevailing ocean wave heights and direction, changes in the tidal regime and changes in precipitation patterns. Since a long time it was suggested that mangroves claim land from the sea but recently it is widely accepted that mangroves follow sedimentation (WOODROFFE, 1992), although their intricate root system undoubtedly assist accretion and hamper erosion (FURUKAWA et al., 1997). Re-deposition of sediment in mangrove environments is often attributed to currents induced by tides. Rainfall as a driver for sediment re-deposition was not investigated yet. However, in combination with annual water level variation it can play an important role for sediment re-deposition and im- and export of matter.

In Can Gio along the Dong Nai River (Fig. 1) a reforested estuarine mangrove monoculture exists with a belt of natural mangroves (*Avicennia*) fronting the coastline. This belt developed at the interface to the mudflats after the reforestation with *Rhizophora apiculata*. Due to long-term human impact the density of mangrove vegetation has considerably changed along the whole southern Vietnamese coastline since the late 19th century, especially in the area of the Dong Nai River estuary, the Mekong delta and the adjacent peninsula towards Ca Mau (MAZDA et al. 2002).

Changes in the density of the mangrove root system cause changes in the tidal prism, as tidal flow, inundating the forest, encounters drag force from the vegetation (MAZDA et al. 2005). Decrease in tree-density increases the tidal prism. However, currents induced by rainwater runoff during low tide conditions can be much higher in the intertidal domain than current velocities induced by tides. In the area rainfall shows a strong annual variability with high precipitation from Mai to October and very limited rainfall in the dry season from December to April (Fig. 2).

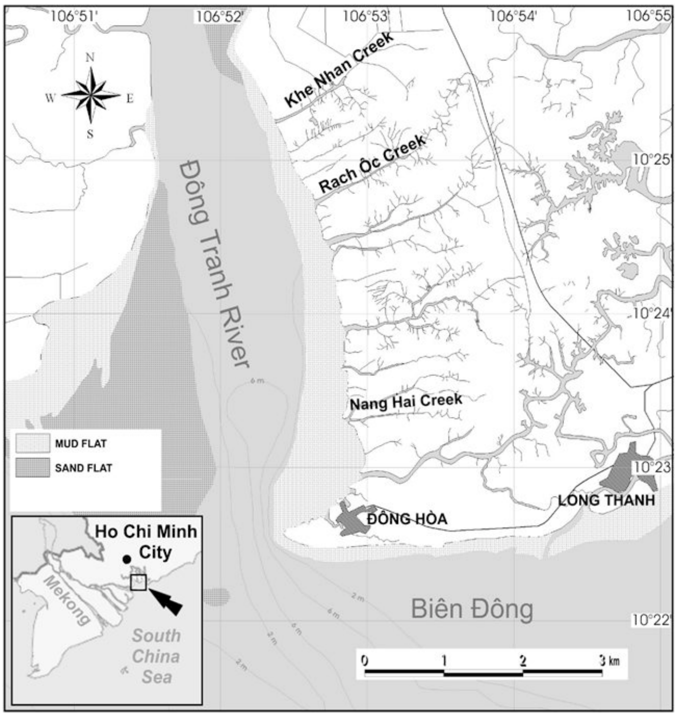

Figure 1. Can Gio Mangrove Reserve in Vietnam – the area for detailed studies of sediment re-deposition in a mangrove-dominated environments.

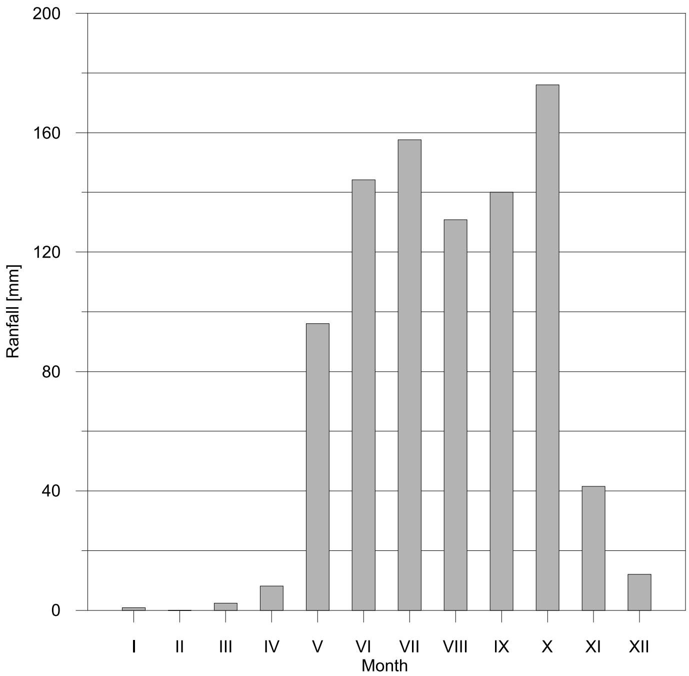

Figure 2. Average total monthly rainfall in Can Gio from 1980 – 2008 (Data Source: SRHMC-Center).

As part of the research project SEDYMAN[1] field measurements have been carried out in Can Gio Mangrove Reserve to study processes which control sediment re-deposition in mangrove environments. Here depending on the monsoon there is a strong annual variability in water level heights and tidal range (Fig. 3).

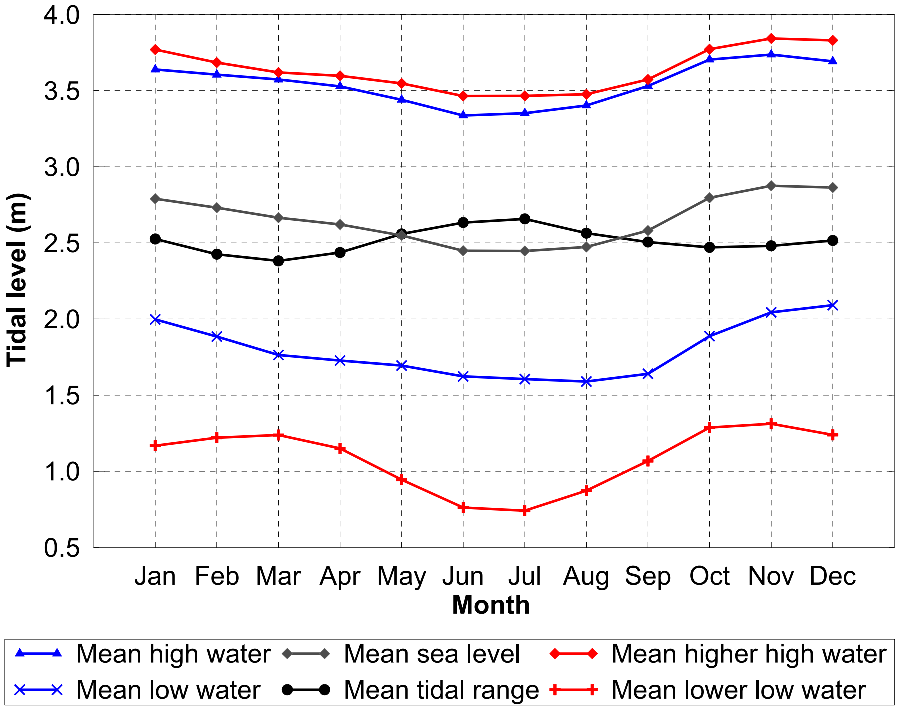

Figure 3. Average of annual water level and tidal variations for the 19-year period from 1990 to 2008.

While in June during the rainy season the maximum water level reaches only 3.34 m, the highest water level in November, when the dry season starts is, 3.73 m – a difference of 39 cm. Additionally the tidal range reaches its maximum during the rainy season when we can observe the lowest annual average sea level. Therefore, the highest part of the mangrove forest will not be inundated by tides during the rainy season. Sediment re-deposition in those high areas is only possible due to precipitation.

Rainfall is independent from tidal situation. If rainfall happens during low tide, strong currents will appear all over the mangrove environment as the rain-water has to flow towards the creeks. This will induce strong currents in the mangrove forest and partly the creation of small gullies. Depending on the amount of rainfall these currents induce sediment mobility and the amount of suspension load can be much higher than that induced by tidal flow. Consequently the influence on sediment re-deposition and im- and export will be stronger. A conceptual model will be presented to outline how sediment re-deposition will be influenced by tides and/or by strong rainfall events.

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Seasonal variability of sea levels and waves in the Red and Mekong river deltas

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Introduction

Sea levels and waves are fundamental information to be considered when assessing the potential occurrence of geohazards along deltaic coasts. This study focuses on the seasonal variability of sea levels and waves in two major deltas in Vietnam, the Red and Mekong river deltas, by employing monthly-mean tide-gauge data and results from numerical simulations.

Methods

To analyze sea levels around the Red and Mekong river deltas, monthly-mean tide-gauge data distributed by the Permanent Service for Mean Sea Level (PSMSL) (Woodworth and Player, 2003) and daily sea-level of the Western North Pacific Ocean derived from JCOPE2 reanalysis dataset (Miyazawa et al., 2009) were used. The duration of the analysis ranges from 1992 to 2001, when the number of missing data in the tide-gauge records was small. Significant wave heights in the South China Sea were calculated numerically by a wave model called WAVEWATCH III version 3.14 (Tolman, 2009). To run the wave model, wind data equipped with high spatial resolution (1/4 degrees; NOAA/NCEP CFS4 reanalysis dataset) was introduced to resolve wind fields within the enclosed sea adjacent to the Red River Delta.

Results and discussions

Time series of monthly-mean sea level observed at the mouth of the Red and Mekong rivers are shown in Fig. 1. Sea levels in both deltas show high value during autumn and winter, a typical feature in the western South China Sea caused by changes in wind-stress curl (Shaw et al., 1999). Such seasonal change induced by synoptic winds is also observed along Indian coasts (Shankar, 2000), whereas high sea levels appear during summer in the East China Sea are considered to have caused mainly by thermal expansion (Wakata, 2009; Tseng et al., 2010). The duration of high sea-level period was found to be longer at the Mekong River Delta than at the Red River Delta (Fig. 1). As the assimilation model results (Miyazawa, 2009) showed higher sea levels along southern Vietnamese coasts than offshore during periods from October to February, when the sea-level at the Mekong River mouth was high, the longer duration of the high sea-level stage in the Mekong River Delta may have induced partly by a seasonal geostrophic current.

Figure 2 shows the relative frequency of high waves (wave height exceeding 1 m) at each month in 1993 at areas off the Red and Mekong river deltas. In each deltaic region, three monitoring sites were selected along 20 m depth contours. It was found that the seasonal pattern of wave heights differs among the two deltaic regions. Off the Red River Delta in the north, high wave occurs mainly during spring and early summer (March to July), whereas high waves were much more frequent during winter and early spring (November to March) than other seasons off the Mekong River Delta. Such difference in the seasonal wave-occurrence pattern may be ascribed to seasonal changes in the wind system, especially to seasonal transitions between SW monsoon (May to October) and NE monsoon (October to May) (Fig. 3). For example, waves during the NE monsoon period is generally high during the NE monsoon period in the Mekong River Delta region, owing to the northeasterly wind blowing persistently across the South China Sea, developing waves over a long fetch (Figs. 2b and 3b). As for the region off the Red River Delta, wind condition during the last phase of the NE monsoon (March to May) and the initial phase of the SW monsoon (May to July) might be in favor for the generation of high waves. The frequency curve shown in Fig. 2 also indicates a slight difference in wave climate among each deltaic region. For example, high waves were more frequent in the western portion of the Mekong River Delta (Fig. 2b) during the SW monsoon, whereas high waves were generally more apparent in the eastern part during the NE monsoon. Such difference in the wave climate may induce differential erosion/accretion features along the Mekong River Delta.

Summary and Conclusion

The current study indicated that the seasonal variability in sea levels and wave heights were induced primarily by changes in synoptic winds, and that the response to such wind system differ greatly among the two deltaic region located in the northern and southern part of Vietnamese coasts. Differences in wave climates were found to exist also within each deltaic area. These results suggest the necessity to obtain more information on alongshoreward variability of the coastal wave condition to obtain further understanding of coastal processes in two deltaic areas.

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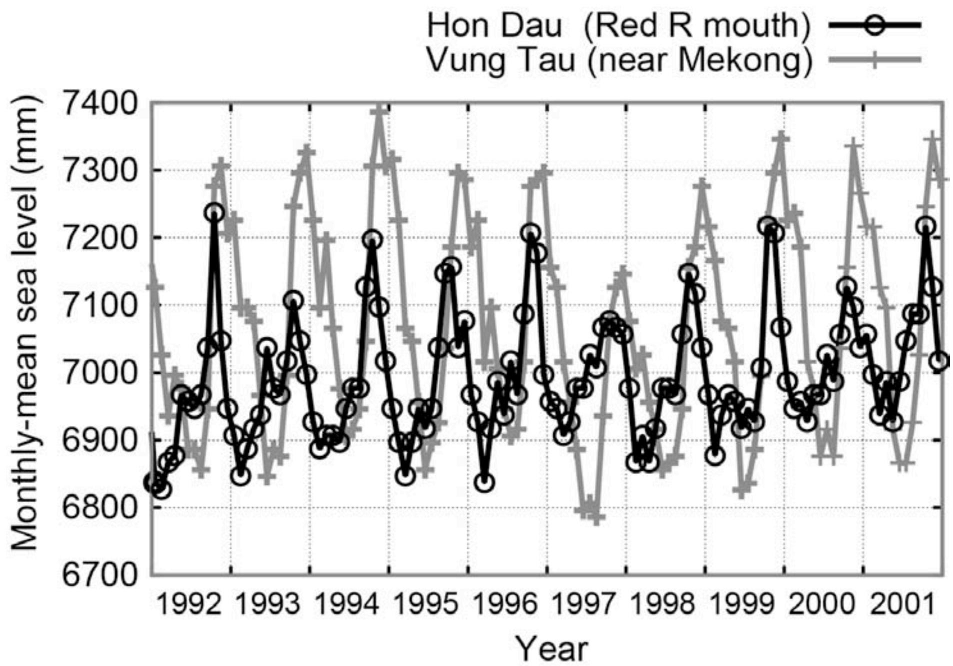

Figure 1. Time series of monthly-mean relative sea level from 1992 to 2001 at two tide-gauge stations; Hon Dau Station situated at the mouth of the Red River, and Vung Tau Station to the north of the Mekong River Delta. It is to be noted that the zero level of each curve is not identical. Data source: PSMSL (Permanent Service for Mean Sea Level, U.K.) website, http://www.psmsl.org.

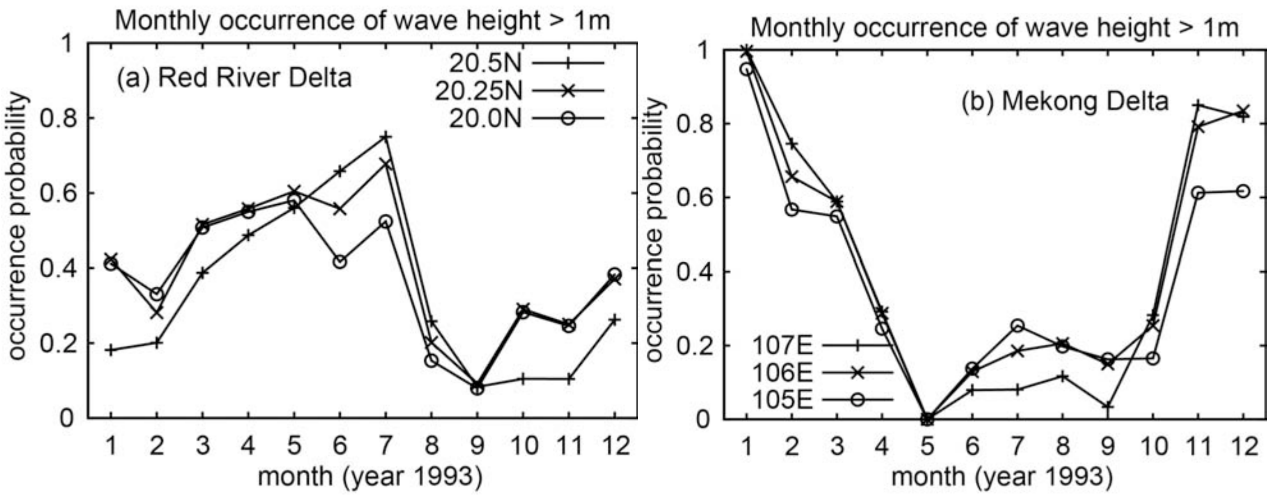

Figure 2. Monthly occurrence of predicted high waves (significant wave height higher than 1 m) at three locations off (a) the Red River Delta and (b) the Mekong River Delta in year 1993, shown in terms of occurrence probability ranging from 0 (no occurrence) to 1 (high waves all the time). The water depth of each site is chosen to be around 20 m.

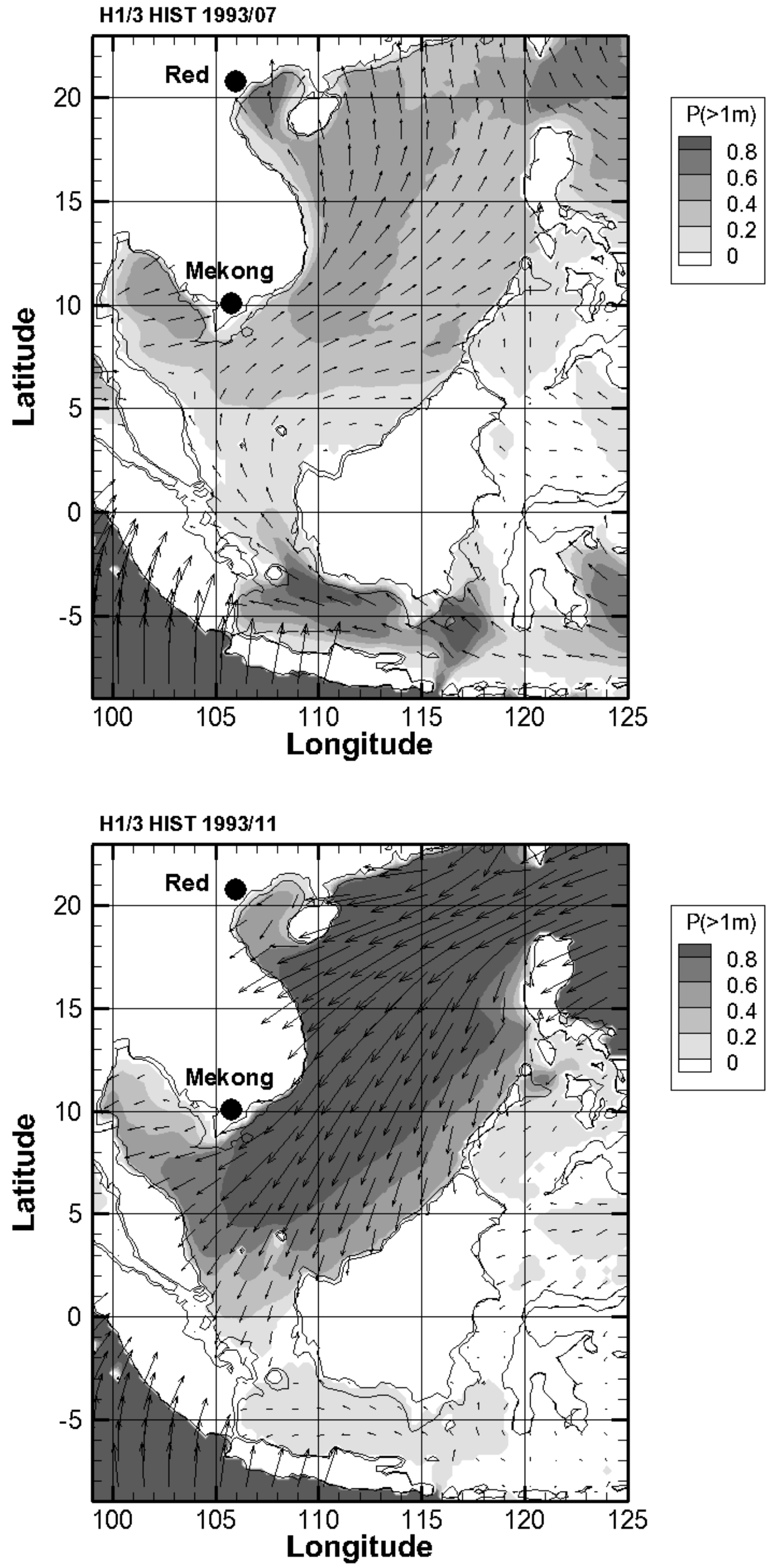

Figure 3. Monthly occurrence of predicted high waves (significant wave height higher than 1 m) in the South China Sea at (upper) July (SW monsoon) and (lower) November (NE monsoon) 1993. Offshore contours denote isobath of 20 m depth and arrows indicate the monthly-mean wave direction.

Coastal landform changes at the active delta plain in the Mekong River Delta, Vietnam

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We studied coastal landform variations of the Mekong River Delta (MRD) at the active delta over the last 3 ka, particularly, changes that have occurred in the past 50 years. Morpho-sedimentary maps and detailed investigations of deltaic facies in boring cores were used to identify depositional facies and delta evolution patterns. The active delta plain has been a tide- and wave-dominated delta for the past 3 ka. The coastline is more than 300 km long and has been subjected to northeast monsoon activity in the East sea (South China Sea) (Ta et al., 2005). The delta is characterized by a well-developed beach-ridge system on the subaerial delta plain, longshore sediment dispersal, and steep delta-front topography in the proximal delta. Fine sediments such as silt and clay have been transported southwestward and deposited in the distal delta of the Ca Mau deltaic margin (Ta et al., 2005). Topographic maps, satellite images, and field measurements show that the coastline has changed considerably by both erosion and deposition at the active delta plain in the past 50 years. Deposition has occurred around active river mouths at a rate of 15–20 m/y. Severe coastal erosion has occurred at the south side coast of distributaries at a rate of 10–15 m/y in some areas and as high as 30–40 m/y in Ben Tre and Tra Vinh provinces (Nguyen et al., 2009). This phenomenon is probably driven by decreasing sediment supply from upstream, the rapid growth of sand mining in the Mekong River channels, the cutting of mangrove forests, and climate changes.

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Coastline changes in the last 100 years at the Ca Mau deltaic margin, Mekong River Delta, Vietnam

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The Ca Mau deltaic margin located in the southwest part of the Mekong River Delta is well known as a rapid deposition coast (Nguyen et al., 2000). Tide-dominated delta progradation has been occurred since the last 3–4 ky. It is characterized by well-developed mangrove marsh on the subaerial delta plain. There are no any sandy beach ridges to be found in the subaerial delta plain. The subaqueous delta shows pro-delta and shelf mud facies. Sediment supply is almost fine materials such as silt and clay, which are mainly transported south-westward from the Mekong River mouth due to northeast monsoon activities and deposited in the distal delta of Ca Mau deltaic margin (Ta et al., 2005). Since the last 100 years at least, sediment supply to the western coast of the Ca Mau has been supplemented from eroded materials at the eastern coast.

On the basis of topographic maps, satellite images and field measurements, coastline changes are analyzed during the last 100 years. The eastern coast has suffered strong erosion with 280 km^2 in area meanwhile western coast has been deposition with approximately of 250 km^2 in area. Especially, at Ganh Hao area of the eastern coast, erosion is more severe with averages of 30–50 m/y. In the western coast, the Ca Mau cape is well known as a rapid deposition coastline. Its rate is approximately of 50–80 m/y, some places are up to 100 m/y. This phenomenon is evidently driven by deposition of material discharged by the Mekong river system as well as by material derived from coastal erosion in eastern areas (Nguyen et al., 2010). Moreover, there is a great subtidal mud flat well developed around the Ca Mau cape, about 18 km long with 530 km^2 in area.

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Coastal Erosion in Cat Hai Island and Solution for Coastal Protection

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Settled by over ten thousand inhabitants, Cat Hai (Hai Phong City) is a sandy island in Bach Dang estuary locating in the northeast part of the Red River Delta. The coastal area is shallow and gentle in bottom topography. The total current is mainly tidal one with longer time and greater velocity (max. 90cm/s) in spring tidal phase. The wave height is not big, maximum 2m during typhoons. The local sea level rise has determined as 2 – 4mm/year.

The island coast has been being eroded from longtime with the average rate from 4.5 – 12.9m/year, maximum 50m/year. The strongest erosion happened in the period of 1990 – 2000, decreased significantly from 2000 – 2005, and ceased from 2005 – 2009 when coastal protection were better and very few typhoons attacked (Table 1).

Table 1. Process of coastal erosion in Cat Hai Island

period	1930 - 1965	1965 - 1990	1990 - 2000	2000 -2005	2005- 2009
Total length (m)	6000	6200	6400	3650	0
Eroded area (ha/y)	2.70	3.09	8.27	2.44	0
Average rate of erosion (m/y)	4.5	5.0	12.9	6.7	0

Intrinsic causes of erosion are relative to the evolution of the sandy island which was formed about 2 – 1 thousand years ago in the deltaic accreted condition with regression and relatively lowered sea level. During the period of 5 – 7 hundred last years, that the sea level rising and lack of sediments and stronger tide has caused the longtime coastal erosion.

The direct causes are the total sediment amount of 342,000ton/year is transported out of area by coastal circulation that makes the coast eroded about 118,000ton sediments/year and coastal bottom abraded about 224,000 ton sediments/year (Huy et al. 2002). During the year, the eroded period falls into the southwest monsoon accompanied by typhoons. The current in spring tidal time is the mainly dynamic factors transporting the sediments out of the eroded area. The wave damages directly coast and releases the sediments from the coastal bottom.

Predicting that the coastal erosion should be increased in scale and intensity if the coast is not protected effectively; and the natural eroded rate will be 14.9m/year until 2020, 16.7m/year until 2050, and 19,0m/year until 2100.

For coastal protection in Cat Hai Island, the solution of soft construction was proposed by Institute of Marine Environment and Resources from 1991 (Thanh et al.1997). A system of 28 groins perpendicular to the coast were designed for the beach nourishment. Their building process is starting from two ends, and then closed in the middle part of the eroded coast. Seven groins have been constructed experimentally, and the effective results have been recorded. The development of nourished beaches has contributed to prevent the coastal erosion.

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Study on effect of upland reservoirs to morphological change of coastal Red river delta by using remote sensing data

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This study focuses on the use of remotely sensed data for assessing effect of upland reservoirs to morphological change of Coastal Red River Delta. The distribution of coastline and ecosystems in before and affter dams construction were detected by satellite images processing. For the satellite image data processing, the shoreline was defined as the mean sea level on the muddy coast where the tide is the dominant dynamic factor and as the mean high sea level on the sandy coast where the ocean waves are the dominant dynamic factor. A GIS approach was used for the quantitative analysis of coastline and ecosystems change in before and affter dams construction. The change of coastline and ecosystem distribution in before and affter dams construction was compared based on effected factors to identify the impact of the upland reservoirs to morphology of the Coastal Red River Delta.

Seasonal variation of hydrodynamics and suspended sediment dynamics in the coastal zone of Red River Delta

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Hydrodynamics and sediment transport dynamics are main factors impact on coastal erosion in the coastal zone. In this study, a three-dimensional hydrodynamic model, based on Alternating Direction Implicit (ADI) finite difference technique and sediment transport modeling of the Delft3d, were used to investigate seasonal variation of hydrodynamics and sediment dynamics in the coastal zone of Red River Delta (RRD). Data input for the model included hydrographic surveys and suspended sediment concentration were conducted in the rainy season and dry season of August 2009 and Mach 2010 in 9 main river branches. In addition, observed data in the meteorology station and characteristic of tide in the RRD coastal are also used for model setup. The results showed river dynamics and wind monsoon are determinate factors to seasonal variation of hydrodynamics and suspended sediment dynamics in the coastal zone of RRD. Hydrodynamics and suspended sediment dynamics are strong seasonal variation, especially in near the river mouth. In the rainy season, outflow velocities is higher and the period of outflow is longer, whereas inflow velocities is low; therefore suspended sediment with high concentration transported further than from the river mouth. In the dry season, tide currents dominate flow pattern due to the decrease of water and sediment flux of the Red River system; the sediment in this season is mainly re-suspended locally and transported to directly southward.

Hydro-dynamic Process and Erosion-Accretion in the Coastal Zone of Haiphong

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Haiphong has 125 km of coastline with 5 main river mouths go into the sea, therefore the hydro-dynamic regime is rather complexity. The current regime in the area is shown through the interaction between tide, wave, wind, river current and terrain of the area. The wave regime depends on wind regime, terrain features and coastline shape. Wave is mainly transmitted from offshore, in dry season the east direction is dominant and in rainy season, the south direction is fully dominant. In recent years, the accretion and erosion of the coastal zone of Haiphong has occur strongly in terms of intensity and scale, which has seriously influenced the social-economic activities of the area. There is approximately 16.1 km out of 125.0 km in total of the coastline of Haiphong had been eroded (about 23.0%). The erosion occurs at Dinh Vu Island, the southern part of Bai Nha Mac, alongside of the road No14, Cat Hai Island and Phu Long area with the velocity of 1.2 to 9.6 m/year (averaging 5.4 m/year). The deposition in the coastal zone of Haiphong occurs in a complicated manner also, especially in the Cam River. Annually, the amount of dredging of the river bed is about 2.5 to 2.9 million tones. In addition, southwest of the Doson Peninsula is strongly affected by the deposition phenomenon. This leads to a difficulty in construction of the deep-sea port in the area.

Sedimentation in tidal flats of Hai Phong coastal area

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Sedimentation study in tidal flats in Haiphong coastal area was carried out by using sediment traps and ^{210}Pb method for two sediment cores taken from Bang La and Ngoc Hai tidal flats in September 2008 and April 2009. Sediment accumulation rates show a range of 0.07–22.81 g/cm^2/year, with an average of 9.77 g/cm^2/year in rainy season; 1.34–6.98 g/cm^2/year, with an average of 4.29 g/cm^2/year in dry season. Sedimentation rate in the tidal flat calculated by CRS model shows a range of 0.13–15.00 cm/year, with an average of 2.18 cm/year. Sediments deposited in traps were coarse aleurites to aleuritic-pelitic muds, with mean diameters of 0.008 - 0.084 mm. Sedimentation in tidal flats depends on vegetations and topography, the highest accumulation area was in the center of mangrove forests, lower accumulation area was upper parts and out side of mangrove forests.

Coastal Mangrove Wetland Ecosystems Management in Red River Delta, Vietnam

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The coastal mangrove wetland ecosystems in Vietnam is supporting local economy of the country which is under threat due to various degrees of environmental, anthropogenic and Sea level rise (SLR) impacts. The coastal people are suffering the highest impacts by SLR, salinity intrusion and coastal erosion in the Red River and Mekong River Delta. The *Song Hong* (Red River) is the largest river in northern Vietnam. It rises inYunnan Province of China and flows 1,175 km southeast through deep, narrow gorges to enter Vietnam and discharge into the Gulf of Bac Bo (gulf of Tonkin) through the delta. It carries silt which is rich in iron oxide, making its water red and giving its name. The total sediment discharge of the Red River system is 100-130 million tonns/yr and the average sediment concentration of the river is 0.83 – 1.08 kg/m^3. The maximum water discharge is 23,000 m^3/s at Hanoi station reaches in July –August and minimum flow is 700 m^3/s in the dry season (January –May). The Red River Delta covers 10 provinces and 95 towns including Hanoi and Haipong. The area of Red River Delta is about 14,806 km^2. In the delta plain , the river diverses into two major distributaries in the vicinity of Hanoi: the Red River to the southwest and the Thai Binh River to the northeast. The Thai Binh River carries on 20% water discharge. The Red River delta plain can be divided into wave, tide and fluvial dominated systems on the basis of surface topography and hydraulic processes. The tide dominated system has developed in the northeastern part of the delta, where Hainan Island shelters the coast from strong waves.The population density is the highest (1225 people/ km^2) density in Vietnam. The sea level varying from 1.75 to 2.56 mm/ year at 4 Vietnamiese stations and the tide range reaches about 4.0 m. The high value is observed in the Red River Deltaic area. The Red River Delta contains one of the main remaining large tracts of mangrove wetlands in Vietnam, with some 30 species of mangroves. The mangroves in the Red River Delta are exposed to impacts of salinity intrusion and anthropogenic influences. As a result mangrove wetland ecosystems and its services in the coastal region are under threat. The magrove forest has drastically destroyed due to shrimp cultivation, settlements development and agrochemical pollution in the coastal region of the Red River Delta.

This perspective and the already existing pressure on limited resources aggravate any effort to advance the country's socio-economic development. This is because climate change can cause SLR and upstream fresh water extraction can changes that could damage farmland, agricultural crop production and human settlements which lead to ecosystem services, food insecurity and poverty in the coastal society. The Red River delta erosion has extended over a length of 30 km. As sea level rises, the depth of the freshwater lens in the coastal zone is greatly reduced, leading to salinization of water supplies. Because tidal pressures, saltwater now penetrates 30 – 50 km up the Red River. In recent years, 2% salinity contour has moved landward by 4-10 km in the northeast part of the delta. The salt water intrusion is a serious problem not only for coastal agriculture and mangrove wetland ecosystem but also for other economic sectors as well. Salinity is one of the most important determinants of mangrove forest growth and distribution. However magrove do needs a certain amount of freshwater during their growth cause fresh water dilutes the salinity of sea water. Therefore, measures need to be taken to develop and maintain these coastal mangrove wetland ecosystems in order to fight against food insecurity and poverty in the coastal society. The study carried out based on secondary data sources. GIS and Remote Sensing (RS) application could be a proper tool for the decision

makers to make a appropreate management plan of mangrove wetland ecosystems.The objective of this study is to investigate the present status of mangrove wetland ecosystems and make some practical recommendations for future development that could meet the needs of the present inhabitants of the Red River Delta in Vietnam.

Key Words: Red River delta, Sea level rise, Mangrove wetlands, Coastal ecosystems and Management

Polycyclic aromatic hydrocarbons (PAHs) in core sediments from Sundarban Mangrove Wetland, Ganges River Delta, India and their ecotoxicological significance

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Polycyclic aromatic hydrocarbons (PAHs) are a group of lipophilic, persistent organic contaminants (POPs) that are widespread in the environment. The present work elucidates the distribution and potential sources of 16 PAHs in sediment cores (<63 μm particle size) of the Indian Sundarban mangrove wetland, a Unesco World Heritage Site, were investigated by gas-chromatography coupled to mass spectrometry (GC-MS). Four sampling sites have been chosen taking into consideration of the representative locales of the variable environmental and energy regimes of the wetland which covers a wide range of substrate behavior, wave-tide climate, and intensity of bioturbation (animal-sediment interaction), geomorphic-hydrodynamic regimes and distances from the sea.

The total concentrations of 16 PAHs ($\sum_{16}$PAHs) ranged from 132 to 2938 ng g^{-1}, with a mean of 634 ng g^{-1}, and the sum of 10 out of 16 priority PAHs ($\sum_{10}$PAH) varied from 123 to 2441 ng g^{-1} with a mean of 555 ng g^{-1}, and the 5 carcinogenic PAHs (benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, benzo[*a*]pyrene, indeno[1,2,3-*cd*]pyrene and dibenz[*a,h*]anthracene) accounted for 68-73% of the priority PAHs. The prevalent erratic vertical distribution of PAHs might be mainly related to the non-homogenous textural composition of the different sediment core layers resultant from the particular hydrological conditions of the Ganges estuary and adjoining Sundarban wetland situated under a meso-macrotidal setting and seasonal flow rate fluctuations. Maximum concentrations of the sediment core were obtained at subsoil depth of 12-16 cm. The prevalence of 4-6 aromatic ring PAHs and cross plots of specific isomer ratios such as phenanthrene/anthracene, fluoranthene/pyrene and methylphenanthrenes/phenanthrene suggested the predominance of wood and coal combustion sources, the atmospheric deposition and surface runoff to be the major transport pathways. A good correlation existed between the benzo[*a*]pyrene level and the total PAH concentrations, making this compound a potential molecular marker for PAH pollution. Total toxic equivalency (TEQ_S^{carc}) values calculated for samples varied from 6.95 ng g^{-1} TEQ_S^{carc} to 119 TEQ_S^{carc} with an average of 59 ng g^{-1} dry wt TEQ_S^{carc}. Sediment quality values were used in the calculation of risk quotients included the Hong Kong Interim Sediment Quality Value (HK-ISQV) and Canadian Sediment Quality Guidelines (CSQG) as well as effects range low (ERL) and the effects range median (ERM) values.

Relative to other urbanized coastal areas worldwide, the prevalent PAH content of the Sundarban sediments can be considered low to moderately contaminated resulting from the impact of the rapid economic development of the surrounding regions for the last two decades. The PAH diagnostic ratios indicated that the PAHs in the sediment cores were mainly of pyrolytic origin mainly transported by surface runoffs. The data provide background information that should be useful in designing future strategies for environmental protection of the important delta, considering the industrial and agricultural growth around this coastal environment.

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Evolution of mangrove vegetation in Mahanadi Delta, India: A palynological assessment

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This paper provides information on the Late Quaternary evolution of mangrove vegetation at Chilka Lake, part of Mahanadi Delta, situated on the east coast of India. Mangroves are halophytic plants found at the land-sea interface and therefore, considered natural trackers of sea level fluctuations. Palynological investigations have been used to study environmental and mangrove dynamics at Chilka Lake, supplemented by radiaocarbon dates to fix the chronology of various events. In order to understand the composition of modern pollen rain, fifteen surface samples were studied from different regimes of the study area. The results reflect a strong presence of present day taxa in the modern pollen spectra. Whereas, the palynological investigations of two sediment cores collected from the northeastern and eastern regions of the lagoon indicate that the development of mangroves was initiated in the Early Holocene. The mangrove vegetation reached an optimum in the Mid Holocene, probably due to high precipitation and humidity, and the forest had well established following sea level stabilization. Thereafter, a rapid decline in the mangroves is observed during Late Holocene, which can be attributed to subsequent drier conditions and also reflects sea level regression at the core sites. The decline in mangrove vegetation is also indicative of anthropogenic activities during the recent past.

Keywords: Palynology, mangrove, sea level, Mahanadi Delta

The Sundarbans: A delta with unique character and unique problems

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The World's largest delta is formed mainly by the rivers, the Ganga and the Brahmaputra, which are known as the Hooghly and the Meghna respectively in the last part of their courses. There are few other rivers and approximately 400 inter-connected water courses forming a network of channels at this Estuarial delta consisting of more than two hundred islands. Two flow tides and two ebb tides everyday with an average range of 5 meters result in deposition of silts forming new islands and cricks, thus keeping the formation of this Deltaic land still active. The flow and ebb tides also result in voluminous mixing of saline and fresh water. Different degrees of salinity in water give rise to and support the two prominent ecosystems of the region- The fresh water swamp forests and the Mangrove forests presently covering 10,000 sq. km. of area shared by India and Bangladesh- almost a 3rd of it's size 200 years ago. This region appears in the list of World Heritage Sites. The Indian part is designated, a Biosphere reserve, while the part in Bangladesh is designated under Ramsar Convention. The altitude of the land varies from 0.9 meters to 3 meters in most of the areas. The entire area is prone to vagaries of nature leading frequently to disasters. Severe cyclonic storms generate enormous tidal waves which leads to inundation of large areas. These all lead to large scale destruction of human life and habitation, loss of cattle fish and agricultural production and cause long lasting damages to the economy by increasing the salinity of fresh water sources, groundwater and the soil. These also upset the ecological cycle of the region destroying the wildlife and the marine life.

Under tremendous pressure of the population increase, the forest area has dwindled in the last 200 years making way for human habitation but the area has many inherent problems for such settlements. The islands are separated by waterways, sometimes 2 km. wide. Transportation by road and rail was virtually non-existent until very recent years. Electric Supply has still not reached many villages. Solar Energy has therefore now been the principle source of power. Difficulties of communication have also similarly given a boost to use of cellphones.

However the economic activity is largely based on pisciculture in low saline water notably of prawns and shrimps. Collection and processing of forest products provide for livelihood of a large number of people. This is rather a risky profession and deaths occur regularly due to mauling by Royal Bengal tigers, crocodiles, and snake bites. The forest also provides excellent timber but the better varieties are almost extinct by large-scale exploitation. Agriculture is minimal but dairy and poultry are very well spread. Perhaps the only organized industry is brick making. Tourism has tremendous and it is growing steadily sometimes with a threat to the ecology.

While the people struggle hard to live in this basically unfriendly terrain, future holds even a darker picture. Global Warming may result in a rise of Mean Sea Level (MSL), the Inter-Governmental Panel of Climate Change has estimated that a rise of 450 mm of MSL could lead to destruction of 75% of the Sundarbans. Already a few islands have disappeared underwater and currently 12 sea facing islands in this delta are experiencing erosion.

To save this delta, unique ecologically and the last habitat for a large number of endangered species, integrated efforts are necessary. This will be apart of the global fight to arrest the climate change. But immediate steps, specific to the area, are also needed. Indeed some are already taken up.

The State Government has embarked on an ambitious project of building sea walls and other coastal protections around these islands. These are integrated with the project of connecting the islands wherever possible. Poldering in a panned and eco-friendly manner is also being considered as a long-term solution.

The paper focuses on the above mentioned aspects with the help of maps, charts and photographs.