Workshop on Deltas : Coastal Vulnerability and Management

Dec 7 - 11, 2009

Anna University Chennai

Chennai, INDIA

Sponsors

Land - Ocean Interaction in the Coastal Zone (LOICZ), Geesthacht, Germany

Ministry of Environment and Forests

United Nations Environment Programme (UNEP)

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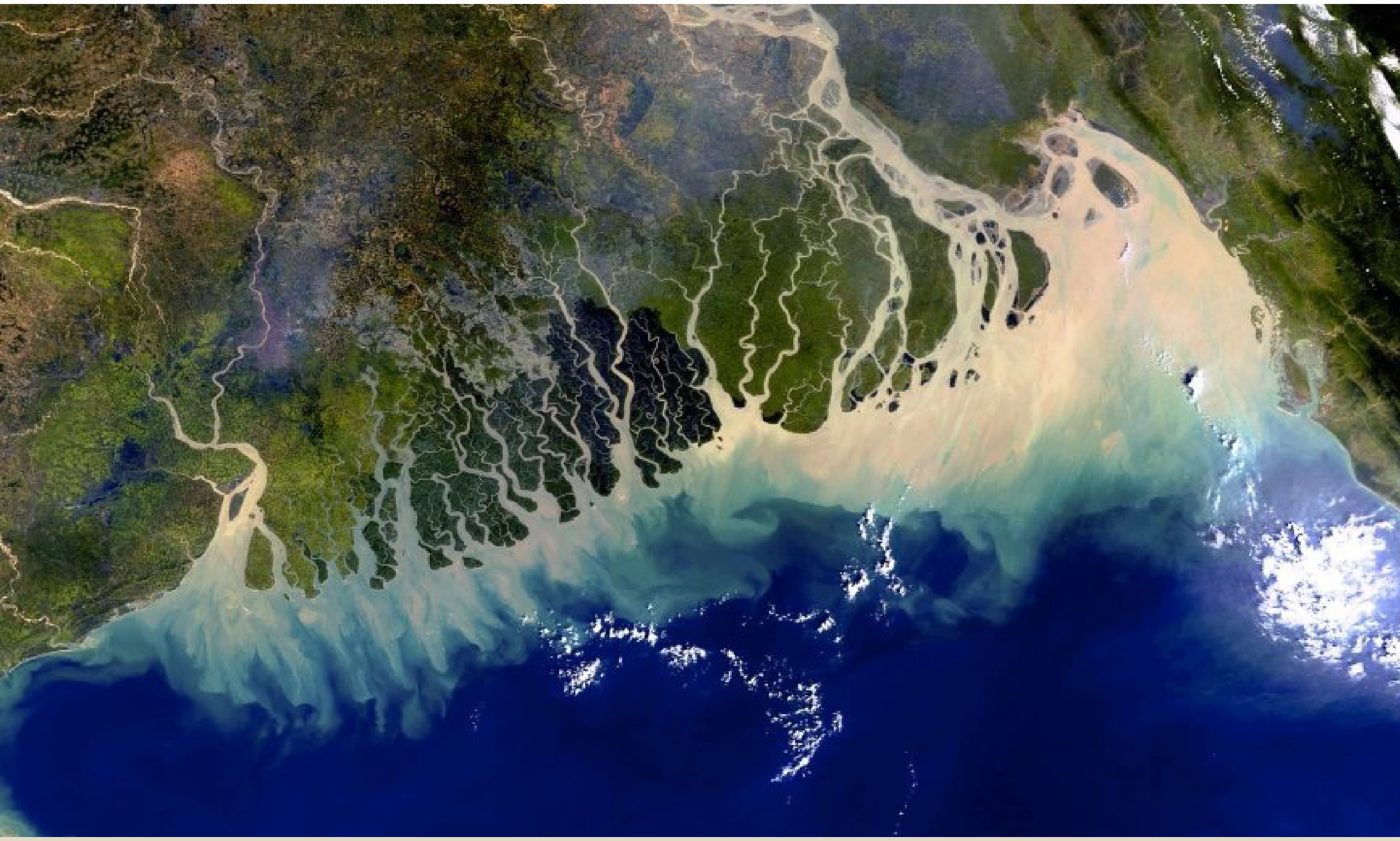

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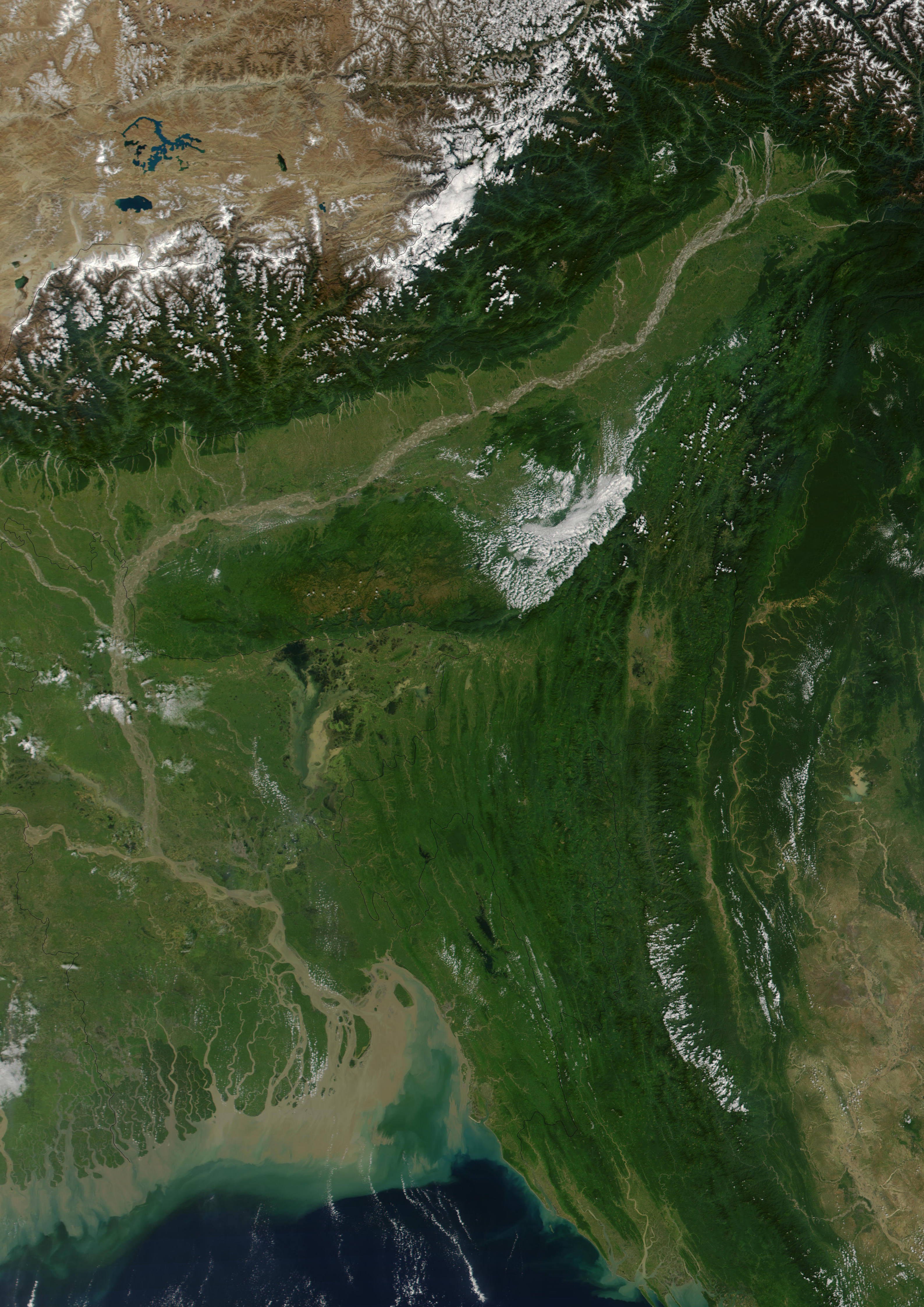

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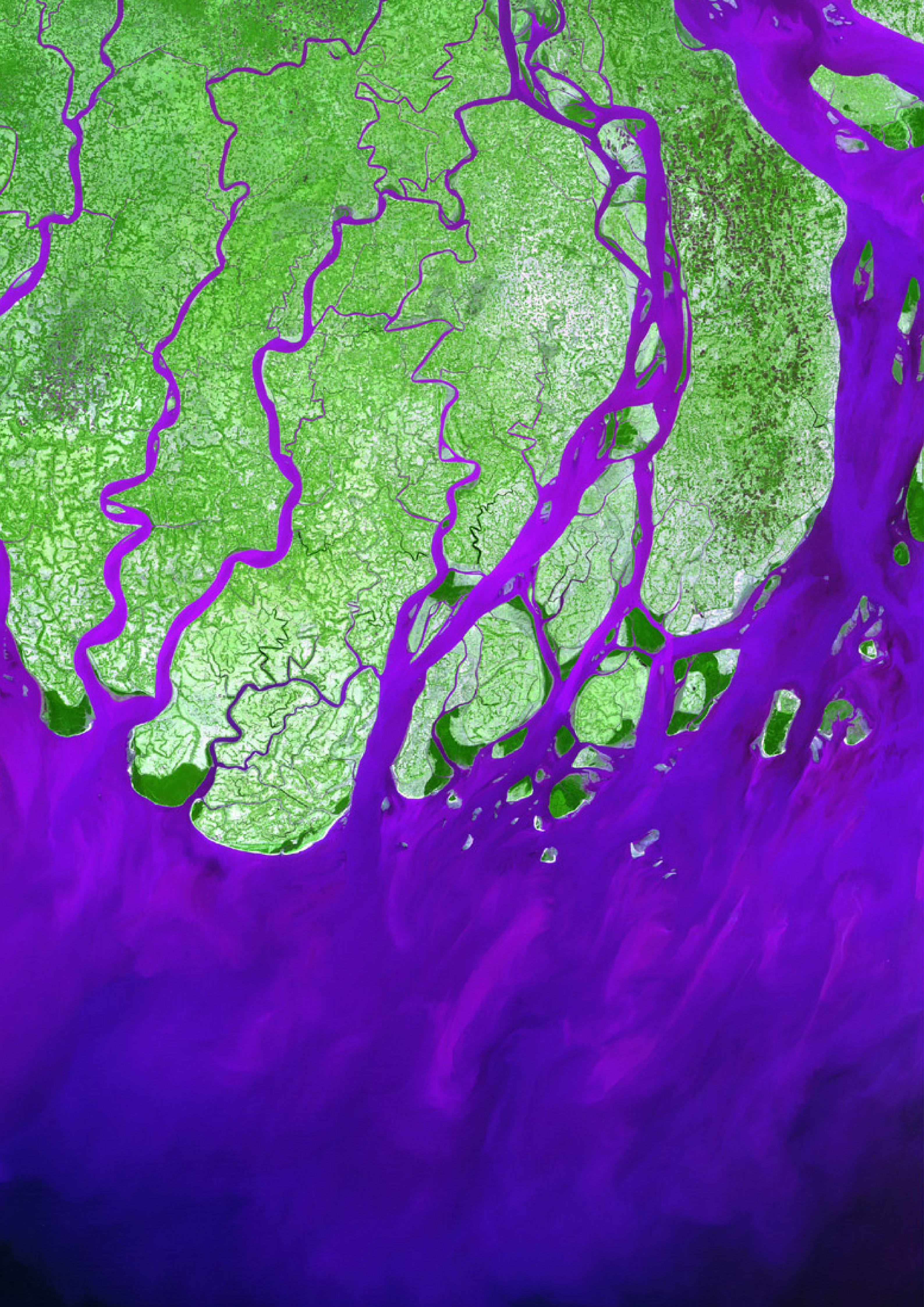


DAY 1 December 7, 2009

INAUGURAL SESSION

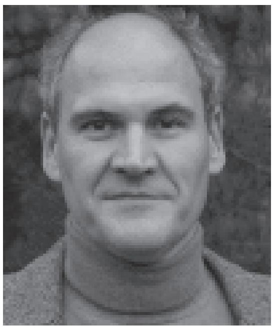
09:00 - 09:25	Registration
09:30 - 10:30	Inauguration

10:30 - 11:00 COFFEE BREAK

TECHNICAL SESSIONS

FORENOON: 11:00 - 13:00 hrs

Special Address



11:00 - 11:30

Hartwig Kremer

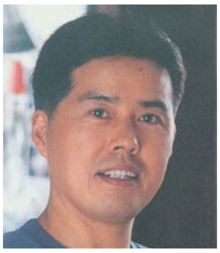
Global Change and Coastal Systems: Challenges at the Science Policy Interface

DAY 1 December 7, 2009

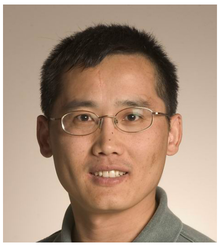
SESSION 1:
TYPES, FORMATION AND CHARACTERISTICS OF DELTA

Chairman **Hartwig Kremer**
Rapporteur **Kesavadas**

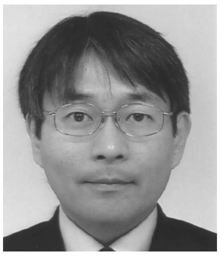
11:30 - 12:00
Colin D. Woodroffe
A Geomorphological Framework for the Classification of Deltas and Estuaries



12:00 -12:30
Zhongyuan Chen
Mega-estuarine Ecohealth and Challenge: High-low Turbid Examples from the Yangtze and Nile



12:30 - 12:50
Paul Liu
Dispersal and Accumulation of the Mekong River-Derived Sediment in the South China Sea



12:50 - 13:10
Katsuto Uehara
Influence of Delta Front on Tidal and Wave Actions Along the Yellow River deltaic coast

13:10 - 14:00 **LUNCH**

Keynote Presentations

DAY 1 December 7, 2009

SESSION 2:
BIOGEOCHEMISTRY AND NUTREINR BUDGETING OF DELTAS

Chairman **Chris Tompkins**
Rapporteur **Asha Kandelwal**

AFTERNOON: 14:00 - 15:30 hrs

14:00 - 14:30
Chris Tompkins
Emerging international and regional institutional managment approaches with a focus on the Global Partnership for Nutrient Management (GPNM)

14:30 - 15:00
Eric Wolanski
The Importance of Biology in Estuarine Fine Sediment Dynamics

15:00 - 15:30
Kathiresan, K
Nitrogen Cycling in Mangrove Ecosystems

15:30 - 16:00 COFFEE BREAK

Keynote Presentations

Technical Sessions

AFTERNOON: 16:00 - 17:00 hrs

16:00 - 16:15
Subramanian, V
Large Rivers- Can they be Sink for CO_2?

16:15 - 16:30
Ajay Ray
LOICZ Nutrient Budgeting for Chilika Lake, Orissa

16:30 - 16:45
Ramanathan, AL
Nutrient, REE and Metal Behavior in the Cauvery delta – Estuarine Complex in SE India

16:45 - 17:00
Arthur James, R
Pathogenic Indicators in Coastal Region of Tamil Nadu, India

17:00 - 17:15
Senthil Kumar, B
Organic Carbon Source and Burial during the Past One Hundred Years in Pichavaram Mangroves, South India

17:15 - 17:30
Mario Tucci
Nutrient Budgeting for the Adyar River Estuary (LOICZ Approach), Chennai

17:30 - 17:45 SHORT BREAK

Poster Session

17:45 - 18:30
Interactive Session: Display of Posters

18:30
Departure from Dana Bergh Hall, Anna University to GRT Radisson

19:00 - 21:00
DINNER at GRT Radisson

DAY 2 December 8, 2009

SESSION 3:
GLOBAL CLIMATE, HAZARDS AND VULNERABILITY

Chairman **Yoshiki Saito**
Rapporteur **Ahana Lakshmi**

Technical Sessions

FORENOON: 09:00 - 10:30

09:00 - 09:30
Yoshiki SAITO
Changing Deltas and Present Crisis

09:30 - 10:00
Ramesh Ramachandran
Vulnerable Deltas of South Asia

10:00 - 10:30
Brigitte Urban
Luminescence Dating of Coastal Dunes at the Cauvery Delta Showing Rapid Environmental Changes

10:30 - 11:00 SHORT BREAK

Keynote Presentations

DAY 2 December 8, 2009

Technical Sessions

FORENOON: 11:00 - 13:00

11:00 - 11:15
Saha, S.K.
Mid Holocene Marine Transgression in and around Dhaka City, Bangladesh

11:15 - 11:30
Seshachalam Srinivasalu
Clues for Tsunami Recurrence during the Past in the Cauvery Delta Region, India

11:30 - 11:45
Mani Murali,R
Inter-annual Shoreline Changes of Gahirmatha coast, Orissa

11:45 - 12:00
Jayaprakash, M.
Climatic variability on Holocene Deltaic Core Sediments of Muthupet Lagoon, SE-coast of India: Geochemical and Paleoenvironmental implications

12:00 - 12:15
Pravin D. Kunte
The Cellular Nature of Littoral Drift along the Northeast Andhra Pradesh Coast, India

12:15 - 12:30
RM. Narayanan
Shoreline Analysis in Gulf of Kutchch, Gujarat: A Remote Sensing Approach

12:30 - 12:45
R. Narayankumar
Paleogeomorphic Evolution of Mahanadi Delta –A Cartographic Appraisal Using Geographic Information System

12:45 - 13:00
Shilpa Singh
Modern Pollen-Vegetation Relationship as an Adjunct in the Interpretation of Fossil Pollen Records in Chilka Lake, Orissa, India

13:00 - 14:00 LUNCH

DAY 2 December 8, 2009

SESSION 4 : HUMAN PERSPECTIVES

Chairman **Colin Woodroffe**
Rapporteur **Paul Liu**

Keynote Presentations

AFTERNOON 14:00 - 15:10

14:00 - 14:30
Annie George
Participatory Irrigation Management in the Tail-End Region (TER) in the Cauvery Delta

14:30 - 14:50
Ahana Lakshmi
Vulnerability Analysis of Agrarian and Fisheries Sector in Cauvery delta

Technical Sessions

14:50 - 15:10
Saudamini Das
Role of Mangroves in Identifying the Vulnerable Hotspots of a Vulnerable Area: Measuring the Relative Vulnerability of Coastal Villages of Mahanadi Delta from Cyclone and Storm Surge risk

15:10 - 15:30
Sandeep Saxena
Community Participation in the Management of Cyclone in the Delta region, Cuddalore District, Tamil Nadu

COFFEE BREAK 15:30 - 16:00

Technical Sessions

DAY 2 December 8, 2009

16:00 - 16:15
Hema Achyuthan
Radiometric Dates and Sedimentation along the East Coast of Tamil Nadu: An Archeological Perspective

16:15 - 16:30
Anupa Ghosh
Need for Paradigm Shift: Disaster Management to Adaptation Strategy - A Study Based on Evidence from Indian Sundarban

16:30 - 16:45
Elango, L
Groundwater Quality of Cauveri Deltaic Regions of Karaikal, Tamil Nadu

AFTERNOON: 16:45 - 17:45

REPORTING AND CONCLUDING SESSION

Chairman **Zhongyuan Chen**
Rapporteur **Annie George**

16:45 - 17:15
Remarks by Chairman Session I
Remarks by Chairman Session II
Remarks by Chairman Session III
Remarks by Chairman Session IV
Remarks by Chairman Nutrient Budgeting Session

17:15 - 17:30
Discussions/ Products and Way Forward

17:30 - 17:45
About the Field Visit to Cauvery Delta

PARALLEL SESSION

11:30 - 15:30 hrs

Nutrient Budgeting for Muddy Coastal Waters

Chairman **Eric Wolanski**
Rapporteur **Kathiresan, K**

Participants

Senthil Kumar & Kathiresan, K
Pichavaram Mangrove

Ajay Kumar Ray & Ramesh, R
Chilika Lake

RM Narayan, Purvaja Ramachandran & Paneer Selvam, A
Vembanad Lake and Muthupet Mangrove

Rita Chauhan & Ramanathan AL
Mahanadi Estuary

Mario Tucci & Aravind Mukesh
Adyar Estuary

Day 1: December 7, 2009

Session 1: Types, Formation and Characteristics of Deltas

Chairman : **Hartwig Kremer**

Rapporteur : **Kesavadas**

11:30 - 12:00

Colin D. Woodroffe

A Geomorphological Framework for the Classification of Deltas and Estuaries

12:00 -12:30

Zhongyuan Chen

Mega-Estuarine Ecohealth and Challenge: High-Low Turbid Examples from the Yangtze and Nile

12:30 - 12:50

Paul Liu

Dispersal and Accumulation of the Mekong River-Derived Sediment in the South China Sea

12:50 - 13:10

Katsuto Uehara

Influence of Delta Front on Tidal and Wave Actions along the Yellow River Deltaic Coast

A Geomorphological Framework for the Classification of Deltas and Estuaries

Colin D.Woodroffe

School of Earth and Environmental Sciences,
University of Wollongong,
NSW2522, Australia

Deltas are shaped by riverine processes, related to both the amount of discharge and the quantities of sediment supplied from the catchment, and the incident wave climate and tide regime at the coast. The large rivers of Asia draining from the Himalayan massif deliver large sediment loads to the oceans and their mouths are characterized by complex and dynamic assemblages of landforms. By contrast, the Australian mainland is much drier; its rivers carry little sediment and its coastal waterways are influenced predominantly by wave and tidal processes. Stratigraphy and dating of coastal sediments around the Australian coast, indicate distinct patterns of development from estuary to delta for both wave-dominated and tide-dominated sections of the coast. River, wave and tide influences vary spatially, and have changed over time. This paper discusses the extent to which it is possible to place the deltas and estuaries of Australia into a framework based on the relative influence of river, wave and tide processes, and explores the relevance of such a classification for the megadeltas of Asia. In particular, it emphasizes the environmental similarities of the broad coastal plains of northern Australia with those of the Asian region, with the contrast that much of coast of northern Australia is sparsely populated and human impacts on the systems are minor. Comparison of estuarine and deltaic systems from these regions may provide an opportunity to assess the significance of anthropogenic alteration of these environments.

Mega-Estuarine Ecohealth and Challenge: High-Low Turbid Examples from the Yangtze and Nile

Zhongyuan CHEN

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East China Normal University,
Shanghai 200062, China,
Z.Chen@ecnu.edu.cn

The mega-estuary of the world provides abundant natural resources for human society and has been densely populated. Over 70% of the world population has been resided in the estuarine-coastal region. Estuary bridges over the land and ocean, where there occurs an intensive interaction between human and nature. Presently, what will be 'estuarine ecohealth' becomes the most priority for securing hierarchical food chain for human development. However, challenges of ecological degradation are more severe than ever before. In the past decades, anthropogenic impact on the estuarine ecosystem and ecohealth is significant, exemplified as the dramatic changes in land-use, upstream water impoundment, over discharge of industrial and domestic wastewaters, over nutrient loading both from agricultural fertilizer and domestic source, etc. Adding the fact of climate warming of global and regional scale, estuarine ecohealth has become a great concern for sustaining our society.

It has been clear that mega-estuary is changing, simply from highly turbid to extremely low turbidity. The Chinese Yangtze estuary has been largely influenced by numerous dams built in the past half-century, in terms of decreasing sediment load from 470 Mt to <150 Mt, presently, and silicate fixation in the reservoirs. This is remarkably modifying the estuarine ecosystem, causing disproportionate ratio of nutrients in estuarine waters in relation to increase in red tides occurrence and hypoxia expansion. Heavy metals are also highly concentrated in the sea-bottom sediments, together forming an anaerobic cover. Given the situation of geo-ecological evolution of the river Nile after Aswan damming in 1964, there has been almost none suspended sediment concentration (SSC) in the river mouth nowadays. In turn, over-expelling industrial and domestic wastewaters have dominated in the coastal wetlands (lagoons), where there have been aquaculture base for tens of millions of Egyptians. Since extremely low capacity of purification due to none-SSC, over nutrients and heavy metals are threatening the society through broken food chain. Geographic gathering of illness on the coast is closely associated with pollution sources.

Most mega-estuaries of the world are very turbid in nature, but, it is becoming toxic sinks due to minimizing sediment load. There has been so much in geo-biochemical interaction happening in the lower-SSC estuaries, which goes far beyond our knowledge, leading to obstruction of knowledge transfer to administrative level. Securing estuarine ecohealth needs refining geo-biochemical model on the basis of long-term institutional collaboration and effective communication among our networks.

Dispersal and Accumulation of the Mekong River-Derived Sediment in the South China Sea

Paul LIU [1]*

Zuo XUE [1]

Dave DeMASTER [1]

Lap Van Nguyen [2]

Thi Kim Oanh Ta [2]

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Raleigh NC 27695, USA
*E-mail: jpliu@ncsu.edu

[2] Inst. of Resources Geography
Vietnam Academy of Science and Technology,
HoChiMinh, Vietnam

High-resolution CHIRP sonar surveys off the Mekong River delta reveal a subaqueous delta system developed in the east and southwest of the modern delta plain in the west of the South China Sea. The seismic profiles and cores show there is only a limited across-shelf distribution (<20 km) of deltaic silt-sand deposit immediately off the river mouth. Instead, a large downdrift mud-silt deposit and fast progradation has been found around Cape Camau peninsula, about 200 km southwestward from the current river mouths. At eastern side of the Mekong delta shore face, the seismic profiles also indicate strong erosion is happening, with some distinct truncations over the topset facies of the subaqueous deltaic deposit, with some noticeable shoreline retreat. However, in the southwest, both the subaqueous delta and shorelines around Cape Camau are still rapidly growing. The CHIRP profiles also indicate the nearshore sediments have been severely charged by biogenic gas due to the rich organic materials supply from both the coastal erosion and river input.

Combined the data from a series of onshore deep boreholes, in the past 3000 yr, nearly 80% of Mekong derived sediments has been trapped and accumulated within the delta area, results in a very fast seaward progradation. The contribution to the deep ocean from the modern Mekong is very limited.

Influence of Delta Front on Tidal and Wave Actions Along the Yellow River Deltaic Coast

Katsuto UEHARA

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E-mail: uehara@riam.kyushu-u.ac.jp

The Yellow River Delta is fringed by a delta front which is shallower than ca. 4 m in depth and less than ca. 15 km in width (Wang et al., 2007). The offshoreward extent of this feature show seasonal (Wen et al., 2008) and decadal (Li et al., 2000) changes which seems to reflect temporal changes in sediment supply from the Yellow River. The present study focused on the effect of the delta front to modify the impact of near-coast waves and tides along the deltaic coasts, which are the major agents for the coastal erosion taken place in this area. A series of numerical experiments were conducted under simplified bathymetric conditions. A preliminary result suggested that the width of the tidal shear layer along the deltaic coasts is affected by the retreat of the delta front.

Day 1: December 7, 2009

Session 2 : Biogeochemistry and Nutrient Budgeting of Deltas

Chairman : **Chris Tompkins**

Rapporteur : **Asha Kandelwal**

14:00 - 14:30
Chris Tompkins
Emerging international and regional institutional managment approaches with a focus on the Global Partnership for Nutrient Management (GPNM)

14:30 - 15:00
Eric Wolanski
The importance of the biology in estuarine fine sediment dynamics

15:00 - 15:30
Kathiresan, K
Nitrogen Cycling in Mangrove Ecosystems

16:00 - 16:15
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Organic Carbon Source and burial during the past one hundred Years in Pichavaram Mangroves, South India

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Mario Tucci
Nutrient Budgeting for the Adyar River Estuary (LOICZ Approach), Chennai

The Importance of Biology in Estuarine Fine Sediment Dynamics

Eric Wolanski

James Cook University and
Australian Institute of Marine Science

An increase in human activities in river catchments is resulting in increased muddiness of estuaries in many regions of the world. This increased muddiness has management implications, such as

- increased turbidity and decreased quality of life for the human population,
- storing pollutants (e.g. heavy metals) for decades to centuries and making them available if the mud is eroded away or dredged
- changing some coasts from sandy to muddy, which is a significant and usually permanent environmental degradation.

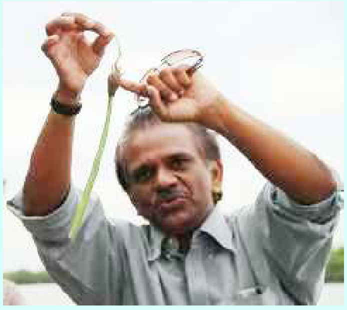
Over the last few decades, much of the knowledge of fine sediment (mud) dynamics, and its modelling, came from the engineering community. Modelling mud dynamics by engineers seemed so 'simple', the belief was that mud was just a messy fluid and that its behaviour could be modelled by adding a few equations for erosion and deposition, with the parameters derived from laboratory experiments and the models could then easily be 'fine-tuned' against some field data for the collection of which ingenious probes were designed.

To everyone's surprise, these engineering models were seen to be largely unable to reproduce much of the field observations for muddy estuaries. A reason for this failure is that these models largely neglect the biology, which has a major influence in controlling

- the settling of mud flocs
- the resuspension of settled mud
- the dewatering (consolidation)
- the patchiness
- the nutrient dynamics

This leads now to view mud and muddy waters as a living body, not just a messy fluid as originally seen by engineers. This enables us to highlight research priorities to advance the knowledge of mud dynamics by quantifying the physics-biology links.

Nitrogen Cycling in Mangrove Ecosystems



Kathiresan K.

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Parangipettai: 608 502, India

Although India has 3% of global mangroves and 5% of Asian mangroves, the role of Indian mangroves in oceanic carbon budget is yet to be understood due to the dearth of data. In this regard, the first estimate of carbon budget in mangrove forests of India in relation to other vegetated habitats and non-vegetated habitats of coastal domain is attempted here.

Macrophyte-dominated habitats, namely mangroves, salt marshes and seagrasses contribute 19.4% of total sediment carbon burial in coastal India, whereas in the world, the vegetated habitats contribute to 47% of sediment carbon. This low contribution by vegetated habitats to carbon sequestration may be due to the limited extent of vegetated area which is only 0.49% of total coastal domain in India, as against 3% in the coastal world.

Occupying just 0.29% of Indian coastal area, the mangroves are highly efficient in contributing to 11.2% of sediment carbon burial, as against only 5.5% by salt marshes and 2.7% by seagrasses. The vegetated habitats which spread just 0.49% of total coastal area, are responsible for 19.4% of carbon burial in India. On the other hand, the non-vegetated habitats, which occupy 97.5% coastal domain, contribute to 80.6% sediment carbon burial in the country. Among the non-vegetated habitats, coastal shelf accumulates 54.5% of total carbon burial, followed by tidal mudflats which contribute 22.7% carbon burial. However, other non-vegetated habitats namely lagoons, estuaries, backwaters and creeks, contribute totally only 3.4% carbon burial. It is therefore, suggested that the extent of non-vegetated habitats especially the tidal mudflats which are available to a large extent of 23,621 sq. km have to be promoted as vegetated habitats especially with mangroves and salt marshes, after assessing their suitability. This effort will have bearing on carbon sequestration and climate changes.

The mangroves fix annually the carbon fixation of 6.05604 Tg carbon, allocated 37.6% to root, 31.2% in litter fall and 31.2% in wood biomass. A major component of 51.3% of mangrove carbon fixed is mineralized, followed by carbon-di-oxide efflux of benthic respiration (19.2%), dissolved organic carbon export (11%), particulate organic carbon export (9.7%) and burial in sediment (8.7%). More published data on these aspects are warranted to get an accurate account of carbon cycling pattern in the mangroves forests of India.

Large Rivers - Can they be Sink for CO_2?

Subramanian V.

SES, JNU,New Delhi 110067

With global warming taking the central stage in all scientific and political discussion, it is appropriate to look into all the 8 major rivers in India and find out their potential for taking in the major GHG such as CO2 by their natural hydrological process All the eight large rivers- Ganges, Brahmaputra, Narmada, Indus, Godavari, Krishna, Mahanadi, Cauvery and Tapti- carry about 2300 Km3 of water besides about a billion tonnes of sediments to their respective delta in the Bay of Bengal and the Arabian sea. All the water in south Asia are alkaline with pH above 7, and generally around 8. The alkalinity of river water is created by rock-water interaction and the main silicate lithology in the Indian sub-continent is the primary contributor of this alkalinity, Consumption of this GHG by weathering in the last three decadeas for witch data are available show clear upward trend. This indicates that as the levels of atmospheric CO2 has been increasing in recent years, so is the weatherability of rocks in the sub-continent. This scavenging of the GHG by simple geochemical processes takes place parallel to forestation programs that is supposed to act as sink foe the excess gas. Combined with the GHG that can be trapped in the large sediment base by production of organic carbon these rivers have, Thus, in nature, there are two competing processes that can handle the problem we face regarding the global warming on account of excess emissions. However, quantification for the large rivers in south Asia that has been attempted are based on scanty data base and may need to be revised to precisely account for the proportion of scavenging capability of this simple and independent geochemical process as a tool for climate change scenario.

Nutrient Budget in Chilika Lake :
A LOICZ Biogeochemical Approach

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Ramesh R

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Biogeochemical processes and budgets of carbon, nitrogen and phosphorus from the semi-enclosed Chilika Lake were constructed through seasonal observations and modeling. The water residence time of Chilika Lake varied seasonally from ~7 days during monsoon to 120 days during premonsoon. The residence time of nutrients (C, N and P) varied with water exchange rates and was about 2-2.5 times longer than water residence time. Riverine inputs and lake distributions of nutrients varied in time and space based on the seasonal sampling. Therefore, the carbon and nutrients exhibited non-linear relationship against salinity. The non-conservative fluxes DIN, DIP, DIC and DOC from the lake varied seasonally, where monsoonal fluxes were predominant and strong compared to premonsoon. The DIP was positive during monsoon, however negative during premonsoon indicating its sink which was significant to the observed atmospheric CO2 sink in the lake, especially in northern and central lake. The organic carbon budget indicated the lake was strongly heterotrophic by transforming riverine organic carbon to the atmospheric sink through negative NEM during monsoon. However, during premonsoon the NEM was positive indicating the lake as an autotrophic system, where the photosynthesis activity exceeding the community respiration (p-r > 0). Overall, the lake heterotrophy was predominant in the system than autotrophy. The lake heterotrophy was also displayed through N-mineralization which suggested the occurrence of denitrification during monsoon and nitrogen fixation (Nfix-Denit > 0) during premonsoon.

Nutrient, REE and Metal Behavior in the Cauvery Delta-Estuarine Complex in SE India

AL. Ramanathan [1]

M. Bala Krishna Prasad [2]

Rajesh Kumar Ranjan [1]

[1] School of Environmental Sciences, JNU, New Delhi

[2] University of Maryland, USA

Sediments in general play a pivotal role in the nutrient biogeochemical processes by behaving as both source and sink for nutrients and other materials in the downstream regions especially in the Deltas and estuaries. Surface and subsurface sediments and water samples were studied in the downstream of the Cauvery river were analyzed for nutrients, stable isotopes , REEs and metals signatures in order to understand the spatial distribution of nutrients and their biogeochemical processes. Sediments from vegetative regions contain higher concentrations of organic carbon (OC) than the estuarine sediments reflecting high rates of organic matter retention. Among the rare earth elements (REEs) light rare earth elements (LREEs) were more enriched than the heavy rare earth elements (HREEs) and the Eu anomaly was relatively weak. Intense weathering of the surface crustal areas controls their distribution. The variation in the enrichment of HREEs was controlled by the salinity gradient and inputs from estuarine zones. Correlation and factor analysis also explain the contribution from the continental weathering followed by other processes like salinity control, input from anthropogenic sources. The enrichment factor substantiates that most of the REEs have weathering sources and are altered in the complex biogeochemical processes. Few metals observed were derived from anthropogenic activities but were generally below the contamination levels. The Ce, Gd, and Eu ratios confirm the natural and anthropogenic source. In general, the interior channels and high-salinity zones were more enriched with HREEs than LREEs. This system contribute around 70%–80% of the LREEs (including middle rare earth elements) and 20%–30% of HREEs to the adjacent sea. Sedimentary C isotope signature demonstrates the greater influence of plant litter and organic matter on sedimentary organic matter. Enriched signature of N isotope in sediments suggesting the influence of anthropogenic nitrogen derived from agricultural fields and human settlements. A two-end-member mixing model indicate that the terrigenous OM was dominant in the estuarine zones, while in the vegetative zone terrigenous supply accounts for 60% and marine input accounts for 40%. Solid phases of phosphorus fractions in the surface and subsurface sediments show the existence of complex biogeochemical cycling and bioavailability of phosphorus. Low levels of Fe bound P indicate the high salinity inhibition of phosphate adsorption onto the Fe-oxides/hydroxides. Post-depositional reorganization of P was observed in surface sediments, converting organic P and Fe bound P into the authigenic P. The burial rates and regeneration efficiency of P shows high burial efficiency of P. Significant amount of P is locked in sediments in the form of authigenic P and detrital P . Historical data also indicates a significant increase in dissolved inorganic nutrient concentrations since two decades reflecting increased land use, discharges from agriculture, and the growth of human settlements.

Pathogenic Indicators in Coastal Region of Tamilnadu, India

Rathinam Arthur JAMES*
Sivanandham VIGNESH
Periyasamy KUMARASAMY &
Annamalai RAJENDRAN

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Coastal waters have traditionally been considered as the ultimate sink for the by-products of human activities. The key sources of pollutants affecting coastal water quality are river-in inputs of domestic, agricultural, and industrial effluents and direct sewage discharges from the local population. Over 250 million cases of gastroenteritis and respiratory diseases and 5–10 million cases of hepatitis are reported annually from coastal regions all over the world. The Tamilnadu coast has several perennial and non perennial rivers, which flow west to east towards the Bay of Bengal and Gulf of Mannar. A study was undertaken to assess the pollution indicators and human pathogenic bacteria and their seasonal variations in different locations along the 1076km length of coastal and estuarine region of Tamilnadu, India. Samples (water and sediment) were collected from 15 different sites representing postmonsoon – January 2008, summer - May 2008 and monsoon - October 2008 and were subjected to bacteriological analysis, i.e. total viable count (TVC), total coliform count (TC), total streptococci count (TS), total vibrios count (VLO) and five different types of pathogenic bacteria counts were also studied. From this study, especially the total coliforms (TC) were in order of magnitude of 104 ml-1 for most of the sites in all the three seasons, respectively, which is substantially high. From a comparative assessment of distribution and abundance of pollution indicator and human pathogenic bacteria in the coastal sample of Tamilnadu, it is inferred that the counts of all the groups are higher than Mondovi and Zuari estuary in Goa coast of Arabian sea (Nagvenkar and Ramaiah; 2008). All groups of indicatory bacteria were 100-1000 times more numerous in the sediments than in water (Niewolak; 1998). Similar observations were obtained in our studies. The monsoon season got high level of bacterial pollutions in both the sample and its sequence was observed as monsoon>summer>postmonsoon. The results of bacteriological analysis of water revealed that the situation is alarming. It is suggested that inclusion of these groups could be made mandatory in coastal and estuarine region for the environmental impact assessment.

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Organic Carbon Source and Burial during the Past One-Hundred Years in Pichavaram Mangroves, South East Coast of India

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Organic carbon (OC), total nitrogen (TN), and unsupported ^{210}Pb activity in core sediments were measured to quantify the burial of organic carbon and the relative importance of allochthonous and autochthonous contributions during the past one hundred years in Pichavaram mangroves, South India. The core sediments were dated using ^{210}Pb chronology, which is the most promising method for estimation of sedimentation rate on a time scale of 100–150 years. OC/TN ratios are utilized to trace the sources contributing to sedimentary organic matter. The measured organic carbon burial rates in Pichavaram mangroves were 1.39 – 2.56 mol C m^{-2} yr^{-1}. River Coleroon and Uppanar canal carry eroded soils and organic matter from the land derived sources to the mangrove region and contribute nearly 30 to 40% organic carbon burial to the mangrove sediments. About 75% of the mangrove surrounding areas in Pichavaram is agricultural lands and most of this is paddy fields which are located close to the mangrove region and it would export most POC and DOC to the mangrove sediments. The carbon burial rates in Pichavaram have been accelerated by land-use change in the mangrove surrounding areas and the Coleroon and Vellar Rivers.

Keywords: Mangroves, ^{210}Pb chronology, sedimentation, OC/TN ratio, OC burial rates, land use pattern

Nutrient Budgeting for the Adyar River Estuary (LOICZ Approach), Chennai

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Chennai City is the fifth largest city of India. The southern half of the city is traversed by the AdyarRiver which has a length of about 40 km. On a length of 14 km it passes through the densely populated core of Chennai City where land-use is mainly residential, commercial and institutional. 4 km before the Adyar River enters the Bay of Bengal it forms a wide and shallow estuary with a tidal range of 1 – 2 m. The estuary has a depth of about 1 m and an average surface area of 1.4 km^2. The urban stretch of the river receives significant hydraulic loads of treated and untreated sewage. Summed hydraulic loads of urban outfalls are larger than the base flow of the Adyar River when entering the city limits. These outfalls deliver high loads of phosphorous, nitrogen and organic matter to the river which are expected to impact the Adyar River estuary.

Following the LOICZ nutrient budgeting guidelines budgets for the months of November 2008, December 2008 and January 2009 were produced to determine the estuaries overall metabolism and its behavior to act as a sink or source of dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorous (DIP). Results show that the Adyar River estuary net metabolism is heterotrophic at all budgeted months ([p-r] = -3.6 to -57.3 mmol C m-2 d-1) and that it acts as a source of DIP and DIN. The strong heterotrophic metabolism is a consequence of the large external source of organic matter (sewage) to the estuary and the limitation of primary production within the estuary.

Nutrients delivered to the Adyar River estuary in large amounts stimulate the growth of algae. External organic matter and dead algae partially settle on the bottom of the shallow estuary. While dissolved oxygen is depleted (<0.1 mg L-1) in about 50 % of the estuarine area the sludge is subject of anaerobe digestion. Subsequently DIP and DIN are delivered to the water column explaining the source behavior of the estuary in regard of these parameters. At the same time the productivity of the system is limited to phytoplankton because its strong growth inhibits two important groups of producers in estuaries which are submerged aquatic vegetation and benthic micro-flora.

The produced budgets show that the Adyar River estuary overall metabolism is heterotrophic. While the LOICZ budgeting methodology does not allow conclusions about the estuaries pristine metabolism it shows that anthropogenic influence at least impacts the scale of heterotrophic behavior (increasing) and at the same time the systems role in delivering CO2 to the atmosphere (a core question of LOICZ project).

This research was carried out under the DST-BMBF Project (No. IND 04/003) funded by the Department of Science and Technology, Government of India and the BundesministeriumfürBildung und Forschung (BMBF) in joint cooperation of the Department of Ocean Management, Anna University, Chennai, India and LEUPHANA University Lüneburg, Germany.

Day 2: December 8, 2009

Session 3 : Global Climate, Hazards and Vulnerability

Chairman : **Yoshiki Saito**

Rapporteur : **Ahana Lakshmi**

09:00 - 09:30
Yoshiki SAITO
Changing Deltas and Present Crisis

09:30 - 10:00
Ramesh Ramachandran
Vulnerable Deltas of South Asia

10:00 - 10:30
Brigitte Urban
Luminescence Dating of Coastal Dunes at the Cauvery Delta Showing Rapid Environmental Changes

11:00 - 11:15
Saha, S.K.
Mid Holocene Marine Transgression in and around Dhaka City, Bangladesh

11:15 - 11:30
Seshachalam Srinivasalu
Clues for Tsunami Recurrence during the Past in the Cauvery Delta Region, India

11:30 - 11:45
Mani Murali,R
Inter-Annual Shoreline Changes of Gahirmatha Coast, Orissa

11:45 - 12:00
Jayaprakash, M.
Climatic variability on Holocene deltaic Core Sediments of Muthupet Lagoon, SE-Coast of India: Geochemical and Paleoenvironmental Implications

12:00 - 12:15
Pravin D. Kunte
The Cellular Nature of Littoral Drift along the Northeast Andhra Pradesh Coast, India

12:15 - 12:30
RM. Narayanan
Shoreline Analysis in Gulf of Kutchch, Gujarat: A Remote Sensing Approach

12:30 - 12:45
R. Narayankumar
Paleogeomorphic Evolution of Mahanadi Delta –A Cartographic Appraisal Using Geographic Information System

12:45 - 13:00
Shilpa Singh
Modern Pollen-Vegetation Relationship as an Adjunct in the Interpretation of Fossil Pollen Records in Chilka Lake, Orissa, India

Changing Deltas and Present Crisis

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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 the drainage basin and the delta itself) and in the ocean. A sea-level rise and a tsunami are typical examples of ocean changes 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 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. Megadeltas are not only expected to be vulnerable in the future but also are experiencing serious environmental problems at present. Moreover, similar problems have been recognized in smaller deltas along the coasts of small mountainous islands in Southeast and East Asia. Three keywords characterize the present delta crisis: shrinking deltas, sinking deltas, and ecosystem collapse. These are ongoing global phenomena. 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 sea-level rise, 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 means mainly the loss of wetlands (mangroves, tidal flats, 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 attributed mostly to human activities.

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Deltas are highly productive, ecologically rich and are dependent on the interaction between the river's sediment, water and nutrient flux and the wave and tidal currents. A recent study indicates that most of the world's low-lying river deltas are sinking and making them increasingly vulnerable to flooding from rivers and ocean storms exposing tens of millions of people at risk. At present nearly 500 million people live in deltas. In South Asia the population densities exceed 1000 people km-2 when compared to a global average of 45 people km-2.

Problems associated with this include depleted fresh water supplies, land subsidence and erosion, sea level rise, infrastructure development, salt water intrusion, habitat loss and the threat of natural disasters. Sinking of deltas in South Asia is enhanced by the upstream trapping of sediments by reservoirs and dams that retain these sediments. In this paper, an attempt is made to highlight some of the vulnerabilities, as a result of the changes in some of the major delta regions of South Asia:

a) Reduction of sediment load and freshwater flow
b) Subsidence
c) Coastal erosion
d) Habitat loss

Additionally, GIS mapping has been used as a management tool that allows the identification of such vulnerable zones, i.e. zones which are both sensitive and subject to risks. In this way, it is possible to build models for geomorphological evolution, prediction of changes and management of deltas and coastal areas.

Luminescence Dating of Coastal Dunes at the Cauvery Delta Showing Rapid Environmental Changes

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Aeolian sediments in dryland and coastal areas have great potential for palaeoenvironmental studies.The application of dating methods allows establishing a geochronological frame which can be used, for e.g.to correlate the periods of dune formation and palaeosols to the past dry and wet periods. The investigationof coastal dunes can also provide information about sea level fluctuations. In this study dunes in the northernand southern part of the Cauvery Delta were investigated using optically stimulated luminescence dating.The age of dune formation was unknown. Merely a Holocene age is expected based on former studies aboutsea level fluctuations at the south east coast of India.Our results show a young age of dune formation. Due to the variety of different bedded layers, hiatusesand soil-like horizons a higher age was expected. The investigated dunes in the northern part are not older than 3.5 ka. There is a difference in age between the western and eastern dunes. The eastern dunes show agesat around 0.2 ka. Whereas the dunes in the western part show also formation ages up to the maximum age of 3.5 ka. Comparing the studies of sea level fluctuations with our results it seems, that the dunes reflect sealevel high stand at 4 ka and a low stand during the Little Ice Age.A prominent feature of the investigated sections in the northern part is soil-like horizon containingnumerous artefacts. This horizon indicates a settlement period in that area starting at around 706 AD andlasting until around 1679 AD. The periods of sand movement coincide with periods of reduced precipitationin south east India. The investigated dunes in the northern part of the Cauvery Delta reflect the sensitivity ofthat area against changes in climate and human impact resulting in increased sand movement.In the southern part of the Cauvery delta (Vedaranniyam), palaeo beach ridges were found inland whichreveals sediment accretion and regression of sea to the present day coast. Samples were collected fromdifferent sand units along the profile from the ridges for luminescence studies. Sembodai region, in the north of Vedaranniyam showed intense sand mobility with 3.5 m vertical accretion within the period of 6 decadesfrom around 1900 AD until the second half of the century. Another profile (Tettagudi North) 320 cm highfrom the south of this region gave an age of 700 AD for the bottom layer, with sand accumulation to the topup to 1900 AD. Samples collected from the southern most part (Kodiakarai) of the delta from a massive sandunit at a depth of 50 cm from surface gave a depositional age of about 1350 AD. This gives an implication onpossible chronology for lateral shift of palaeo coastline positions along NNW to SSE towards Point Calimereand wind activity in the region. Further analyses on samples from southern part of the delta are underprogress, which will eventually give an enhanced idea about late Holocene coastline changes and recent sandmobility in the region.

Mid-Holocene Marine Transgression in and around Dhaka City, Bangladesh

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The paper deals with reconstruction of Mid Holocene paleoenvironment in relation to relative sea-level changes in Bangladesh. To reconstruct the paleoenvironment of the study area, five hand-excavated outcrops in and around Dhaka City were examined. Lithofacies characteristics, mangal peat, diatom and paleophysiographical evidences were considered to reconstruct the past position (space) and 14C dating were used to determine the time of formation of the relative sea-level during the Holocene.

With available standard reference datum the required MSL at the surface of five sections were calculated from the surrounding bench mark following the standard procedure of leveling method. It has been noticed that all the lower humic layers (samlples' altitude -4.1 to -3.7 and -2.85 to -0.92m from the MSL) of different sections contain a lot of mangrove pollens likely Rhizophoraceae, Myrtaceae, Leguminosae, Sonneratia, Arecaceae, Avicennia, Myrica, Rbamnaceae etc. Two marine diatoms Cyclotella striata and Campylodiscus sp. have also been found in the studied sections. The humic layers containing mangrove pollens and diatoms were dated by 14C and the obtained dates are 6690±40 (altitude -4.1 to -3.7m from MSL) and 5919±60 (altitude -2.85 to -0.92m from the MSL). The presence of mangroves in the stratigraphic sections and brackish water diatoms, providing support for inflow of shallow-marine water into a supratidal, brackish-water mangal environment and sediments types indicate that the areas were inundated with brackish water at around 6000 years BP. The paleo-coastline then might have moved little south. The river Balu as well as the tributaries and distributaries of the river Buriganga and river Sitalakhaya were acting just like the tidal river. The abundant mangrove pollens in mud succession shows the second transgression around 5500 years BP and, the height of this high stand was 1-2 m higher than the present sea level.

Key words: Bangladesh, Holocene, relative sea-level change, highstand, paleoenvironment, mangal peat, sedimentary facies, pollen analysis, brackish water invasion

Clues for Tsunami Recurrence during the Past in the Cauvery Delta Region, India

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The coastal sediments have great potential to preserve the geological signatures of the past cyclic and noncyclic events. Tsunamis are such episodic events which leave their imprints in the coastal sediments. Such stratigraphic signatures of tsunamis are beautifully displayed in many regions of the world (eg. Atwater et al. 2005, Cisternas et al. 2005). In the perspective of tsunami disaster management, the present investigations are mired by the lack of information on past tsunami cyclicity. The instrumental and historical records of tsunamis have not provided data-set for longer periods of time, whereas, the geological records in the coastal sediments have assisted in identifying past tsunami events (Atwater et al. 2005, Cisternas et al. 2005, Jankaew et al. 2008, Monecke et al. 2008). In the present study, an attempt has been made to identify ancient tsunamis from the Cauvery delta region using sediment records. Though most of the 2004 tsunami deposits have been eroded and destroyed by natural and human activities, there are few places where the tsunami deposits have been preserved. Despite these difficulties, there remain plenty of reasons to expect that the coastal geology of Cauvery river delta can and will extend these timelines of the history of Indian Ocean tsunami. In the case of Tamil Nadu, tsunami deposits from 2004 have already been characterized (Srinivasalu et al. 2007). Keeping the geomorphology and 2004 tsunami sediment characteristics as the key, excavations have been made for candidates on the Cauveri river delta. Candidates have been found at 4 sites within 2 km from the modern beach. Pre-2004 sheets have been traced across the mudflats near the place where the 2004 tsunami inundation were more. Stratigraphic cross sections were assembled from correlated pits and field estimates of particle size and foraminiferal analyses were made. At cuddalore a possible tsunami sand sheet has been identified at a depth of 15cm below a layer of fluvial clay. Another clay layer is present below this event layer. The top 5cm posses the deposits of 2004 tsunami. The top layer (2004 tsunami layer) and the third layer (possible paleo-tsunami layer) have laminations with few thin (few mm) heavy mineral layers. Foraminifers such as Elphidium norvangi, Elphidium spp and Asterorotalia trispinosa are present in both these layers. These marine forms are significantly absent in other parts of the excavated trench. The possibilities of storm deposit or intertidal deposit have been ruled out since Asterorotalia trispinosa lives only around 35m water depth. It is not possible for sediments of this depth to get deposited by storm surge or by high tides. Similar deposits have been identified in other three sites near Poombuhar, Karaikal and Pushpavanam. In all these places, the marine sand sheets were sandwiched between the fluvial clay indicating coastal flooding. Using Sedimentology and micropaleontology and field characteristics, the possibilities of storm surges and other coastal processes have been ruled out for the origin of these deposits and they have been identified as probable candidates of ancient tsunamis.

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Inter-Annual Shoreline Changes of Gahirmatha Coast, Orissa

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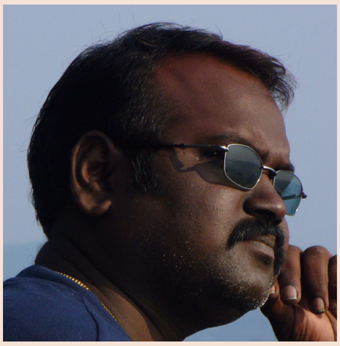
Shoreline changes along the Gahirmatha coast, Orissa was studied using the remote sensing images and field data. The present study area extends to about 35km from Hansua river mouth to Miapura river mouth which is a region of the Mahanadi composite delta formed by the Mahanadi- Brahmini- Baitrani river system. There are mangrove swamps, tidal flats, beaches, sand dunes and spits in the marine environment of the Mahanadi deltaic region. The study region is subject to tropical cyclones, monsoons and floods. 1.5 million metric tons of sand movement take place annually as a result of littoral drift in this region. This coast undergoes seasonal erosion during southwest monsoon as well as during cyclone periods.

The year-wise shoreline positions derived from the satellite data for the years 1999-2009 indicates inter-annual shoreline changes and comparison with 1972-1973 surveyed topographic sheets brings out heavy erosion and accretion along most of the areas. Accretion tendency is observed in the Ekakula spit region and Hansua river mouth, and erosional tendency is observed in many places along the Gahirmatha coast. The year wise changes are analysed and it is observed that the shoreline retreated all along the coast between Ekakula (219 m) to Pentha (947 m) during 1972 to 1999. At the same time, Hansua river mouth had 470m accretion. The year wise length of the Ekakula spit increased from 1999 by 2712 m up to 2008 towards northeast and will reach Outer wheeler islands. This spit underwent marked temporal changes in the past. It lost about 1.8km when compared its position in 1972 with the satellite image of 1999. Since the sediment supply from the south is arrested by the breakwater structures, the morphology of the coast is controlled by the sediment brought by the rivers of that region and reworking, redistribution of sediments available in this area. The changes in the orientation prevent continuity in the littoral drift after the Ekakula spit. Palmyra sandy shoal formations indicate that this region acts as a sink for the sediments brought from south. A close look at the present depositional / erosional scenario with the prevailing hydrodynamic conditions is important as it is one of the important nesting grounds for Oliver ridley sea turtles. Shoreline changes in this region have increased the vulnerability to nesting of marine turtles and inundation during cyclones and storm surge periods.

Key words: Shoreline changes, Gahirmatha coast, Ekakula spit, Remote sensing, Orissa

Climatic Variability on Holocene Deltaic Core Sediments of Muthupet Lagoon, SE-Coast of India: Geochemical and Paleoenvironmental Implications



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Interaction between continental and marginal marine environments and their natural biogeochemical processes provide the history of climate changes in their core sediments at successive deeper and older layers. The importance of these ecosystems is to provide a mechanism for trapping sediment and can act as a recorder of climatic changes via geochemical imprints. The aim of the present study is to evaluate the climatic and depositional controls in the Muthupet lagoon, Southeast coast of India, situated at the southern most end of the Cauvery delta. It is a part of mangrove ecosystem and is connected with the Bay of Bengal in south. In general the lagoon is very shallow with an average depth of 1 m, except its mouth where it exceeds 3 m. The Muthupet wetland ecosystem is spread over an area of 86.77 km2 and is fed by minor rivers Paminiyar, Koraiyar, Kandankurichanar, Kilaithangiyar and Marakkakoraiyar, which are the distributaries of the River Cauvery. A sediment core has been collected from the middle of the lagoon and the down core variations of geochemical parameters and their ratios were employed to reveal the characteristics of Holocene climate and associated paleoenvironmental implications of the study area. High values of the Chemical Index of Alteration (CIA) suggest intensive chemical weathering of the source rock under tropical to subtropical climatic conditions. V/Cr ratio has been used as a paleo-oxygenation indicator and in the present study, the ratio V/Cr was found to be < 2 indicating oxic-depositional conditions prevailing in this lagoon. Al/Ti, K/Ti, Fe/Ti, and Fe/Al ratios of the sediments are evaluated and the variations are interpreted to reflect the changes in the input from the marine environment. Fe/Ti and Fe/Al ratios yields valuable information on the impact of climate changes on the sedimentation of the study areas. The results reveal that the higher concentrations of mobile and easily soluble elements such as MgO, CaO, Na2O reflect the enhanced chemical weathering and monsoonal activity in the Bay of Bengal.

The Cellular Nature of Littoral Drift along the Northeast Andhra Pradesh Coast, India

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The littoral-drift regime along the 290 km coastal stretch between Narsapur and Vishakhapatnam, north-eastern coast of Andhra Pradesh (A.P.), India, has been investigated by analyzing coastal drift indicators and landform change detection study based on multi-date, multi-temporal satellite images. Study of offshore turbidity distribution patterns and quantitative estimation of suspended sediments is carried out to estimate suspended sediments and to understand behavior of sediment fluxes. Enhanced Thematic mapper images of Landsat 7, 5 and Landsat MSS are processed and interpreted to determine the long-term cellular nature of drift cells. Along two distinct coastal segments, the Godavari delta coast and Uppanda-Vishakhapatnam open coast, twenty littoral cells were identified. The results of these three independent techniques reveals that: 1) multi-date, multi-temporal satellite images help in understanding the cellular nature of littoral drift along the coast, 2) although the shore drift is bi-directional and seasonal, the overall net littoral drift moves from SW towards NE along the eastern coast of India, and 3) littoral-drift characteristics along the northeast Andhra Pradesh coast indicate that littoral drift regime is well adjusted to the present ambient wave climate.

Shoreline Analysis in Gulf of Kutchch, Gujarat: A Remote Sensing Approach

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Shoreline variations are caused by both natural processes and human activities. Natural processes include tides, waves, currents and storms and major geological events such as tsunami. Human activities affecting the shoreline are construction of ports and coastal structures, land reclamation, and land use practices. Shoreline accretion results in more usable land, while shoreline erosion has been reported to cause potential problems to the infrastructure, community and ecosystems along the coast. Therefore accurate demarcation and monitoring of shoreline variations (long-term and short-term) are necessary for a scientific understanding of coastal processes and for assessing the nature of impact - natural or human mediated, for devising effective coastal management strategies in future.

In the present study an improved method was developed, through remote sensing technology coupled with limited DGPS surveys and integrated in GIS to collect historical shoreline information. In this study base maps were prepared on 1:50,000 scale using Survey of India/US Army toposheets and onscreen digitization of coastline were carried out using various satellite images on 1:15,000 scales and stored as four different layers in GIS environment for the years 1980, 1990, 2000 and 2009. The multi-date shorelines served as input into the USGS digital shoreline analysis model to cast various transects (261 reference stations) along the coastline of Gujarat. A distance of 5-10 km intervals were assigned to calculate the erosion/accretion statistics in ArcGIS 9.3 software. The results obtained were classified as low (0 to -10m), moderate (-10 to -30m) and severe erosion (-30 to -125m) respectively. For accretion, only two basic classification scales were used as accretion areas (0 to +30m) and high accretion zones (+30 to +180m).

Primary observation on the length of coastline reveals that at present, the coast of Gujarat is 2044 km in length, in compared to the published value of 1650km. This statistics includes a linear line along the river mouths/ estuaries/ deltas. Of this 2044 km, the results indicate that nearly 74.24% of the coastline is eroding, of which 35.47% constitutes to low erosion; 16.08% with moderate erosion and 22.59 % as severely eroded areas. It can be concluded therefore that 25.86% of the coast is accreting. The highly eroding nature of the coast of Gujarat is a combination of natural phenomena (high tidal activity of ~6m; and severe wave action) and man-made due to recent proliferation of ports and other structures along the coast. We can decipher from our observations that the rate of accretion could have declined due to reduced sediment input from the major rivers such as the Narmada and Tapi. This result agrees well with the present crisis of vulnerability of river deltas and the sinking phenomenon, most commonly observed in many deltas around the world.

Paleogeomorphic Evolution of Mahanadi Delta - A Cartographic Appraisal Using Geographic Information System

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The paleogeomorphic evolution of the Mahanadi delta region, (India's one of the largest delta systems) were studied through various published maps of historic, geographic, geologic and geomorphic information. Stratigraphically Mahanadi river system emerged during mio-pliocene to recent. During the upper Pleistocene – Holocene period extensive deltaic sedimentation from Mahanadi river system led to the development of the modern Mahanadi delta. The morphology of Mahanadi catchment and delta was structurally controlled by horsts and grabens in Orissa. With the separation of continents during the Cretaceous, the East Coast Basin was formed and the Gondwana graben was faulted along the east coast lineament and down thrown into the East Coast Basin. The major geomorphic features evolved in this landscape are irregular highlands and peneplains. Pneplains are flanked by NNE – SSW trending structural hills, followed by low lying coastal depression on the east. A valley zone has been located between the structural hills on NNE and SSW representing a Mahanadi graben. The minor paleogeomorphic features identified include paleochannels, paleo-beach ridges, paleo-lakes, paleo-river mouths and paleo-tidal features such as flats, creeks. The significant observation of the study reveals that the coastline regression started during Pleistocene (25kms) followed by transgression (5 kms) till Late-Up-Pleistocene. During the end of Pleistocene the regression was found to be vigorous to the extent of 10kms away from the present shoreline. This aggressive regression was followed by a period of slow transgression till early Holocene. The present shoreline is the result of regression from the early Holocene period.

Modern Pollen-Vegetation Relationship as an Adjunct in the Interpretation of Fossil Pollen Records in Chilika Lake, India

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In the present investigation an attempt has been made to evaluate modern pollen-vegetation relationship using pollen proxy in the surface sediments of Chilka Lake, Orissa. The ecosystem of Chilka has remained unique throughout its existence and the pollen data generated from the analysis of surface sediments could be used for the interpretation of the pollen diagrams in terms of past vegetation and climate from the Chilka Lake. Fifty two surface samples which included mud, soil and water samples, were collected from in and around Chilka Lake. The palynological investigations exhibited the dominance of either hinterland or ubiquitous pollen taxa almost in all the samples. The pollen spectra reflected the local and nearby vegetation in a consistent way. On the contrary, in a few cases, actual composition of vegetation was not reflected in pollen spectra either owing to their low pollen productivity or strong tendency towards entomophily. Mangrove pollen grains were very scantily registered in pollen spectra as they are either absent or represent degraded form in present vegetation scenario. However, good representation of grasses showed a more or less close coherence with their actual composition in the present vegetation cover. The abundance of both monolete and trilete spores indicated humid climatic condition. The anthropogenic activity is not especially evident because an investigated area is relatively far away from the main population centre and dry saline zones are used only as pasture areas for cattle.

Thus, the data related to interplay of pollen and vegetation broaden the understanding of the modern relationship among pollen and vegetation and helps in tracing the past climatic changes and vegetation succession in and around the study area and in ascertaining various climatic cycles involved as controlling factors in the past.

Session 3 : Human Perspectives

Chairman : **Colin Woodroffe**

Rapporteur : **Paul Liu**

14:00 - 14:30

Annie George

Participatory Irrigation Management in the Tail-End Region (TER) in the Cauvery delta

14:30 - 14:50

Ahana Lakshmi

Vulnerabilities Analysis of Agrarian and Fisheries Sector in Cauvery Delta

14:50 - 15:10

Saudamini Das

Role of Mangroves in Identifying the Vulnerable Hotspots of a Vulnerable Area: Measuring the Relative Vulnerability of Coastal Villages of Mahanadi Delta from Cyclone and Storm Surge risk

15:10 - 15:30

Sandeep Saxena

Community Participation in the Management of Cyclone in the Delta region, Cuddalore District, Tamil Nadu

16:00 - 16:15

Hema Achyuthan

Radiometric Dates and Sedimentation along the East Coast of Tamil Nadu: An archeological Perspective

16:15 - 16:30

Anupa Ghosh

Need for Paradigm Shift: Disaster Management to Adaptation Strategy - A Study Based on Evidence from Indian Sundarban

16:30 - 16:45

Elango, L

Groundwater Quality of Cauvery Deltaic Regions of Karaikal, Tamilnadu

Participatory Irrigation Management in the Tail-End Region (TER) in the Cauvery Delta

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The Cauvery delta in the south Indian state of Tamil Nadu spreads across four districts including Nagapattinam which was the worst affected district in Tamil Nadu in the 2004 Indian Ocean tsunami. Nagapattinam which lies in the tail end of the delta is traversed by 14 major river systems from which channels have been cut for irrigation. Paddy is the main crop of the district. The delta is known for floods and droughts in the same year as the water quantum released from the dam depends on inflow which depends on the South-West monsoon as well as release of dammed water in the upper reaches of the river by the neighbouring state of Karnataka. During the North-East monsoon period, floods are the norm especially because of the low lying areas in the district as well as the storm surges from the coast because of cyclones. A study on the status of the irrigation system structured around fourteen Tail-End Regulators was carried out in 2007. It was found that both drainage and irrigation channels were extensively damaged and this was a major cause of flooding and drought that the farming community faced. Taking into consideration the fact that it was not mere repairs of the defective agri-infrastructure created but long- term maintenance that would be a sustainable solution to the frequent flooding or droughts that the farming communities faced, a set of interventions were planned and executed as a "Participatory Agri- infrastructure maintenance" model including, both, the local panchayat and the actual users, as active participants in the model. This paper presents some of the challenges faced in terms of institutionalization of the process, the importance of social mobilization to ensure inclusive participation and the end result in attempts at disaster proofing agriculture in Nagapattinam district.

Vulnerabilities Analysis of Agrarian and Fisheries Sector in Cauvery Delta

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Nagapattinam is a coastal peninsular district in Tamil Nadu, surrounded by the Bay of Bengal in the east, Palk Strait in the South, Cuddalore district to the north and Thanjavur district to the west. Spread over a land area of 2715.83 sq km, the district was carved out of the composite Thanjavur district only in 1991. With a population of 1.5 million people, this is a narrow, long district with 187 kms of the eastern coastline and is at the tail-end of the Cauveri Delta.
Fourteen river systems run through this narrow district before draining out into the Bay of Bengal. With each of these river systems further divided and sub-divided into irrigation and drainage canals, this district is criss-crossed with surface water bodies. With a gradient of 0:20000, this flat district is prone to a range of hazards: floods, both meteorological and poor maintenance of the river systems, salination due to back- flow of sea water during high tides, cyclones due to the proximity of the coastline and even droughts, at times, caused due to lack of rain and closing off of the flow of life-giving water from the Mettur Dam. The major resource based livelihoods are agriculture and fisheries.

This Study is an attempt understanding the differential impacts of such calamities on the farming and fishing communities and their coping mechanisms in the coastal villages of Nagapattinam. Five villages (two each where the dominant livelihood was agriculture or fisheries, and one where other livelihoods were also represented) were studied using structured questionnaires, focus group discussions and interviews with key informants. A map of the seasonal variation in the vulnerability patterns of the farming and fishing communities was developed. The importance of safe credit systems, the role of cooperative societies and the advantages of community led interventions were brought out as important components in reducing vulnerability of these communities.

Bedroc, formerly the NGO Coordination and Resource Centre (NCRC), set up as a platform for post- tsunami rehabilitation efforts in Nagapattinam, has been working on reducing vulnerabilities and improving livelihood security of the farming communities since 2008. TRINet, The Resource and Information Network, has been involved in information collection and dissemination on coastal issues since 2005.

Role of Mangroves in Identifying the Vulnerable Hotspots of a Vulnerable Area: Measuring the Relative Vulnerability of Coastal Villages of Mahanadi Delta from Cyclone and Storm Surge Risk

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The coastal regions of India face a maximum threat from tropical cyclones as these areas are situated at the coast of one of the core areas of cyclogenesis, namely, the Bay of Bengal. Studies on vulnerability indexing of these areas to cyclone and storm surge risks have identified Kendrapada district of east coast to be either the most vulnerable (Patwardhan et al., 2003; Sharma and Patawardhan, 2007) or the second most vulnerable district (Jayanthi, 1998; Kavi Kumar, 2003) of the country. We study the 262 villages of the Mahanadi delta lying within a 10 km distance from the coast of the Kendrapada district and compare the relative vulnerability of these villages by estimating the village wise probability of facing human fatality due to severe storms. We calculate such probability from a cyclone impact (human deaths) function where a wide range of factors including natural ecosystems like presence of mangrove forest are used to control for the exposure and adaptive capacity of the villages. Villages established after clearing the forest in mangrove habitat areas and those with more marginal workers are found to face a very high death risk and thus, need complete evacuation before a high intensity cyclone. In contrast, villages situated in the leeward side of existing mangrove forest or near a major river are seen to be facing a much lower risk of deaths. The results have important implications for conservation of mangrove forests in cyclone prone areas and also in the design of development policies for villages established in the mangrove habitat. Moreover, during cyclones, evacuation, rescue and rehabilitation works are undertaken at the village level and the study, by identifying the relative vulnerability of the villages, help the policy maker in prioritizing the rescue and relief works during a calamity like cyclone or tsunami.

Key Words: Coastal vulnerability, Human mortality, Mangrove forests, Mangrove habitat, Orissa, Super cyclone

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Community Participation in the Management of Cyclone in the Delta Region, Cuddalore District, Tamilnadu

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The only certainty about a natural hazard is that it is always uncertain in its location, time of occurrence and magnitude. Natural hazards cannot be totally avoided; however, its adverse impact on the humanity certainly can be minimized by pursuing an appropriate hazard reduction strategy. While it is the prime duty of the administration to take all necessary steps to evolve a suitable disaster risk reduction plan for each of the expected major hazards the local Community is exposed to, full involvement of community in all the phases of the disaster management, from planning to long term mitigatory measures to immediate relief & rescue to rehabilitation is most desirable for a disaster management plan to be efficient, effective and successful.

Cuddalore district is located on the eastern coast of India in the state of Tamil Nadu, about 175 kms south of the capital city of Chennai. The district is vulnerable to cyclones and flooding of rivers during the N-E monsoon period every year. It is also second worst affected district during Tsunami during December 2004. A major cyclone in Bay of Bengal with wind speed of 160 KMPH hit the coast near the town of Parangipettai (Port Novo) on 26th November 1999 which caused extensive damages in the Coastal villages of Cuddalore and Nagapattinam districts. The Disaster was handled before, during and immediately after the disaster in a planned way with full and active participation and involvement of local community and Panchayat Raj Institutions (PRIs). Though more than 50000 big and small trees were uprooted and fallen on various roads including highways and railway tracks, all major roads were cleared in little over 24 hours of weakening of the cyclone while restoration of rail link by the railways authorities took much longer.

This study attempts to bring forth some of the practical learning about community involvement in Hazard Risk reduction planning and management, which would be very useful in developing an effective participatory disaster management plan.

Radiometric Dates and Sedimentation along the East Coast of Tamil Nadu: An Archeological Perspective

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The East coast of Tamil Nadu is linear and low slopping towards the East. Several rivers drain along this coast. In this study radiometric dating of corals, tidal zones and estuaries and delta peat are presented to understand the process of sedimentation. The age of these corals dated by U/Th and radiocarbon method range in age from >40 ka to 1 ka while the radiocarbon dates of the delta and estuaries range in age from 10 Ka to 0.8 ka BP. Based on dates, occurrence of archaeological sites from middle Paleolithic to megalithic sites indicates that the coast was occupied and inhabited. Since the late Pleistocene period the sea level fluctuated with the present sea level occupying its current position around 3 ka. Aggradation of sediments, river incision and neotectonics formed paleovalleys as result of the dropping sea level. This provided sediment source for the progradation of the coastline. In this paper delta sedimentation process has been discussed.

Need for Paradigm Shift: Disaster Management to Adaptation Strategy - A Study based on Evidence from Indian Sundarban

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Climate science predicts that persistent global warming will increase the probability of coastal flooding throughout the world. Particularly vulnerable are the densely populated deltaic zones in Asia where coastal protection systems are yet underdeveloped (IPCC 2007). The Sunderban is the world's largest single block of halophytic mangrove forest located in the Ganga-Bramhaputra-Meghna delta of India and Bangladesh. Climate change induced sea level change is endangering the existence of this mangrove forest by aggravating the existing threat of coastal flooding and inundation in Indian Sundarbans. On the Indian side, two islands - Lohachara and Suparibhanga, have already been submerged, while other islands like Ghoramara and Sagar Island are gradually losing land to coastal erosion. The submergence of the islands has resulted in large scale migration to the Sagar Island which is itself a vulnerable zone. In the Sagar Island therefore, the adverse impacts of coastal erosion is being compounded by the demographic pressures through relocation as relief or disaster management strategy. At stake are human lives, livelihood options that are mostly agriculture and forest dependent, food security, economic development and local biodiversity.

The objective of this paper is to argue, based on evidences and analysis of specific vulnerabilities to coastal flooding, that current practice of disaster management many a times enhance the probability of maladaptation. Predictions under the climate change scenario are challenging the existing developmental and extreme event management strategies. We argue in this paper that disaster management strategies alone will fail to address the threats from climate change. Adaptation strategy that builds resilience needs a paradigm shift in financial allocation and budgeting. Shift from maintenance expenditure, relief based financial flow to capital investment in current period to reduce damage cost in future need to drive the decision makers. We use the LIFE approach as the operational rule for sustainable development and derive adaptation cost curve based on responses from household surveys in the Sagar Island. The future of sustainable development in the region lies in the mainstreaming of climate change issues in traditional development policies. Conventional development policies are based on the theory of economic cost minimization that does not necessarily ensure environmental impact cost minimization, thereby leading to maladaptation. To sustain development benefits in the long run, climate risk minimization strategy can be the basis for current developmental plans. Our study shows that a resilience enhancing strategy can be the damage risk minimizing path which is not necessarily the economic development strategy of cost minimization. Adaptation strategy calls for reprioritization of developmental action and mobilization of resources beyond the standard source of developmental finance. It is therefore imperative to design least cost adaptation paths that are also damage risk minimization paths that guarantee sustainable development.

Groundwater Quality of Cauveri Deltaic Regions of Karaikal, Tamil Nadu

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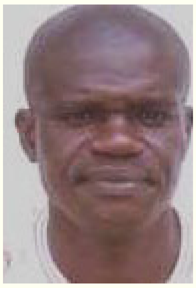
Groundwater quality is studied by systematic collection and analysis of samples, thus enabling us to properly manage the resources. The present work was carried out with the objective of assessing the groundwater quality in the Cauveri deltaic regions around Karaikal, Thiruvarur and Nannilam. In Cauveri river basin, the stretch from Karaikal to Thanjavur district is intensively cultivated and groundwater is the major source for irrigation. About 45 groundwater samples were collected from this area from the month of September 2006 to September 2009 and were analysed for EC, pH, TDS, Na, K, Ca, Mg, CO3, HCO3, Cl and SO4. The pH of all the water samples was around 7 and occasionally alkaline. In about 32 wells, the recommended limits for drinking water quality standard have exceeded in one or more of the other parameters. In general, the groundwater of this area is suitable for irrigation. However, there are few places where the water is not suitable for irrigation. This study reveals that the agriculture activities, geological formation and local environmental conditions control the groundwater quality. Thus, this work has given an insight into groundwater quality in a part of the Cauveri Delta.

Climate Change, Impacts and Consequences on Nigerian Coastal Area



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The impacts and consequences of climate change is a major concern to many countries in the world. The WMO Secretary General in 1977 noted that climate shapes our cultures, many of our settlements and all our landscape. Sea level rise would increase erosion and flooding along coastlines, threatening many cities. In Africa more than one quarter of the population live within 100km of the sea coast rendering a great number of people vulnerable to rise in sea level as a result of climate change. Rise in sea level would cause inundation along more than 70% of the Nigerian coastline placing land at risk many kilometer inland (Awosikaet.al. 1992). This paper examines climate change, its impacts and consequences in Nigeria generally and the coastal Area as a case study. Statistical analysis of temperature and rainfall in six major coastal cities for 25 and 50 years respectively, were made. The study reveals increase in temperature confirming global warming in coastal area of Nigeria. Decline in rainfall in most parts of the coastal area were revealed. Nigerian Coastal Area with its high population density and heavy economic activities faces the challenges and consequences of climate change ranging from storm surges, flooding, soil erosion, salination of surface and sub-surface water, toxic gas release, drought, health problems, etc.

Effects of Winds on Nigerian Ports and Harbours

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This work aims at identifying the pattern of wind in Nigerian coast and its effects on ports and harbour operations. The wind speed, wind direction and wind duration were graphically analysed. Their effects on near – shore ocean whose driven mechanism is mainly the local wind conditions were discussed and the associated weather phenomena highlighted. Statistical analysis was used to investigate into the nature and characteristic of the coastal winds for the period of ten years, 1997 – 2006. This was carried out on monthly basis, using data from Victoria Island, Lagos. The analysis revealed that winds were predominantly from WSW and WNW directions. Winds from fetch area (lat. 10°S – 20°S and long 10°E - 20°W) generally increase from East to West with their strength lying between 6-20kts. This agrees with previous works carried out by other scientist e.gAfiesimama et al (2001). For the period of study, the weakest winds were observed between Oct – Jan while the strongest winds were mostly observed during summer period especially in the month of August which coincide with the period of little dry season. There were no major interruptions of ports and harbours operation as a result of direct adverse wind flow. Ports and harbour installations, engineering works, shipping operations, etc however faced the risk of being damaged during summer period, if not well protected. Some wind related meteorological factors such as storm surges, fog, thunderstorms etc generally disrupt coastal activities including those of ports and harbours.

Climigration and Lake Chad

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The hydrological basin of lake Chad is shared between Algeria, Cameroon, Central Africa Republic, Chad, Niger, Nigeria, Sudan and some extend Libya. In the last four decades, the hydrological regimes of lake Chad has changed. The changes apparently reduced the water supply security for the population and economy (fishery and food production) in the Chad basin. The decline in the lake level is attributed to reduced rainfall (as result of the recent climate change) and Droughts. The research paper concludes that there is teleconnection between climigration in Nigeria and Lake Chad. This is evidence because climate change in Nigeria is having a very real impact and needs urgent attention especially in internal displacement of its people and one of the easiest ways of adapting to climate variability in Nigeria is internal migration.

Mega Dam Initiative in the Tsangpo-Brahmaputra Basin: Modified Sediment Flux and Future Vulnerability of the GBM Delta

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With almost 3000-km length and up to 1000-km width, the Bengal Fan is the largest fan system in the world (Curray and Moore, 1971) and forms the northeastern part of the Indian Ocean. Bearing a similar origin to the mud – rich fans like the Amazon, Nile, Mississippi and Indus, the Bengal Delta Fan have been formed by long term input of riverine sediments (Weber, 2003), of which the rate of supply of sediments by the Ganga and the Brahmaputra Rivers is the highest of any rivers (Kolla and Coumes, 1984). The sediment deposits on both shelf and slope have been modulated by glacio-eustatic sea-level fluctuations, climatic change, and tectonic activity (Flood et al, 1995). The enormous amounts of sediments discharged by the Ganga- Brahmaputra River systems are distributed into major depositional areas on the shelf and the Swatch of no Ground, through tide and storm driven processes (Michels et al, 2003). The GMB delta plain represents one of the geologically youngest and tectonically active drainage basins of the world (Morgan and McIntire, 1959; Coleman, 1969; Valdiya, 1984) and also includes the second largest delta in the world (Coleman, 1981), the Bengal delta. The delta lies at the confluence of the world's largest GBM sediment dispersal system (Kuehl and others 1989) and has come into existence due to the depositional activities of the Ganges, Brahmaputra and the Meghna. The GBM river systems are the main conduit carrying the terrigeneous sediments into the Bay of Bengal and contribute in the delta formation.

Out of the several different factors of water diversion, consumptive losses, mining, canal and levee construction (Day et al., 1995) contributing to the decrease in the sediment load to the GBM delta, reservoir construction both by China and India in the Tsangpo-Brahmaputra basin has emerged as one of the major factors. Reservoirs tend to decrease sediment delivery downstream through damping of peak flows, fragmentation of river channels and also reservoir siltation (Ericson et al, 2006). It has been estimated that 25–30% of the total global suspended sediment flux is intercepted by the population of approximately 45,000 reservoirs (with dams > 15 m high) (Vörösmarty et al., 2003 and Syvitski et al., 2005). With a large number of reservoirs underway to tap more than 50,000 MW power potential of the Brahmaputra system, potential alteration in the amount of sediment load carried to the delta system is posing severe threat to the GBM delta.

In the light of Brahmaputra-Ganges system currently carrying a colossal load (including 6.24x106 tons C/year, 8.5x105 tons N/year, 8.4x104 tons P/year as calculated in the present study) to the GBM delta, uncertainty about future effect on ecological and biogeochemical processes in the delta region is increasing. The magnitude and direction of impact could be significant both in relative and absolute terms. The future state of the delta may be impacted significantly by the modified flux since its role in evolution of the delta could be critical. An estimate of the modified flux has been attempted in the paper. Co-ordination between the countries sharing the GBM river system will be of utmost importance to address the issue. Although some cooperative arrangements exist between Bangladesh and India, other countries of the GBM basins – China, Nepal and Bhutan should be part of a comprehensive regional sediment management plan to address this grave problem

Reusing Agricultural Drainage Water in the Nile Delta of Egypt: A Tool for Sustainability or Source of Environmental Stress – A Case Study from El-Salam Canal Project

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As many countries in the Middle East and North Africa (MENA), water is scarce in Egypt. The limited water resources, high rate of population growth and improved standards of living cause a continuous declination for the per capita share of fresh water in the country.
With the conventional irrigation methods used in most of the Nile Delta regions, the available water is insufficient to irrigate enough land in order to achieve a reasonable level of food security. Therefore, agriculture drainage water reuse in irrigation became an official policy since the mid 1970's to reduce the gab between water supply and demand.
In the Nile Delta, the drainage system is composed of 22 catchment areas. Depending on their quality, effluents are either discharged into the Northern Lakes or pumped into irrigation canals at 21 locations along the main drains to augment freshwater supplies.
However, the drainage water reuse requires a great care especially for the long run effects on the physical and chemical soil properties, on crop yields and on the environment in general.
Today, intensified industrial and agricultural activities cause water pollution to spread rapidly throughout Egypt, especially in the Nile Delta. Huge amounts of municipal and industrial effluents as well as farm and rural domestic wastes are discharged into agricultural drains without treatment causing a serious threat of the reuse practice.
The main objectives of this article are to assess the drainage water availability for agricultural reuse in the Nile Delta region and investigate the variability of some quality parameters with time.
The possible environmental hazards that are connected to the reuse practice are also investigated employing historical water quantity and quality data from some Nile Delta drains (Hadus, Lower Serw and Farsqur drains) that feed the El-Salam Canal Project. This canal has been initiated since the late 1980s to divert 2 billion m^3/y of drainage water from Hadus and Lower Serw drain basin to reclaim and irrigate 78,000 ha west of Suez Canal and 170,000 ha in Sinai.

Keywords: Drainage Water Reuse; Water Quality Monitoring; Water Pollution; Environmental Hazards

The Development and Changes of Coastal Morphological Landscapes of Ganges-Brahmaputra Delta in Bangladesh

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The Ganges delta is one of the largest deltas in the world and occupies the lower part of the Bengal Basin of the South Asian region of Bengal. The delta has come into existence by the depositional activities of the three mighty rivers of the region, the Ganges, the Brahmaputra and the Meghna. This delta is a tract of vast alluvial flat roughly resembling the Greek letter 'Δ' (Delta) and commences at the off-take of the Bhagirathi near Gaur ofMalda district in West Bengal, India. The alluvial land has been developed at the southern portion of the Bengal Basin by the combined depositional activities of the Ganges, its various distributaries and the other large and small streams of the region. The Ganges-Brahmaputra (GB) delta is situated just above the Bay of Bengal with its major portion occupied by Bangladesh. The Ganges Delta comprise part of the districts of Kushtia, Jessore, Khulna, Rajshahi, Pabna, Faridpur, Barisal, Patuakhali, Nowakhali and Dhaka of Bangladesh and major portion of West Bengal of India. The Sundarbans is one the productive tidal mangrove wetland ecosystem is situated in Ganges-Brahmaputra (GB) delta. The silt deposits of the delta cover an area of about 80,000 km^2. The delta is about 360 km wide along the Bay of Bengal. The river courses in the delta are broad and active, carrying a vast amount of water and sediments (2.3 million tons). The Ganges-Brahmaputra (GB) deltaic morphology of the southern region of Bangladesh is characterized by its funnel shaped vast network of rivers, strong tidal and wind action and enormous river discharge laden with bed and suspended sediments. The deltaic coastal landscapes of Ganges mouth area is undergoing rapid hydro-morphological and ecological changes due to natural geomorphic process and human influences on the landscapes (fig. 1). The landscapes of the deltaic region is encompasses strong aesthetic, cultural, biological and geological values. The coastal landscape erosion and depositional action has been shown in figure 1. The study has been conducted based on primary and secondary data sources. The time series image analysis has been done to characterize the landscapes changing behavior in the Ganges delta for the last 400 years. The objective of this paper is to understand the development and changing behavior of coastal landscapes and threatened ecosystems in the Ganges delta in Bangladesh. The findings of this study could contribute in making a national management plan for protection of coastal morphological landscapes and its ecosystems in the Ganges delta in Bangladesh.

Key words:Ganges-Brahmaputra delta, Coastal landscapes, Changes, Development and Ecosystems.

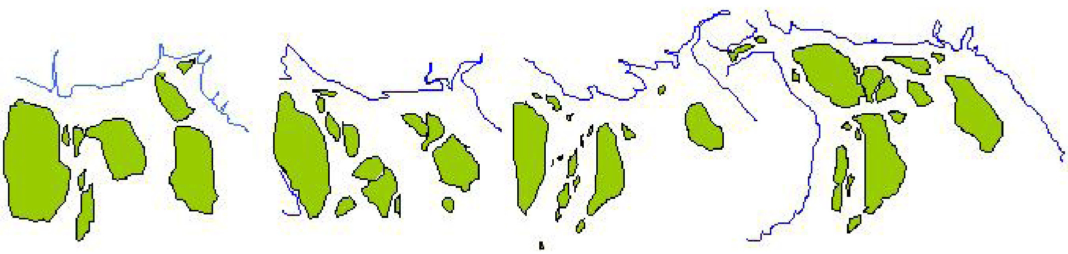

Figure 1 Morphological landscapes changing pattern in Ganges mouth (1780-2009).

GIS based Marine Pollution Studies In The Coast of Calicut, Kerala.

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Coastal environments of India are under immense stress due to discharge and disposal of domestic and industrial wastes from point and nonpoint sources as a result of rapid growth of population and economic activities. The main causes for marine pollution are population growth, urbanization and industrialization. Marine pollution includes a range of threats including land-based sources, oil spills, untreated sewage, heavy siltation, eutrophication (nutrient enrichment), invasive species, heavy metals from mine tailings and other sources resulting in the destruction of coastal and marine habitats. A check on the health of our coastal waters is an urgent need and any time delay may induce irreversible effects. Keeping this in view, a study has been attempted to assess the pollution of Calicut coastal waters. A time series analysis of the significant water quality parameters such as Dissolved Oxygen, Biological Oxygen demand, Suspended sediment concentration, chlorophyll-a, total nitrogen and total phosphorous have been attempted using Ocean Data View. The results were compared with land use changes between 1990 to 2000 and trends of pollutant concentration observed from 1991 to 2008. Secondary data of Calicut has been collected in the form of Driver Pressure State Impact Response (DPSIR). This helps in comparing the results obtained to find out possible threats and pressure over the coastal ecosystem of Calicut.

Rapid Assessment of Water Quality and Faunal Diversity in the Harbour Area of Vishakhapatnam Port, South India

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A study of water quality parameters such as dissolved nutrients (NH_4^+, NO_3^-, NO_2^- and PO_4^-), biochemical oxygen demand (BOD), dissolved oxygen (DO), Chlorophyll a and benthic macro invertebrates was carried out in 20 locations during summer 2009 in order to assess the ecological impact of pollution loading in the harbour area of Vishakhapatnam port, South India. pH and Conductivity showed a decrease towards the inner harbour and salinity showed a sudden drop in the inner harbour area. Dissolved nutrients concentrations were observed to be high in the inner harbour area due to input of domestic sewage from a canal and disposal of floor washing and dispersion from the inner berths which mainly consists of fertilizers which leads to oxygen stress in the water column. In the present study, Shannon-Weiner index were used to measure the diversity of plankton in the water column which indicate deterioration of water quality towards inner harbour area. The most dominant macrobenthic taxa collected were Polychaetes and Bivalves which contributing 28% and 18% respectively and the meiobenthic community dominated by Nematodes (14%), Polychaetes (13%) and Archiannelids (12%). Statistical analysis of the data showed a trend toward gradual pollution in the water column and a peak was observed in the inner harbour due to domestic wastewater discharge and dispersion from cargo handling such as fertilizers and coal.

Key words: Vishakhapatnam, harbour, water quality, benthos, domestic sewage and fertlizer

GIS based Marine Pollution Studies for the Coast of Mangalore, Karnataka

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The ocean plays an important role as a resource for humans on the coastal zones. Marine pollution causes degradation of the natural quality of the coastal environments and affects the health and survival all forms of life including human beings. The main causes for marine pollution are population growth, urbanization and industralisation. Marine pollution includes a range of threats including land-based sources, oil spills, untreated sewage, heavy siltation, eutrophication (nutrient enrichment), invasive species, heavy metals from mine tailings and other sources resulting in the destruction of coastal and marine habitats. A check on the health of our coastal waters is an urgent need and any time delay may induce irreversible effects. Keeping this insight, a study has been attempted to assess the pollution of Mangalore coastal waters. A time series analysis of the significant water quality parameters such as Dissolved Oxygen, Biological Oxygen demand, Suspended sediment concentration, chlorophyll-a, total nitrogen and total phosphorous have been attempted using Ocean Data View. The results were compared with land use changes and trends of pollutant concentration across time scale. Further, secondary details of Mangalore in the form of Driver Pressure State Impact Response (DPSIR) has been collected and compared with the results to find out possible threats and pressure over the coastal ecosystem of Mangalore.