



The role of breakwaters on the rehabilitation of coastal and mangrove forests in West Kalimantan, Indonesia



Aji Ali Akbar ^{a,*}, Junun Sartohadi ^b, Tjut Sugandawaty Djohan ^c, Su Ritohardoyo ^b

^a Faculty of Engineering, Tanjungpura University, Pontianak, Indonesia

^b Faculty of Geography, Gadjah Mada University, Yogyakarta, Indonesia

^c Faculty of Biology, Gadjah Mada University, Yogyakarta, Indonesia

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ABSTRACT

The breakwaters, which were built by the government of West Kalimantan, Indonesia in late 1993 were aimed to protect the coast and mangrove forest. However, the effectiveness of building the breakwaters is not known because no measurement has been done. This study aimed to reveal the effectiveness of building breakwaters to protect the coast and its role in the rehabilitation of mangrove forest.

The role of breakwaters in protecting the coast and rehabilitating the mangrove forest were assessed by comparing differences between the condition when there were no breakwaters versus condition after the breakwaters built. Beside building breakwaters, the government plant *Rhizophora* to restore the mangrove forest. The success rate of mangrove rehabilitation effort was determined by measuring density and distribution of *Rhizophora* and colonization of *Avicennia marina*. The study conducted using survey method with a landscape approach conducted in three bays of the South China Sea, West Kalimantan, Indonesia, which are: Penibung, Sungai Duri, and Karimunting. The measurement of parameters was conducted with purposive sampling technique based on perpendicular toward the sea area. The parameters measured were shoreline differences, the distribution of bottom and drift sediment, and the prediction of longshore sediment transport alongside the shore.

The result showed that the breakwaters built in Karimunting and Penibung Bay were successful to reduce the amount of coastal erosion up to 70% within 22 years. On the contrary, the breakwaters built in the Bay of Sungai Duri could not reduce the coastal erosion. The effects of breakwaters on mangrove rehabilitation were clear, which can be observed on the colonization rate of *Avicennia marina* and reforestation of *Rhizophora* sp. in Karimunting Bay. The abrasion of shoreline still occurred although there were breakwaters built. It might be caused by the construction of breakwaters were segmented. The condition worsens by activities of beach sand excavation.

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1. Introduction

Coastal erosion and mangrove ecosystems damage are environmental disasters that have altered the socio-economic life of the coastal society in West Kalimantan (Akbar et al., 2008). The rate of coastal erosion and mangrove ecosystems damage in West Kalimantan is 20 m/year on average during the last four decades. In West Kalimantan, the abrasion has caused damage to the economy, such as damage to the people settlements, agricultural areas, and the main road (Akbar et al., 2008; Institute of River Region

Kalimantan I, 2011). The destruction of mangrove forests in West Kalimantan was triggered by rapid reclamation, increasing coconut plantations and settlements since the 1950s, followed by extensive expansion of shrimp farms in the early 1980s (Akbar et al., 2008). The degradation of mangrove forest has diminished the role of mangroves as coastal protection (Blasco et al., 1996; Ewel et al., 1998; Rönnback, 1999; Sathirathai and Barbier, 2001; Mazda et al., 2006; Thampanya et al., 2006; Walters et al., 2008). Therefore, the degradation of mangrove forest aggravates coastal erosion in West Kalimantan.

The breakwaters were planned in 1992 and built a year after by the Government of West Kalimantan to decrease coastal erosion. The Government was targeted to build 60 km of breakwaters along the shoreline. Unfortunately, the target could not be achieved, only

* Corresponding author.

E-mail address: aji.ali.akbar.2011@gmail.com (A.A. Akbar).

22 km of breakwaters were built. Basically, the purposes of constructing breakwaters are 1) protecting the road, settlements and agricultural areas from coastal erosion; and 2) to let the mangroves breed and sprout (Institute of River Region Kalimantan I, 2011).

This study is essential because there is lack of study about the effectiveness of breakwaters built on the shorelines of Indonesia. This study examined the effect of breakwaters built to 1) the changing of coastal erosion and the trap of surrounding sediment; 2) the effect of breakwaters on the physical and chemical characteristics of sediments and soil, which are: soil texture, nutrients (NH_4^+ , PO_4^{3-} , SO_4^{2-} , H_2S , NO_3^- , Organic Compound and Fe^{+2} , pH and salinity; and 3) the growth and spread of *Rhizophora* sp., which has been planted and the colonization of *Avicennia marina*.

The analysis conducted in this study are: the changes in shorelines and bathymetry, bottom and drift sediment, wind direction and speed as the wave generator, wave direction and speed,

longshore sediment transport rate, the estimated cost of the breakwaters construction, and mangrove vegetation growth conditions at the research locations.

2. Materials and method

2.1. Location studies

The determination of research locations based on the conditions of: biophysical condition of eroded coast, mangrove forests, land transportation accessibility, settlements denseness, and the presence of breakwaters. This study used a survey method with landscape approach in three research locations at the bays of South China Sea, West Kalimantan, Indonesia, from north to south (Fig. 1): 1) Bay of Karimunting $0^\circ 42' 49.42''$ – $0^\circ 47' 24.43''$ North Latitude (N) and $108^\circ 51' 7.61''$ – $108^\circ 52' 20.85''$ East Longitude (E). 2) Bay of

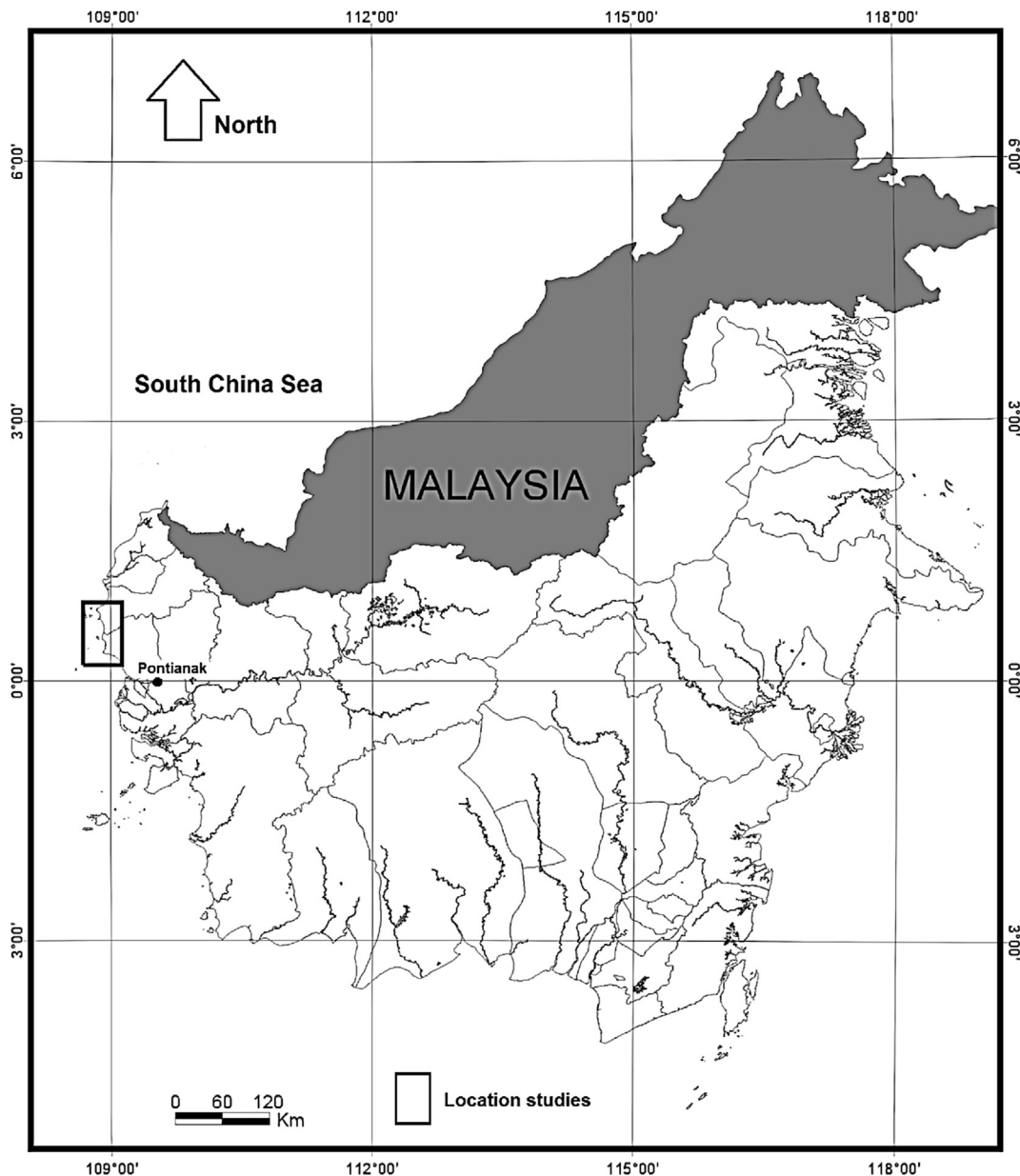


Fig. 1. Location studies: Bay of Karimunting, Bay of Sungai Duri, and Bay of Penibung, West Kalimantan.

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