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Sediment Accretion in a Protected Mangrove Forest of Kuala Selangor, Malaysia

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Abstract: Sediment accretion/erosion study was conducted by artificial horizon method at Kuala Selangor Nature Park Mangrove forest, Malaysia. Monthly sediment accretion and erosion ranged from 0.32 to-0.34 cm. During the 20 months of study period, a total 1.69 cm sediment was accreted in the mangroves, which constitute the monthly and yearly rates of 0.085 and 1.02 cm, respectively. A significant (F, $p<0.05$) relationship was observed among the monthly sediment accretion/erosion, rainfall and number of spring high tide that flooded the forest floor.

Key words: Accretion, artificial horizon, erosion, mangroves, sediment

INTRODUCTION

Mangrove ecosystems are open and exchange inorganic and organic compounds to the adjoining marine ecosystem[1-4]. As mangroves are situated in intertidal areas, the exchange of compounds is associated with tidal inundation, while tidal characteristics, current, wind and rainfall play an important role in the exchange and sediment accretion/erosion in mangrove areas[5,6]. Mangroves encourage the sedimentation process leading to site modification, species succession and creation of supratidal surface too high for mangroves[7]. The economic importance of mangroves is being widely appreciated[8], but geomorphological role of mangroves has been neglected. In west coast of Peninsular Malaysia, little effort was spent on the study of sediment dynamics in mangroves, while most of the studies were concerned with the productivity of mangroves[9-12]. Therefore, present study aims to estimate the sediment accretion/erosion in a protected mangrove at west coast of Peninsular Malaysia.

MATERIALS AND METHODS

The study area consists of 100 ha of mangrove forest (Latitude 3°20' N and Longitude 101°14' E) at the Kuala Selangor Nature Park, Malaysia and it has been totally protected since 1987. This mangrove forest is inundated by only the spring high tides and can be categorized under Watson's tidal inundation class 4[13]. Species of mangroves from the families of *Avicenniaceae, Rhizophoraceae, Sonneratiaceae* and *Euphorbiaceae* are found in this forest, but *Bruguiera parviflora* constitutes about 80% of the growing stock. The mean annual rainfall is 1790 mm and mean minimum and maximum temperature are 24 and 32°C, respectively.

Sediment accretion/erosion was measured by placing 36 solid tiles (10x10 cm) base randomly in the forest area. The tile bases were placed flatly at 5 cm depth from the sediment surface and marked by numbered flags. Initial sediment height (cm) on each tile was recorded and monthly accretion/erosion was estimated by deducting the sediment height on the same tile base of previous month from the current month. This study was conducted for 20 months from December 2001 to July 2003. Mean with standard error of monthly sediment accretion/erosion was calculated and compared by one way analysis of variance (ANOVA) followed by Duncan Multiple Range Test (DMRT) by using SAS (6.12) statistical package. Multiple linear regression analysis was performed among monthly sediment accretion/erosion, rainfall and number of spring high tides by using SAS (6.12) statistical package.

RESULTS AND DISCUSSION

Monthly sediment erosion and accretion ranged from -0.34 to 0.32 cm and erosion was observed during May 02,

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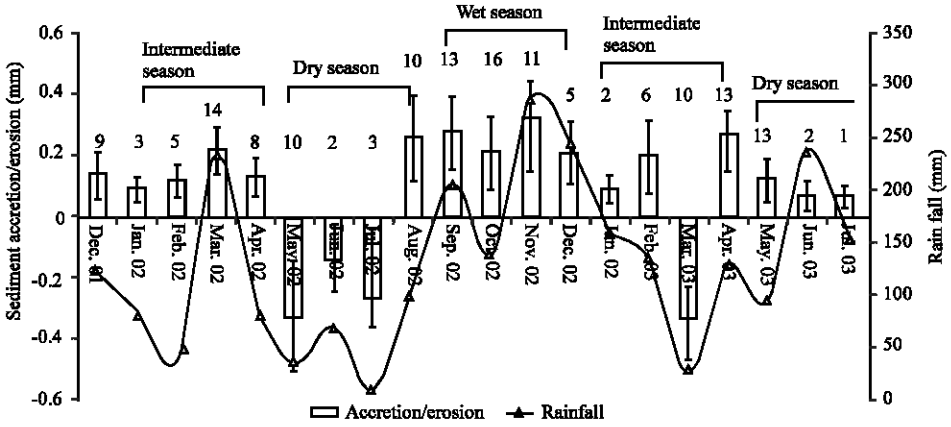

Fig. 1: Sediment accretion and erosion during the study period of 20 months (December 2001 to July 2003) at Kuala Selagor Nature Park mangrove forest. Numbers on the bars represents number of spring high tide during the respective months

Jun 02, July 02 and March 03. During the 20 months of study period, a total 1.69 cm sediment was accreted which constitute the monthly and yearly rates of 0.085 and 1.02 cm, respectively. A significant (F, $p<0.05$; $R^2=0.54$) relationship was observed among the monthly sediment accretion/erosion, rainfall and number of spring high tide that flooded the forest floor. Comparatively (ANOVA, DMRT, $p<0.05$) higher sediment accretion (0.32 cm) was observed during November 02, which was associated with higher amount of rainfall (286.3 mm) and higher number of spring high tides (11). On the contrary, relatively (ANOVA, DMRT, $p<0.05$) higher sediment erosion (-0.34 cm) was observed during March 03 with low amount of rainfall (24.9 mm) and grater number of spring high tide (10) that flooded the forest floor (Fig. 1).

Tide is the dominant factor of sediment dynamics in the mangroves and responsible for transportation, deposition and erosion of sediment[5,14]. During the high tide, strong currents are able to carry sediment through the creek[15] and high shear stress of flood velocity with transported sediment creates higher concentration of suspended sediment[16]. The carried sediment is deposited on the marsh surface during the period of slack water and low velocity flow and the export of sediment from the marsh system also depends upon the velocity of the ebb tide[16]. Spring high tides during the drier months may carry lower amount of suspended sediment and the ebb tides can transport away more sediment from the mangrove forest. Tropical rivers carry massive amount of sediment during the rainy season[17]. Spring high tides at wet season transport a lot of sediment into the mangrove areas and increase the rate of sediment accretion because the amount of sediment transported to the mangrove areas exceeds the amount of sediment export away from the mangroves[6].

Table 1: Sediment accretion rate at different mangrove forest in the world

Location and source	Species	Accretion rate (cm/yr)
Magnetic island, North Queensland, Australia [7]	*Ceriops* sp.	-8.16 to 11.04
	Rhizophora sp.	-6.46 to 4.61
	Rhizophora sp.	-3.84 to 4.00
Mexico [18]	*Rhizophora* sp.	0.30
Northern Australia [19]	*Rhizophora* sp.	0.60
Kuala Kemaman, Terengganu, Malaysia [6]	*Rhizophora* sp.	0.64 to 1.46
Kuala Selangor, Malaysia	*Bruguiera parviflora*	1.02

Different rates of sediment accretion are observed at different mangrove areas. Sediment accretion rate in the present study is comparatively higher than *Rhizophora* sp. dominated mangrove forest at Mexico[18] and Northern Australia[19]. However, similar accretion rate is observed at Kuala Kemaman, Terengganu, Malaysia[6] (Table 1). The rate of sediment accretion is also influenced by mangrove vegetation pattern and the height of forest areas from the mean sea level[7] mangrove roots system and pneumatophore play a significant role in trapping sediment particles by retarding current velocity[20]. The sediment trapping ability of mangroves is not only important for mangroves itself in terms of nutrients input into the system but can play a major role in land building process and soil stability in the coastal areas.

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