

## **HỢP TÁC SONG PHƯƠNG GIỮA ĐỨC VÀ VIỆT NAM TRONG LĨNH VỰC KHOA HỌC BIỂN**

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**TÓM TẮT** *Hiện tượng nước trôi và sự vận chuyển dinh dưỡng, trầm tích từ rừng ngập mặn tác động đến đới ven bờ Việt Nam. Các quá trình sẽ được nghiên cứu thông qua những chuyến khảo sát trên đất liền tại khu vực phục hồi rừng ngập mặn và những chuyến khảo sát trên biển để có cái nhìn tổng quan về tương tác giữa đất liền, đại dương và khí quyển vào các mùa khác nhau.*

## **THE BILATERAL COOPERATION BETWEEN GERMANY AND VIETNAM ON THE FIELD OF MARINE SCIENCE**

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**ABSTRACT** *Coastal upwelling and nutrient and sediment transports from the mangrove impact the coastal zone of South Vietnam. Processes will be jointly studied by land-based investigations in a rehabilitated mangrove area and sea-based investigations comprising cruises with RV Nghien Cuu Bien for a synoptical view of the land-ocean and atmospheric interaction zone at different seasons.*

### **I. INTRODUCTION**

With a focus on land-ocean-atmospheric interactions in the coastal zone of South Vietnam the project merges the efforts of five north German Research Institutes in Bremen (Center for Tropical Marine Ecology, Bremen), Hamburg (Institute for Marine Science; Institute for Biogeochemistry and Marine Chemistry; both Hamburg), Kiel (Institute for Geo-Sciences, University of Kiel) and Warnemunde (Institute for Baltic Research).

On the Vietnamese side, among

others, the following institutions are being involved: Vietnam National University, Department of Botany and Ecology (Ho Chi Minh City), Institute of Ecology and Bioresources (Hanoi), Vietnam National Center for Natural Science and Technology (Hanoi), Natural Science University (Ho Chi Minh City), Vietnam National University, Physical Oceanography (Ho Chi Minh City), Institute of Oceanography, Marine Hydro meteorological Center (Hanoi).

The area to be studied in the South China Sea (SCS) (Fig. 1) belongs

to the Sunda-Arafura Shelves Province as defined by Longhurst (1988). Basic processes to be encountered here are schematically depicted in Figure 2. The coastal zone and its deltas are mangrove dominated consisting of numerous patches of mono-species stands of different age and a remaining stock of still natural stands. Different or even opposite impact of rehabilitation actions on nutrient and sediment output can be expected and demands the integration of knowledge on the biota dynamics with the whole range of hydrological processes: including the river system, catchment level, and microhabitat and off-shore areas.

The rivers discharge high sediment loads to the shelf waters with possible alongshore and offshore transport of nutrients and consequences for the primary production and bottom structure. By reconstructing the coastal evolution during the Holocene, future impact of sea level changes can be predicted.

During the SW-monsoon period cold and nutrient-rich, high-salinity water is upwelled off southern Vietnam and advected northeastward. During the NE-monsoon low-temperature and saline Western Pacific surface water intrudes into the SCS being constantly modified and depleted in nutrients, moves counterclockwise along the continental slope to the southern coast of Vietnam; downward Ekman transport occurs off the coast, occasionally in association with stationary cold-core eddies.

The single most prominent signal in year-to-year climate variability is the El Niño-La Niña/Southern Oscillation (ENSO). In case of an El Niño (La Niña) event anomalously warm (cold) surface waters expand over the upwelling region and the entire South China Sea.

Nutrient input to temperate shelf seas is often dominated by river run-off whereas the large upwelling areas of the eastern boundary currents and the Arabian Sea are generally situated in arid climates with negligible river run-off. In contrast the SCS is seasonally fertilized by monsoon upwelling and in parallel receives an enormous river run-off due to heavy precipitation over the Indo-Pacific Archipelago.

The coastal zone will be impacted by both, the upwelling processes and the nutrient and sediment transport processes from the mangrove which will be linked by sea-based investigations with RV Nghien Cuu Bien for synoptical views of the land-ocean interaction during seasons with differing monsoon forcings.

To study the impact of climate variability and/or land use changes and biogeochemical gradients in a coastal zone in Southern Vietnam, which is bordered at its landside by mangroves and off shore by an up-welling system and oligotrophic oceanic conditions. In particular, the influence on sediment mobility, hydrology, nitrogen cycle dynamics, and water mass distribution will be investigated from the Can Gio mangrove reserve to the upwelling zone off SE central Vietnam, i.e. from fresh water to oceanic conditions and from

very shallow coastal environments over the shelf and continental margin to the adjacent deep sea basin of the South China Sea.

Following are the specific objective to be studied:

1. Natural mangrove stands and rehabilitated areas of different age and structure will be compared with regards to their sedimentology, nutrient and sediment output into the delta and their benthic community structure as indicator for system stability.

2. Mangrove impact on ecology, coastal evolution and shelf dynamics.

3. Functioning and distribution of pelagic production regimes including their particle exports in response to changes in nutrient availability and nitrogen sources in particular (rivers, upwelling, N-fixation).

4. Impact of ENSO events on the upwelling system on different time scales.

## **II. MANGROVE IMPACT ON THE COASTAL ZONE**

### ***+Organic matter and nutrients and forest structure***

Coastal outwelling of dissolved and particulate nutrients from mangrove swamps can affect considerably the biogeochemical cycles of coastal regions and has a recognizable effect on their food webs. However, the system forces driving material export or import, as well as the reasons for the eventual seasonal oscillation of these wetlands as sources or sinks of nutrients and organic matter are poorly known. Many

inconsistencies amongst published data may have resulted from methodological differences and from large and apparently random tidal-dependent oscillations. Furthermore, differences among the studied ecosystems such as tidal-range, inundation regimes, geomorphology, sediment chemistry or the structure of forest and benthos communities are possible reasons for apparent inconsistencies amongst different investigations, which have hitherto precluded a more integrated vision of these ecosystems.

The existence of monospecific mangrove stands of known ages in distinct topographic set-ups represent an exceptional study case for better delimiting the interactions among system components. Mangrove replantation at Can Gio District has been carried out using mainly one species, *Rhizophora apiculata* (FAO, 1993). The analysis of the vegetation structure will be a significant input of the Vietnamese colleagues. The influence of stand age of this species on benthic decomposition, recycling of organic matter and nutrient availability was studied by Alongi *et al.* (1998) in managed mangrove forests of Malaysia. Decomposition of sediment organic matter was examined in relation to forest age in 2-, 15- and 60-year old, managed *R. apiculata* stands. There were site differences in the dominance of specific diagenetic pathways. Rates of sulfate reduction, solute efflux across the sediment-water interface and vertical profiles of dissolved Mn, nitrate and nitrite suggest that manganese reduction and

denitrification-nitrification, coupled with aerobic respiration, account for most oxidation of organic matter at the 2-year old forest. A shift to proportionally less sulfate reduction in sediments of regenerating forests may result in greater availability of dissolved nutrients and some trace metals, and serve to reduce exposure of *R. apiculata* seedlings to anoxic, toxic solutes (e.g. sulfides). This diagenetic shift may facilitate rapid seedling growth and regeneration of forests.

Thus, investigations on nutrient and organic matter dynamics in mangroves require tight linkages to the work proposed in the other subprojects of Focus Point 1. Further, it seems essential to perform an accurate quantification of the extent and frequency of surface inundation as a function of tidal level and regime, as well as their influence on mobilization or retention of nutrients.

The results of this working group will be the input for the study on coastal processes, coordinated by Prof. V. Bodungen.

#### **+Sedimentation processes**

The nature of the material transported to the coastal environment is controlled by the landscape, the interaction between hydrodynamics, particles and the biogeochemical processes taking place at the land-sea interface as well as at the freshwater-seawater interface. Such external processes are responsible for the maintenance and renewing of mangroves. However, there is still a significant lack of well-established quantified relationships between

hydrodynamics, mangrove forests and sediment -erosion, -accumulation, -re-deposition and -turnover.

Changes in the mangrove belt have a tremendous influence on the sediment mobility. A well working mangrove environment keeps mobile material (suspension load, bed load) in the estuarine/deltaic systems while the destruction of mangroves releases huge amounts of sediment to the offshore area. The aim of the proposed studies is to record the up to now poorly known influence of clearing and reforestation of mangroves to changes in coastline development. A surplus or a limitation of sediment will lead to either a retreating or prograding coastline. The final goal is to elaborate a sediment budget for selected key areas and to get a better understanding of the coastal evolution in longer time scales.

The hypotheses for the proposed studies are:

1. A destruction of mangroves leads to an increase of sediment-loss and to a destabilization of the coastline;
2. Rehabilitated mangrove forests trap sediments;
3. Monoculture mangrove forest cohorts and natural forests differ in their influence on hydrodynamics and sedimentological and geomorphological development.

The results will be used by the affiliated subprojects to answer the question on the fate of sediments in a mangrove dominated land-ocean interaction zone in South Vietnam.

#### **+Benthos community structure**

Mangrove rehabilitation has changed the soil's properties thanks to

the sediment formed by litter fall with the help of large quantities of fine, fibrous root matter. These muds have the highest concentration of organic carbon and nitrogen (Alongi & Christoffersen, 1992) This has directly influenced the distribution of benthos. Hong *et al.* (1996) and Nhung (2000) have carried out first studies on benthos communities in the area of Can Gio mangrove forest however, without taking into consideration forest structure (rehabilitated vs. natural forest) and age.

The study will contribute to the discussion to what extent rehabilitated mangroves are comparable to natural sites.

#### **+ Coastal processes**

Pelagic processes and biogeochemical fluxes

With a focus on pelagic processes and biogeochemical fluxes including nitrogen dynamics the project on coastal processes by Institute für Ostseeforschung (IOW) addresses five interlinked objectives, all work for which will be carried out in the area outlined in Figure 1, which is located between the coastal mangrove belt and the upwelling system. The projects links coastal/shelf pelagic processes with those at the continental margin and over the adjacent deep-sea basin. Pelagic systems relying on 3 different nutrient sources (riverine input, upwelling and atmospheric nitrogen fixation) will be investigated as to the relative importance of these nutrient sources, as to the fate of produced matter in terms of export or remineralisation, and as to changes in

their spatial and temporal distribution. The work will be done primarily in co-operation with proposals on ocean physics with a focus on upwelling dynamics (Dr. Pohlmann, Hamburg University) and on geochemical fluxes as measured by annually moored sediment traps at the continental margin (Dr. Wiesner, Hamburg University). Sediments and sedimentary nutrient sources in shallow waters and riverine exports as well as finger prints of pelagic system exports in surface sediments will be followed in co-operation with proposals by Prof. Saint-Paul *et al.* (Center for Tropical Marine Ecology, Bremen), Dr. Schwarzer (Institute for Geosciences, Kiel University) and Prof. Stattegger *et al.* (Institute for Geosciences, Kiel University). A joint working programme is planned with partners from Nha Trang Institute of Oceanography and also with Hai Phong Institute of Oceanology, Vietnam, whose contributions include assessments of plankton and nutrient distributions, work on historical data sets and who will co-operate in the field of satellite oceanography.

In detail, the following topics will be addressed:

- Pelagic system and particle export variability
- Nitrogen sources for production and export
- Spatial distribution of pelagic system properties
- Participation in analyses of annual flux time-series
- Screening and merging of historical data

### **+Holocene**

Within the focus area 2 of the proposal on holocene coastal evolution, sea-level fluctuations, terrigenous sedimentation and sediment dynamics on the continental shelf investigations on the reconstruction of the coastal evolution in SE-Vietnam during the Holocene period are planned. Main tasks are:

1. Recording and analyzing major sediment-bodies and sediment surfaces to reveal,
2. Depositional patterns and stratigraphic architecture,
3. The principal hydrodynamic and sediment-dynamic processes in the coastal and shelf zone,
4. Evaluating and balancing the terrigenous sediment input, and
5. Investigating the magnitude and influence of short and longer term sea-level fluctuations and coastline migration.

The results are expected to provide principal knowledge of the geologic history and evolution of the SE-Vietnamese coastal zone over the last 10,000 years. In addition, these results should support planning strategies for integrated coastal zone management with respect to sustainable development. Reference should be given to competing interests between potential users of the coastal zone e.g. tourism, fisheries, exploitation of mineral resources.

### **+Impact of ENSO events**

The single most prominent signal in year-to-year climate variability is the El La-La Nina/Southern Oscillation (ENSO). The El NiNo (La Nina) mode

manifests itself in a quasiperiodic warming (cooling) of the surface waters in the eastern and central equatorial Pacific forcing an eastward (westward) displacement of the Western Pacific Convection Zone. To protect natural ecosystems and economies against ENSO-related hazards, intergovernmental agencies have in recent years promoted research programs in El Nino/La Nina prediction and on-land impacts. However, ecological damage is expected to be severe in the Vietnamese sector of the SCS, because there the amplitude of ENSO-induced perturbations of the seasonally reversing Southeast Asian monsoon system is at its maximum, and it is this system that accounts for the high fertility of that region.

The major scientific goal is to assess, qualitatively and quantitatively, the effects of short and long-term variations in land-ocean-atmosphere interactions on the dynamics and efficiency of the upwelling region off Vietnam, with the following specific objectives:

- to monitor the fluxes of particulate matter under El NiNo, La Nina and ENSO-free conditions by means of high-resolution time-series sediment traps.
- to characterize and quantify the fluxes and composition of biogenic particulates, including phyto- and zooplankton communities and organic matter.
- to determine the contribution and sources of terrigenous particulates transported across-shelf into the upwelling zone.

- to characterize the link between monsoon strength, riverine input, ecosystem structure and downward biogeochemical fluxes.
- to identify and quantify ENSO-related biogeochemical anomalies.
- to test and calibrate (and/or establish) proxy indicators to assess the effect of the Holocene warming and superimposed periods of monsoon changes on the productivity of the region on the basis of high-resolution sediment cores.
- to combine the past and present-day scenarios to establish a process-response sedimentation model and predict future trends.

The results are expected to contribute to a better understanding of the possible consequences of global climate change in Southeast Asia and will assist in testing and tuning impact models of ocean ecosystem response to enhanced greenhouse conditions.

#### **+Upwelling**

The upwelling occurs along the entire coastal zone and continental shelf of Southern Central Vietnam. The centre, i.e., the strongest upwelling is observed in the coastal waters and the continental shelf of the Ninh Thuan to the northern the Binh Thuan provinces. Here the cold water from the deep-reaching Western Boundary Current is upwelled from a depth horizon of 125 m.

Due to the increased availability of nutrients, primary bio-productivity in the upwelling area is larger than in any other areas along the Vietnamese coast,

reaching maximum values between 200 and 300 gC (m<sup>-2</sup> y<sup>-1</sup>). Because of the extremely high primary productivity in this area, also elevated concentrations of plankton, benthos, and fish are found. Interestingly, the largest ecological effects are not found directly in the centre of the upwelling but in its southwest periphery, in the Ca Na-Phu Quy-Phan Thiet triangle.

In the coastal water of South Vietnam there are mainly two nutrient sources: Those coming from the upwelling and the other released by the mangroves. The impacts of the seasonally of the upwelling phenomenon on the bio-geo-chemical characteristics and of the ecological processes are far from being understood. In order to understand coastal processes, linked studies on all processes being involved have to be studied.

#### **+Overall goals**

The results are expected to contribute to basic knowledge of the ecological functioning and status of the SE-Vietnamese coastal zone. In addition, these results should support planning strategies for integrated coastal zone management with respect to sustainable development. Reference should be given to potential sea-level rise and to competing interests between different user-groups of the coastal zone e.g. tourism, fisheries, aquaculture, coastal protection.

The linkage between the three focal areas is only possible through the joint research vessel cruises.

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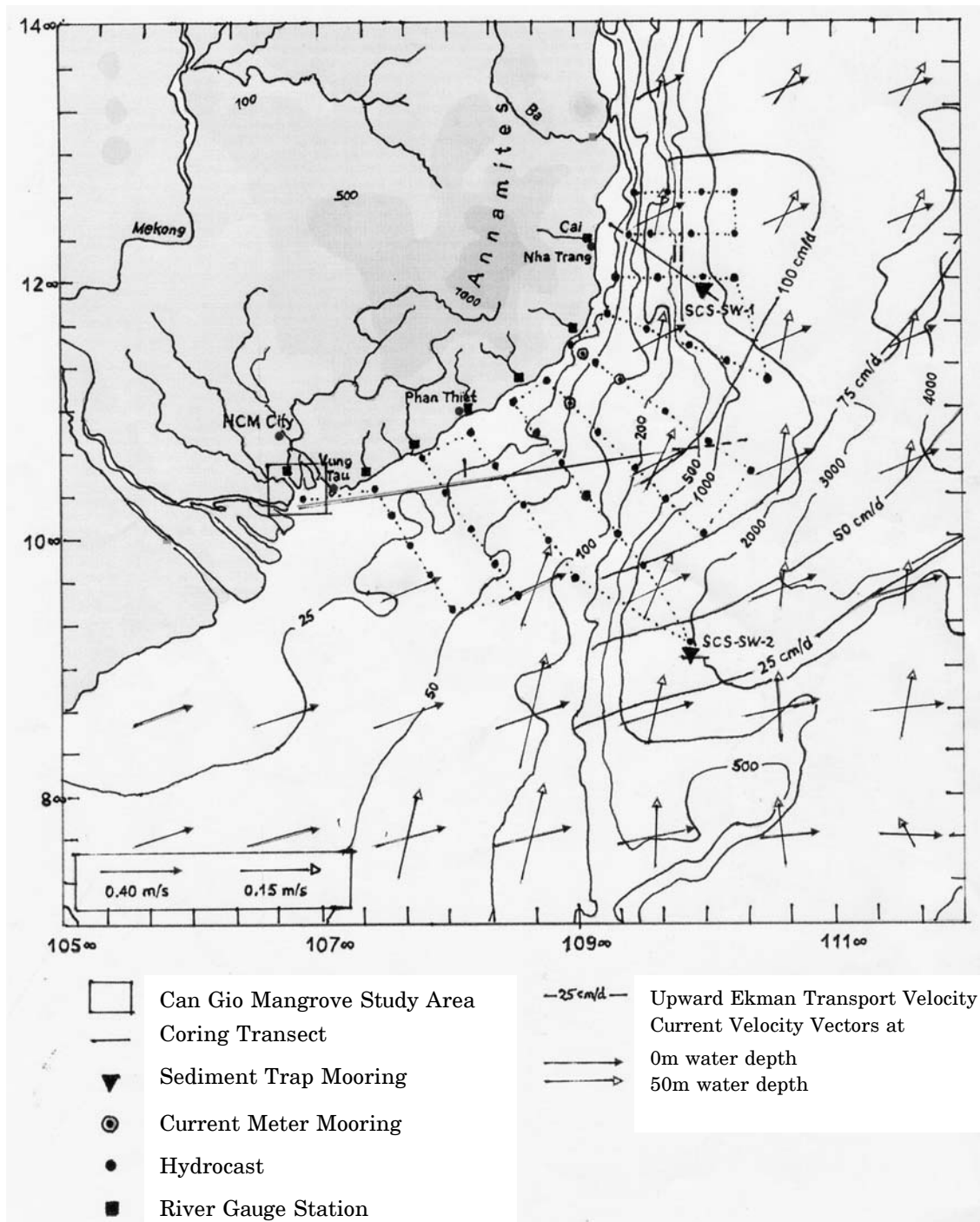


Fig. 1: Investigation site and cruise tracks; current regime during SW-Monsoon

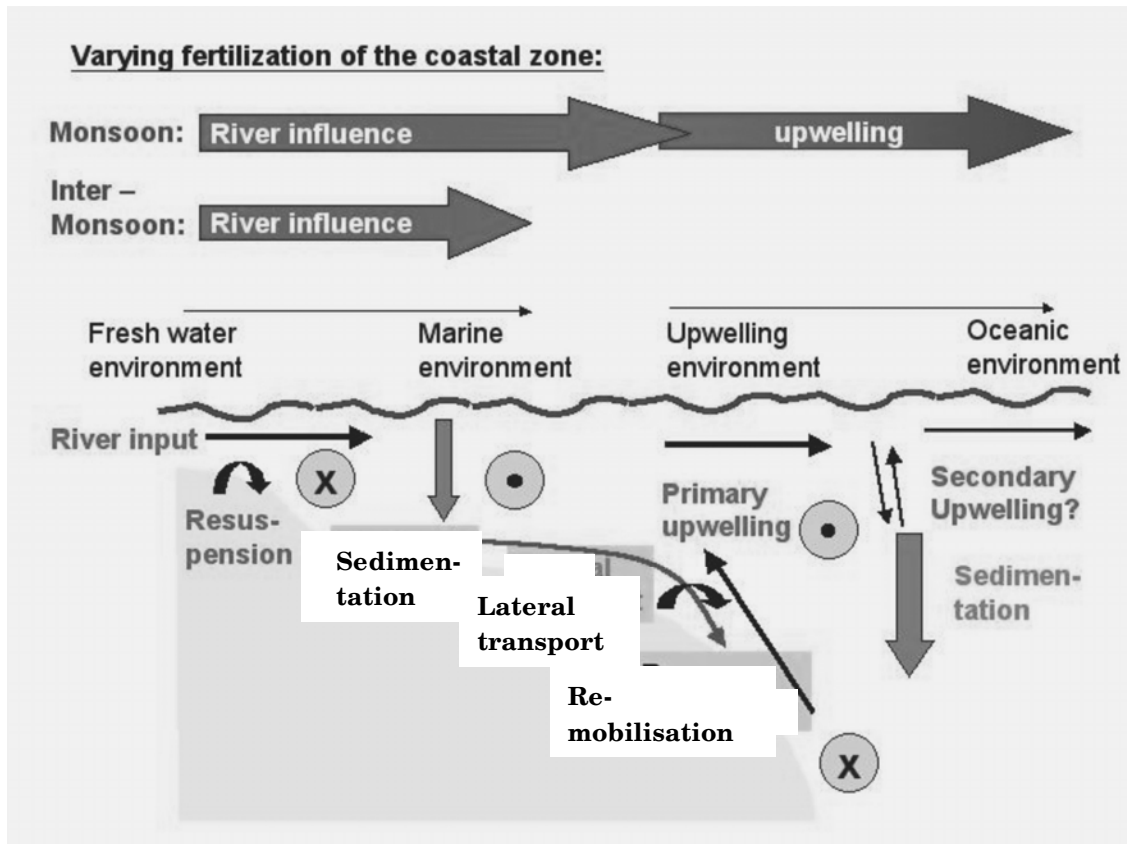


Fig. 2: Linkages between the three focal areas