B-12.3 Global warming effects and its prediction on mangrove forests

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Abstract This project aims to make a model of physical processes in mangrove forests and surrounding environment for evaluation of global warming effects. The environmental monitoring data for a dry-season and a rainy-season were corrected at Ranong biosphere reserve in Thailand. Water level, salinity, temperature, and suspended sediment in the creek and swamps were observed by oceanographic measurements. Forest structure was also plotted in detail at two points. Inundation time distribution in the swamps has close relation with forest structure pattern. Tidal propagation, wave attenuation, and salt transport were modeled numerically to test effect on mangrove forests by different SLR scenarios. Tides propagate more rapidly, wave attenuates more rapidly, and area of optimum salinity condition will be reduced under SLR scenarios.

Key Words Mangrove Ecosystem, Thai Coastal Zone, Impact Assessment, Sea Level Rise

1. Introduction

Total area of tropical rain forests in the world is said about 19.3 x 10^6 km^2 (13 % of total land surface), and total area of mangrove forests in the world is said 0.17 x 10^6 km^2 (0.9 % of total tropical rain forests). 27 % of mangrove forests are in Asia. In such a small area of mangrove forests are well developed and utilized by human activity, and now facing fare of diminishing. The human activity is not only directly affecting on mangrove habitats, but also causing in-direct effect on mangrove habitats like SLR (Kikuchi, 1995).

Mangrove forests is developing between MWL (mean water level) and HWL (high water level). Geological record reviled that mangrove habitats shift or stay according to the speed of SLR (Miyagi, 1998). When the speed of SLR greater than the limit of a peat accumulation speed, mangrove forests submerged in the sea and die. The peat accumulation is a combined process of physical and biological processes.

In the case of low island mangrove forests like Bermuda, there is an evidence of mangroves keep up with slow sea-level rise by peat accumulation. The mangroves had built up substrate with speed of 8.5-10.6 cm 100 $years^{-1}$, while from 4000 to 1000 years BP SLR declined to 6 cm 100 $years^{-1}$. Then, this mangrove forest was stayed at the same place for 4000 years with fear of dieback in the speeded up SLR last 1000 years BP (Ellison, 1993).

2. Observation Methods and Results

Khlong Ngao is located near the Ranong Mangrove Research Center (RMRC), Royal Forestry Department of Thailand and discharged to Andaman Sea. St. 1 was set at a front type mangrove forest in Hadsaikao Village just out of the mouth of Khlong Ngao. St. 2 was set at the mouth of Khlong Ngao, and St. 3 was set at a riverline type mangrove forest 5 km upstream from St. 2 (**Figure 1**).

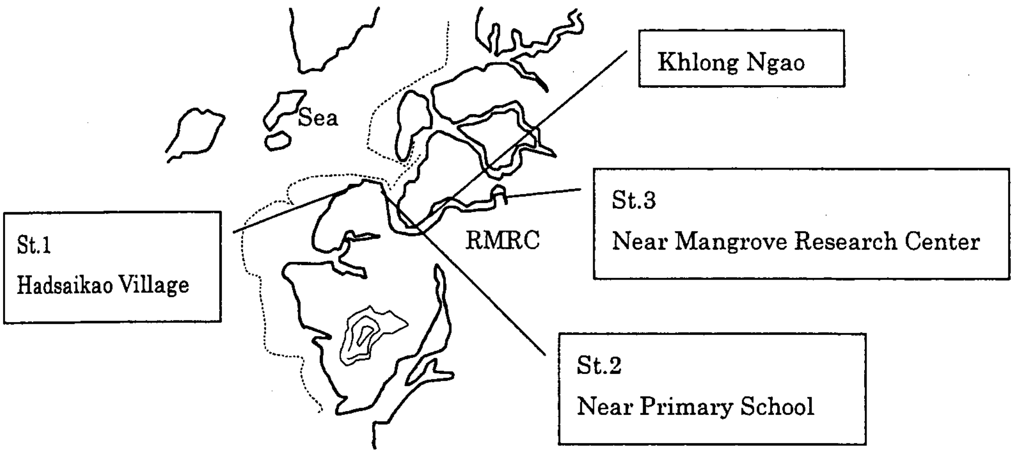

Figure 1 Site map of Khlong Ngao at Ranong, Thailand

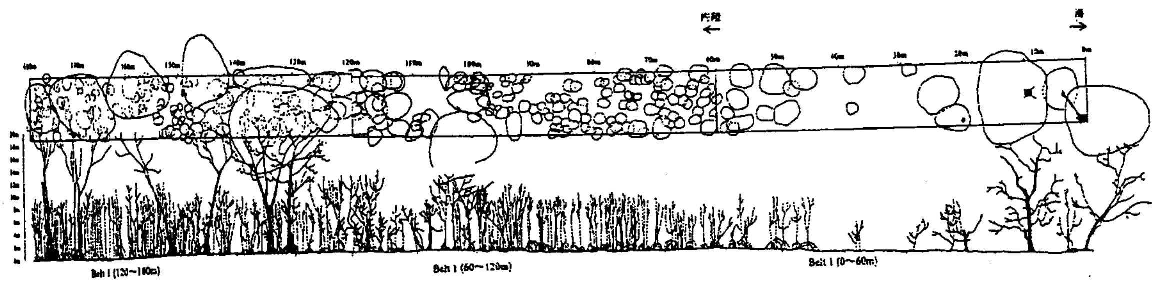

Figure 2 Forest structure at St.1

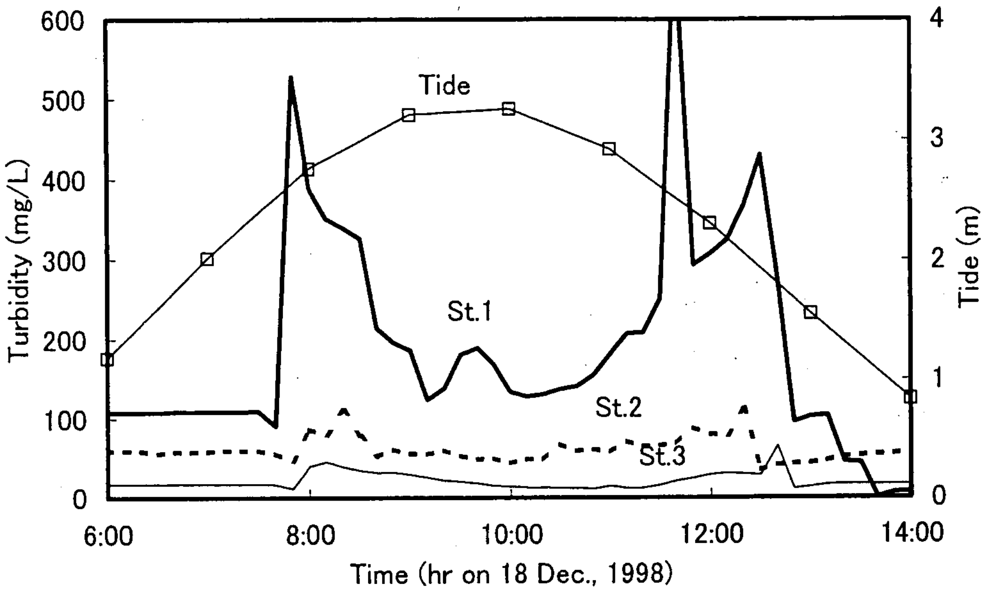

Figure 3 Sediment Transort processes

At St.1, a 10 m width belt-transect are set for 200 m from shore line. As shown in **Figure 2**, dominant species are *Sonneratia alba, Avicennia alba, Rhizophora apiculata, R. mucronata, Buruguiera parviflora, B. gymnorhiza, Ceriops tagal, Xylocarpus grannatum,* and *X. moluccensis*. Bottom datum varied range is c.a. 1m. There is a sand dune at 50-60 m point on a gradual uphill slope from shoreline (0.01-0.001). The zonation of mangrove corresponds to datum and small-scale topography pattern (dune, creek, etc.).

Figure 3 shows sediment transport processed in and around Klong Ngao. Most turbid water was observed at St.1 (Sea side) in shallow water time. Re-suspension of bottom sediment by waves is a one of possible source. Suspended sediment in water column was drastically reduced in St.2 (creek mouth) and St.3 (upstream). Further more, other experiment shows fraction of Chl.-a in water column was very low (< 5 mg/L).

A long-term monitoring for salinity distribution in Stns. 2, 3 shown in **Figure 4**. Even in dry season, some rainfall was observed in Ranon this year. The corresponding reductions of salinity (freshwater inflow) were clearly recorded about twice a month. Salinity difference between downstream and upstream is about 2-4. A trend of salinity is increasing 2-4 / 60 days according to decreasing of flesh water stock in Klong Ngao. This flesh water stock is able to maintain by flesh water input from upstream, and storage effect of mangrove forests.

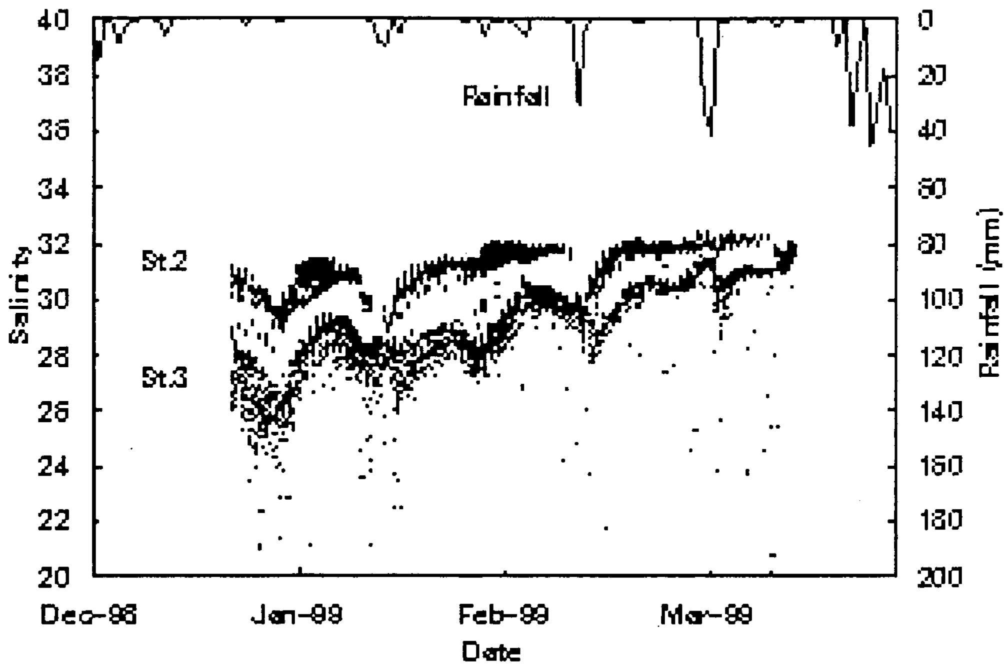

Figure 4 Salinity Distribution in Khlong Ngao

3. Discussion

The major processes in Khlong Ngao in dry season are; 1) flesh water stock in upstream, 2) water exchange due to tidal current, 3) increasing of salinity due to drainage of flesh water, 4) small amount of suspended sediment supply from sea side, and 5) forest's formation corresponding to small scale topographical conditions. On the contrary, teh major processes in wet season are; 1) rapid decreasing of salinity due to fresh water supply, and 2) high contents of suspended sediment from upstream was carried by creek.

The SLR effect will effect on mangrove forests by following way.

1) enhance tidal exchange due to acceleration of tidal propagation in deeper water in the creek,
2) reduce sediment re-suspension by reducing wave height in deeper water, and
3) change salinity, inundation pattern on swamp.

Point 1) may cause high saline stress for mangrove and trigger change of zornation (**Figure 5**). Point 2) may reduce source of suspended sediment, nevertheless sediment deposition will speeded up by water become more still.

A numerical calculation of tidal propagation shows 5% increase of tide amplitude at 5 km upstream of the creek under 1m SLR scenario. It will enhance sediment movement from mangrove swamp due to increasing of inundation date. Trend of erosion or accretion of sediment are controlled by local balance of sediment transport. The more water level reduce tidal asymmetry in both creek and swamp. It reduce downstream transportation of sediment in creek and upstream transportation of sediment in swamps.

The other effect of SLR will cause on wave attenuation in fringe type mangrove forests. Both field observation and numerical calculation shows high wave energy attenuation occurs in shallow water conditions. SLR will cause the more wave energy penetration in the forest that causes erosion of sediment.

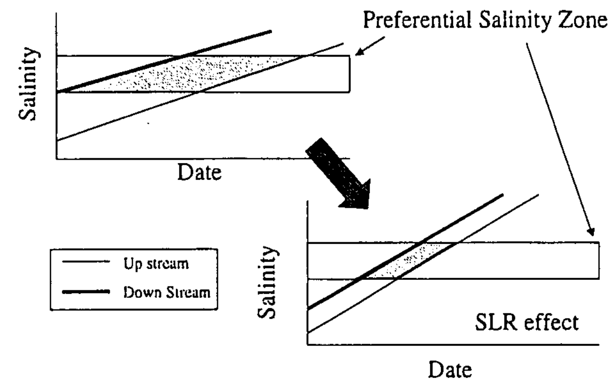

Figure 5: Schematic image of effect of salinity change by SLR

The modeled phenomenon are predicted quantitative effect of SLR on mangrove forests. Nevertheless, the scenarios are also one of model of real world. Thus, careful monitoring of environment and redo the assessment is crucial for setting suitable countermeasures for the effects.

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