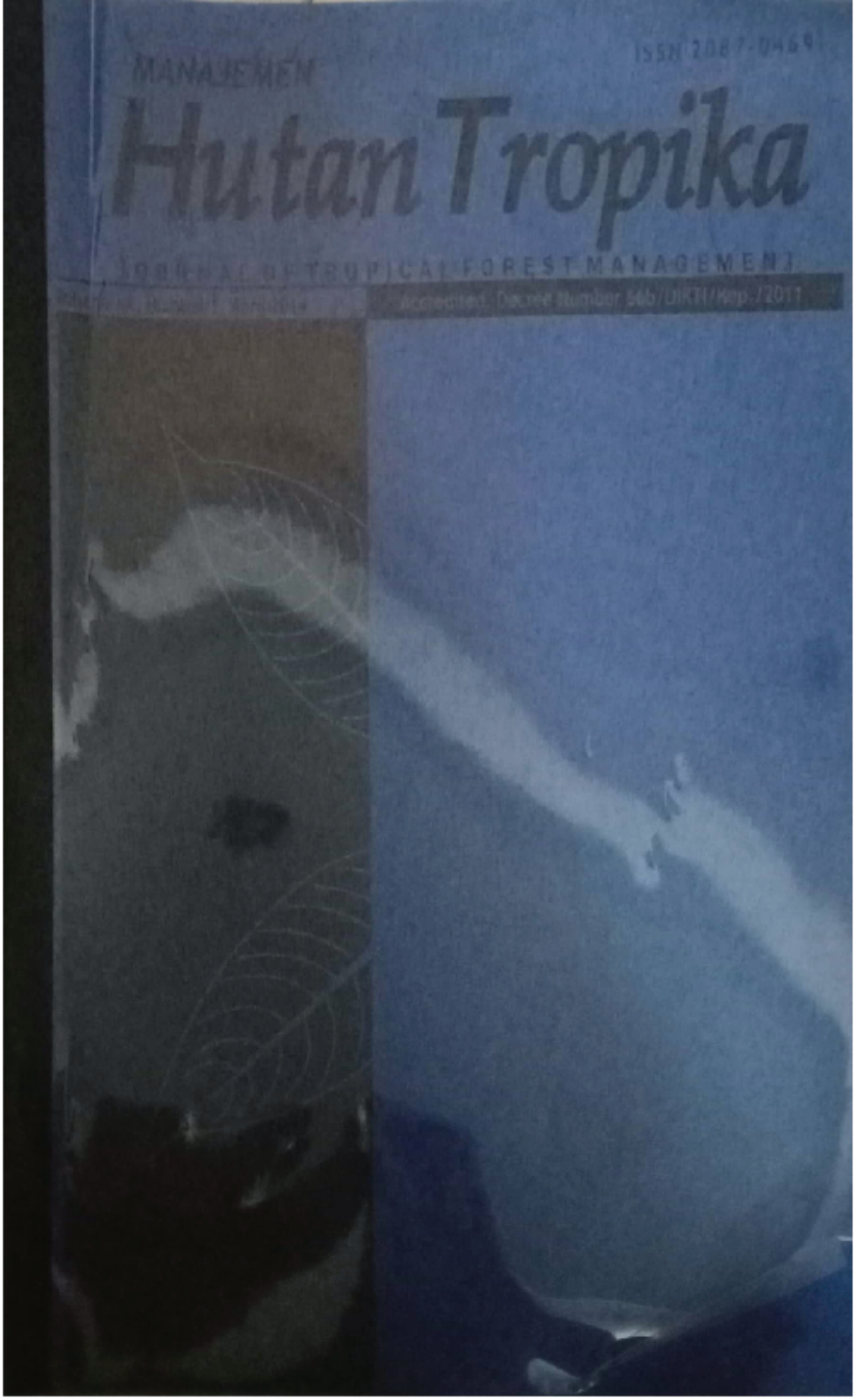
ISSN 2087-0469

MANAJEMEN

Hutan Tropika

JOURNAL OF TROPICAL FOREST MANAGEMENT

Accreditated Decree Number 56b/DIKTI/Kep./2011



LEMBAR PENGESAHAN

Judul Jurnal Nasional	:	**The Existing Condition of Mangrove region of *Avicennia marina*: Its Distribution and Functional Transformation**
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6. Fakultas/ PS	:	Teknik/Teknik Sipil
Nama jurnal/Publikasi	:	**Journal Of Tropical Forest Management (JMHT: Jurnal Manajemen Hutan Tropika, IPB, Bogor)**
Terbit	:	**JMHT Vol. XX, (1): 26-34, April 2014 EISSN: 2089-2063 ISSN : 2087-0469 DOI: 10.7226/jtfm.20.126**
Tahun Penerbitan	:	April 2014
Akreditasi	:	DIKTI No 66b/DIKTI/Kep./2011 berlaku sampai dengan Agustus 2016

Bandar Lampung, 3 Juli 2014

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JMHT Vol. XX, (1): 26–34, April 2014
EISSN: 2089-2063
DOI: 10.7226/jtfm.20.1.26

Scientific Article
ISSN: 2087-0469

The Existing Condition of Mangrove Region of *Avicennia marina*: Its Distribution and Functional Transformation

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Received December 3, 2013/Accepted April 6, 2014

Abstract

Mangrove ecosystem existence is important for environment and other organisms because of its ecological and economical values, so that management and preservation of mangrove ecosystem are needed. The purpose of this research was to determine the existing condition of mangrove, both its distribution and its functional transformation in Indah Kapuk Coastal Area. Avicennia marina becomes important as wave attenuation, a form of abrasion antidote. Transect-Square and Spot-Check methods were used to determine the existing condition of A. marina mangrove forests. Autocad program, coordinate converter, Google Earth, Google Map, and Arc View were applied in process of making mangrove distribution map. In western of research location exactly at Station 1 and Station 2, the density value of mangrove was 450 and 825 tree ha^{-1}, respectively with sparse category because they were contaminated by waste and litter. In eastern of research location namely Station 3, Station 4, and Station 5 the mangroves grow well with density value of 650 (sparse), 1,500 (very dense), and 1,200 tree ha^{-1} (fair), respectively, eventhough the contamination still happened. The mangrove forests around the stations do not function as wave attenuation because there were many waterfront constructions which have replaced the function of mangrove forests to damp the wave. In short, it can be stated that the mangrove's function has changed in a case of wave attenuation. The function of mangrove forests is not determined by mangrove forest density but it is determined by mangrove's free position.

Keywords: Avicennia marina, mangrove, wave attenuation, waterfront constructions

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Introduction

Mangrove forest is a forest that is always inundated by sea water in coastal areas which is located in the lower reaches of the watershed bordered by the sea and influenced by tidal but not influenced by climate (Robertson & Duke 1990; Bengen 2002). Mangroves are a prominent feature of many tropical/sub-tropical coastal systems, where they provide a habitat for various aquatic organisms (Robertson & Blaber 1992; Kathiresan & Bingham 2001). This habitat function has been associated with food availability and shelter from predators (Camilleri 1992; Acosta & Butler 1997; Primavera 1997; Laegdsgaard & Johnson 2001; Macia *et al*. 2003; Meager *et al*. 2005; Nagelkerken *et al*. 2008). The role of mangrove detritus as a food resource, however, remains uncertain, recent studies having reported that mangrove organic matter does not constitute a major contribution to secondary production (Newell *et al*. 1995; Loneragan *et al*. 1997; Bouillon *et al*. 2000; Dehairs *et al*. 2000; Chong *et al*. 2001; Bouillon *et al*. 2002; Bouillon *et al*. 2004; Kieckbusch *et al*. 2004; Kon *et al*. 2007). Mangrove forests is general term used to describe a variety of tropical coastal communities dominated by several species of trees or shrubs characteristic that has the ability to grow in the salty waters. The species tolerates a wide range of soil water salinity and is the dominant species where aridity and or cool temperatures limit the productivity of mangroves (Morrisey *et al*. 2010). So, mangrove ecosystem is a system in which the natural course of life into a place that has a reciprocal relationship between living things with their environment and between the living creature itself, which is located in the coastal areas, influenced by the tide, dominated by species of trees or shrubs typical, and able to grow in salty or brackish waters (Suryanarayanan & Kumerasan 2000; Kumerasan & Suryanarayanan 2001; Maria & Sridhar 2003; Gopal & Chauchan 2006).

One third of world's mangrove forests have been lost over recent decades as a result of reclamation, deforestation, engineering, and urbanization (Farnsworth & Ellison 1997;

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Alongi *et al.* 1998; Duke *et al.* 2007; Lewis *et al.* 2011; Peixoto *et al.* 2011; Penha-Lopes *et al.* 2011), and transformation to provide fishpond (Alongi 2002). Mangroves are plants that live in tidal areas dominated by several species of trees that can grow and develop in muddy substrate areas and can withstand significantly in salinity changes. Mangrove forest is a typical tropical forest growing along the coast or a river estuary that is affected by tidal. Mangrove forests can grow well in areas that have large estuaries and deltas that flow of water containing mud. Based on the mangrove function in aquatic ecosystems, mangrove ecosystems provide a place to spawn and raise various types of fish, crustaceans, and other aquatic species (Nagelkerken & van der Velde 2004; Lee 2008). Mangroves can usually grow well in places sheltered from the waves and having minimal water movement (Nybakken 1997; Ida 2004). Noor *et al.* (1999) revealed that generally the width of mangrove forests sparse exceeds 4 km, except in some estuaries and shallow-closed bays. Biological functions of mangrove forests are as fertility waters source, breeding sites and place to safeguard marine life, dwelling birds (especially waterfowl), habitat for many wildlife, and sources of biodiversity (Clarke 1995; Plaziat *et al.* 2001). Therefore, the existence of the mangrove ecosystem is important for the environment and other organisms (especially humans) as ecological as well as economical values, the need for management and conservation of mangrove ecosystem is significant.

There are many mangrove forests in Jakarta exactly along the coast of North Jakarta, such as mangrove Muara Angke Wildlife Sanctuary (BKSDA), Protected Forests (Forest Service Jakarta), Cengkareng Drain, and Angke Kapuk Park. Mangrove vegetation continues to degrade as a result of the development of urban development seaside town. Mangrove vegetation is dominated by *Avicennia marina* which generally grows naturally and *Rhizophora* sp. which is mostly cultivated. The position of *A. marina* becomes important to know because of its existing condition as a form of defense of the wave attenuation, abrasion antidote and elements of waterfront construction. The purpose of this research was to determine the existing condition of mangrove, its distribution and its functional transformation.

Methods

The research locations included Muara Angke Wildlife Sanctuary, Protected Forests, Angke Kapuk Park, and Muara Kamal, Jakarta. Geographically, they locate between the coordinates of S6°5'31.27" E106°43'33.70", and S6°6'1.54" E106°45'59.43".

There were some requirements determined as research station points namely: free position of *A. marina* mangroves, the variety of density of *A. marina* mangrove, and big moving wave. In western of research site, there were Station 1 (S6°5'31.70" E106°43'37.70") and Station 2 (S6°5'33.10" E106°43'38.10"). In these locations, *A. marina* mangrove grows and thrives although the water condition is dirty, bad smell, and concentrated. There is not barrier which directly contact with the lips of the waves coming to the mangrove circulation. The density of the mangrove at Station 1 and Station 2 ranged from 60–70 m and 40–50 m, respectively. In eastern area, they were Station 3, Station 4, and Station 5 which are situated in the middle of the Protected Forest, Jakarta. Mangroves stay into groups in each station have free position to face the waves. The thickness of the mangrove at Station 3 (S6°6'13.70" E106°45'33.50"), Station 4 (S6°6'13.40" E106°45'36.50"), and Station 5 (S6°6'13.60" E106°45'38.83") were relatively equal around 40–50 m. *A.marina* mangrove grows well with dirty and muddy water condition.

This study used 2 methods of data collection namely Transect-square and Spot-check method to determine the condition of existing mangroves. Transect-square method was done by drawing a line perpendicular to the coast, and then the line was placed at the top of the square of the size of 10×10 m. The distance between the squares was systematically determined by differences in vegetation structure. Furthermore, on each square was conducted the calculation of the number of individual (mature trees, juvenile trees, saplings), the diameter of the tree, and the tree height prediction for each type (English *et al.* 1994).

Spot-check method was used to supplement the information in species composition, type distribution and the general condition of mangrove ecosystems that were not observed on Transect-square method. This method was done by observing and examining specific zones in the mangrove ecosystem which has special characteristics. Information obtained through this method was descriptive.

The making of situation map of the study area (Indah Kapuk Beach Area, North Jakarta) used 2 different types of programs namely Program Autocad (Autocad 2007) to perform area digitalization, land area calculation, and completion of manufacture that meet the rules of topographic maps and Coordinate Converter Program (accessible through http://twcc.free.fr/.) to convert geographic coordinates into UTM coordinates; and 3 other programs to obtain image study zone on Google Earth, Google Map, and Arc View Programs. These programs have advantages and disadvantages of each, so that by combining all 3, it will be obtained the maximum results in the process. Working groove was described in Figure 1.

Processing steps of the data analysis was:

1 Imaging study zone
2 Using Google Earth Imagery Program, running the program Google Earth on the computer, enterring the address in the "Fly to" and clicking "Enter", deciding visible location, and narrowing zone only on satellite imaging studies which will be reviewed
3 Imaging using google map program, enterring the address in Google Maps in the search box then clicking 'search Icon', deciding the visible location, and narrowing zone only on satellite imaging studies
4 Imaging using arc view program, selecting the Quick Bird satellite imagery with restrictions only on zone imaging studies, getting results of Quick bird satellite imagery is just for comparison of beautiful shore cotton images in 2011 to 2013. The acceleration of the shift of land use in the area of Indah Kapuk Beach Area was very rapid from month to month as a result of the Water Front Construction

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EISSN: 2089-2063
DOI: 10.7226/jtfm.20.1.26

Scientific Article
ISSN: 2087-0469

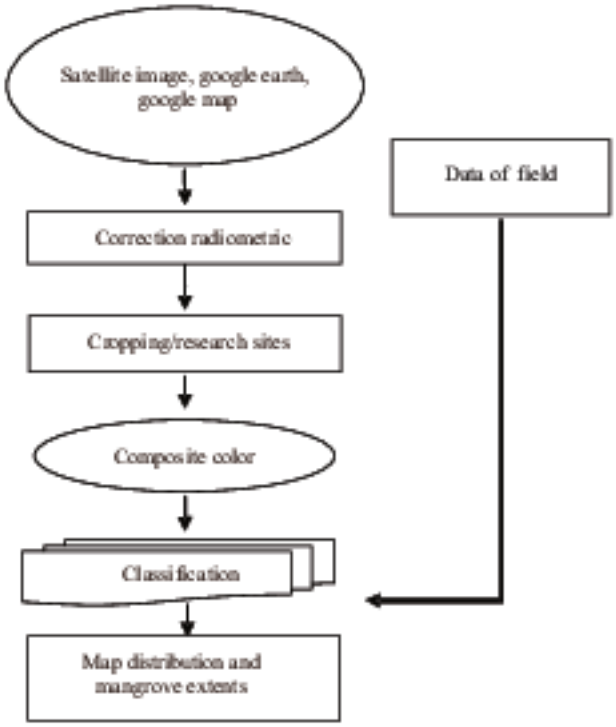

Figure 1 Flowchart of mapping mangrove.

5 Observing comparison of 3 imaging picture above
6 Making changes on the Google Map view of Earth Type to Digital Map Type
7 Doing digitization process and the mangrove forest land area in coastal zone studies and incorporate beautiful cottonwood
8 Determining point in Google Earth coordinates by running the program Google Earth and taking the coordinates to be used as a starting point in determining the UTM coordinates of Auto CAD
9 Determining point UTM coordinates with Program by using The World Coordinate Converter converted by doing geographical coordinates in UTM coordinates using the help of the World Coordinate Converter program. The World Coordinate Conversion Program indicates that the area was used as zone research included in Zone 48 Southern Hemisphere (Zone 48 S)
10 After getting the UTM coordinates of the point, doing placement process images in a way by inserting the UTM coordinates already obtained into images on the Auto CAD program
11 Creating map regions research situation.

Results and Discussion

Density of mangrove In the western of research location, at Station 1 and Station 2, the density value of mangrove were 450 and 825 tree ha^{-1}, respectively with "sparse" category and in the eastern, namely Station 3, Stations 4, and Station 5 the density value were 650 (sparse), 1,500 (very dense), and 1,200 tree ha^{-1} (fair) (Herison *et al*. 2014). Coastlines fringed by mangroves were significantly less damaged than those where mangrove ware absent or had been removed. This coastal greenbelt can protect the land from strong waves and wind, by absorbing and reducing the amplitude (height) and energy of waves. Furthermore, it maintains the shape and structure of the coastline preventing erosion and protecting human settlements from being washed in to the sea. Mangroves in eastern, less developed due to abrasion and contamination. Abrasion due to the "current wave" erode the beaches and mangrove. Current wave is the incident angle is small but continuous wave. Pollution comes from population and industrial garbage disposal. In the west, mangrove well developed due to substrate supply as a result of sedimentation and abrasion no influence. Pollution of the litter is also found in western. Rehabilitation is needed to overcome the underdevelopment of mangroves in the east. The amount of literature on mangroves and mangrove ecosystems is impressive. A number of recent texts give an overview of mangrove distribution, mangrove research, mangrove ecology and mangrove management (Tomlinson 1986; Hutchings & Saenger 1987; Robertson & Alongi 1992; FAO 1994; Field 1995; 1996; Spalding *et al*. 1997).

The description of existing *A. marina* mangrove as waterfront construction elements Searching mangroves with Spot-check method was conducted from the mouth of the river basin estuary Angke to Kamal using the vessel through the sea as well as on foot through the mainland. Figure 2 shows that almost all of the mangroves along seashore (5 km) are growing freely and directly touched by the waves but has been blocked by stones/breakwater as a wave absorbers, garbage piling up, the fence and the death of mangroves.

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(a) (b) (c)

Figure 2 Mangroves are covered by a breakwater (a), stones (b), and litter (c).

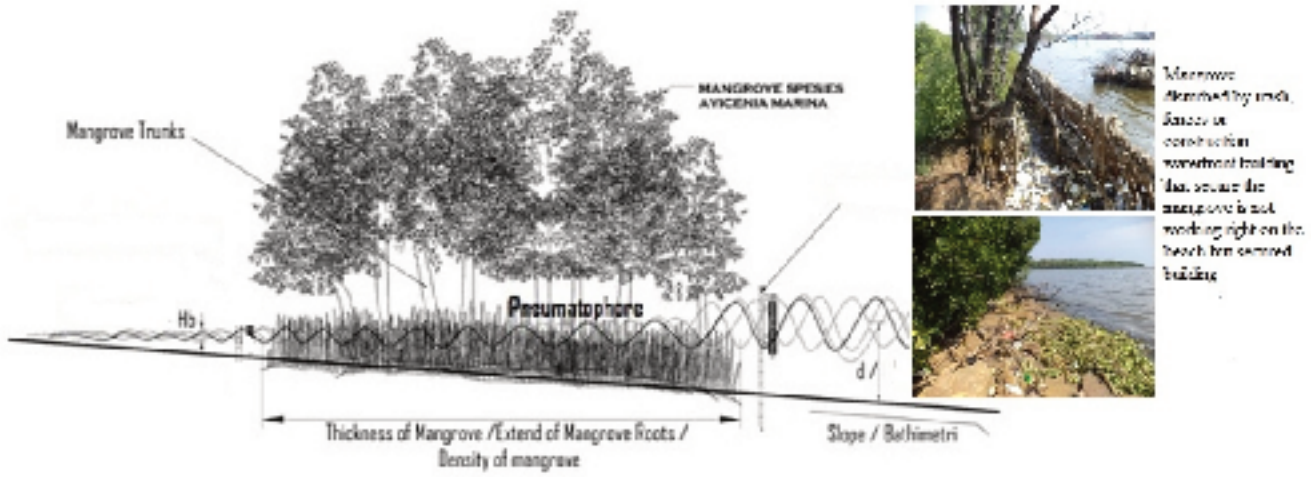

Figure 3 Causes of mangrove function not running (Herison *et al*. 2014).

Mangrove can function properly in doing the wave attenuation if mangrove was completely free of any objects, such as rocks, breakwaters, trash, wood, dead mangrove, and other waterfront construction (Mazda & Magi 1997; Triatmodjo 1999; Kusmana *et al*. 2005; Mazda *et al*. 2006) (Figure 3).

Based on observations in the field of visualization, function of mangrove can be broadly grouped into 2 as shown in Figure 4:

1 The red color indicates that in the region of mangroves can not function to dampen the wave because there are waterfront contructions such as fences, rocks, etc, which replace the function of mangroves. This is done by the ruler of the land so that they are not eroded areas.
2 The blue color indicates that mangrove forest still function to dampen the wave.

It was virtually seen that 100% of mangroves that grow in outermost formations was *A. marina*. In landward position, there was very little of *Rhizophora* sp. In determining the location of the research station must seek the true mangrove of *A. marina* which was completely free of obstacles. Figure 5 shows that only a few stations which were found only in the pair of tools that allows the measurement will be installed when the wave measuring instrument. The place where *A. marina* mangroves thrive well and do potentially as the wave damper. In this condition, mangrove can function to dampen the wave (Mazda *et al*. 2006).

From above condition, it is necessary to present comprehensively the governance and rehabilitation of mangrove by involving stakeholders of Jakarta waterfront construction planner, so that the mangrove will get a large space to live in sustainable ecosystem. Community involvement which gives positive results of preservation of the mangrove ecosystem and the increase of income of the people around the mangrove ecosystem was necessarily maintained (Cintro´n 1990; Field 1999; Gunarto 2004; Cherrington *et al*. 2010).

In general, all mangrove habitats can improve naturally their condition within 15–20 years if normal hydrological conditions are not disturbed and the availability of seeds, seedlings and the distance are not blocked. If the hydrological condition is normal or near normal but seeds can not approach the area of mangrove restoration, it can be restored by means of planting. Therefore mangrove habitat can be improved without planting, the restoration plan should first look at the potential of sea water flow unobstructed roomates other pressures may hamper the development of mangrove (Sudarmadji 2001).

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Therefore conservation and utilization of mangrove depends entirely on integrated planning of taking into account the existing mangrove ecosystem. Proposed development and activities that affect insidentially to mangrove ecosystems should reflect planning and management (Dahuri *et al*. 2004). Thus, the function of mangroves has not changed.

Distribution of mangrove in research location The survey results of distribution maps and satellite technology provided the distribution of mangrove (Figure 6). Based on direct field survey with a sample of the various points and mangrove density calculation results, it can be seen that the category of mangrove based on its density, For example, its categorized " very dense" if mangroves cover the area of 102.11 ha, "fair" if covering an area of 68.94 ha, "sparse" if covering an area of 37.39 ha, and "bush" if covering an area of 84.29 ha. Distribution of mangroves with very dense categories are still commonly found in protected forest areas (around of Cengkareng Drain). In that area, mangrove rehabilitation and planting programs are still having continued by Department of Agriculture and Forestry Province Jakarta. Trash and shrubs are still looked a lot especially in estuarine areas of Cengkareng Drain, Angke River estuary and coastal sidelines between Cengkareng Drain and Angke Rivers (color brown).

Waste supply that can degrade the quality of the environment and ecosystems would be influential in the development and growth of mangrove (Lewis 2000). Mangroves with category of "fair" were mostly found in the fish market, Indah Kapuk Beach area (west of the Cengkareng Drain). Meanwhile, "sparse" category mangroves separate from the group generally because of making of ponds and abrasion. In coastal morphology, it could be seen that Station 1 and Station 2 were eroded or abraded areas while local Station 3, Station 4, and Station 5 were seen much sediment or trash and litter (Lewis 2000). Muara Angke Wildlife Refuges area was categorized "very dense" and the composition was about 25 % with trash and shrubs in large composition. Mangrove areas in Natural Park Mangrove Angke Kapuk (TWA Angke Kapuk) were seen in the category "sparse". Planting mangroves in TWA was

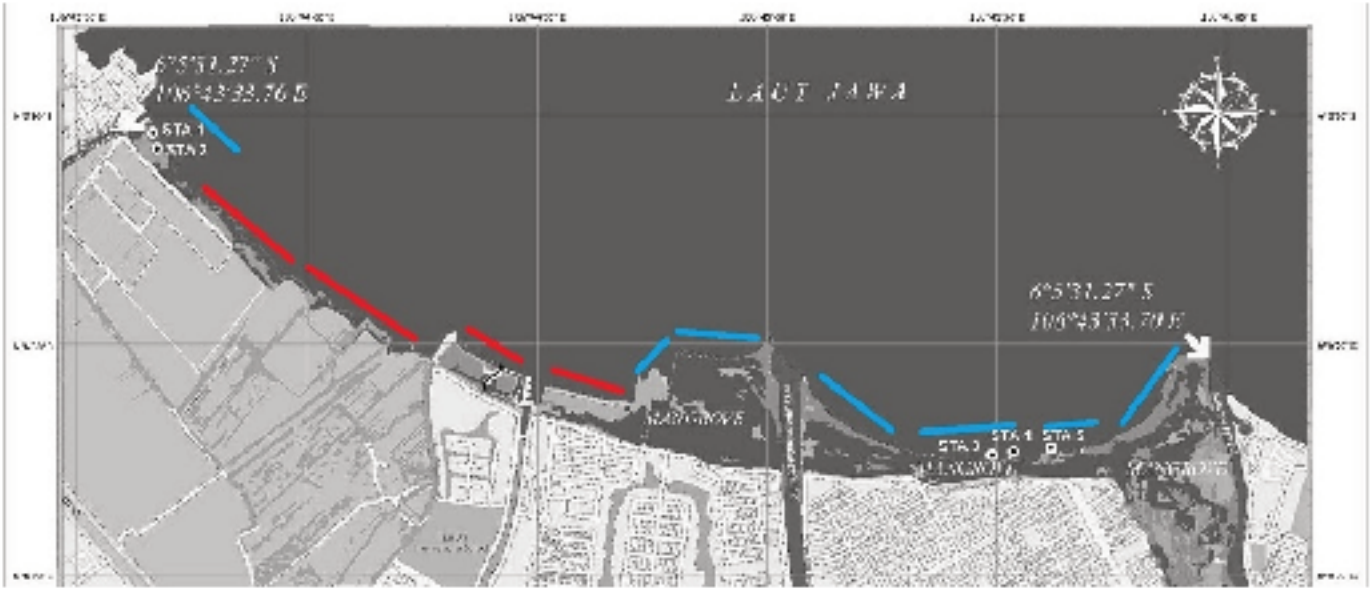

Figure 4 Mangrove area which still serves to reduce wave blue and red (Google Map 1 Desember 2013).

(a) (b) (c)

Figure 5 *Avicennia marina* mangrove as wave attenuation.

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EISSN: 2089-2063
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continuously carried out in collaboration with Government Agencies and private. Projected density of mangroves in the TWA Angke Kapuk will increase in the following years. In general, the distribution of the largest mangrove forests in the region was protected.

The area of mangrove development Mangrove found mostly in research location was *A. marina*. In accordance with this study, *A.marina* as research object existed in 5.06 km along the coastline. Data of mangrove area development in Station 1 and Station 2 stated that in 2003 the growth of mangroves was not very good. Visible increase in mangrove area was begun in 2009 and continued to develop until 2013 covering an area of 9,625.75 m^2. At Station 1 and Station 2, the growth of mangrove was seen rare in only a small cluster. At the Station 3, Station 4, and Station 5, the mangrove area development was also very small in 2003 and rose dramatically in 2004 from an area of 4,281.10 m^2 to 10,472.51 m^2, then tended to be stable until 2010. However, there was a dramatic increase in 2011 covering an area of 13,010.15 m^2 and then continued to increase in 2013 covering an area of 14,952.23 m^2. For more details, mangrove area development can be seen in Figure 7.

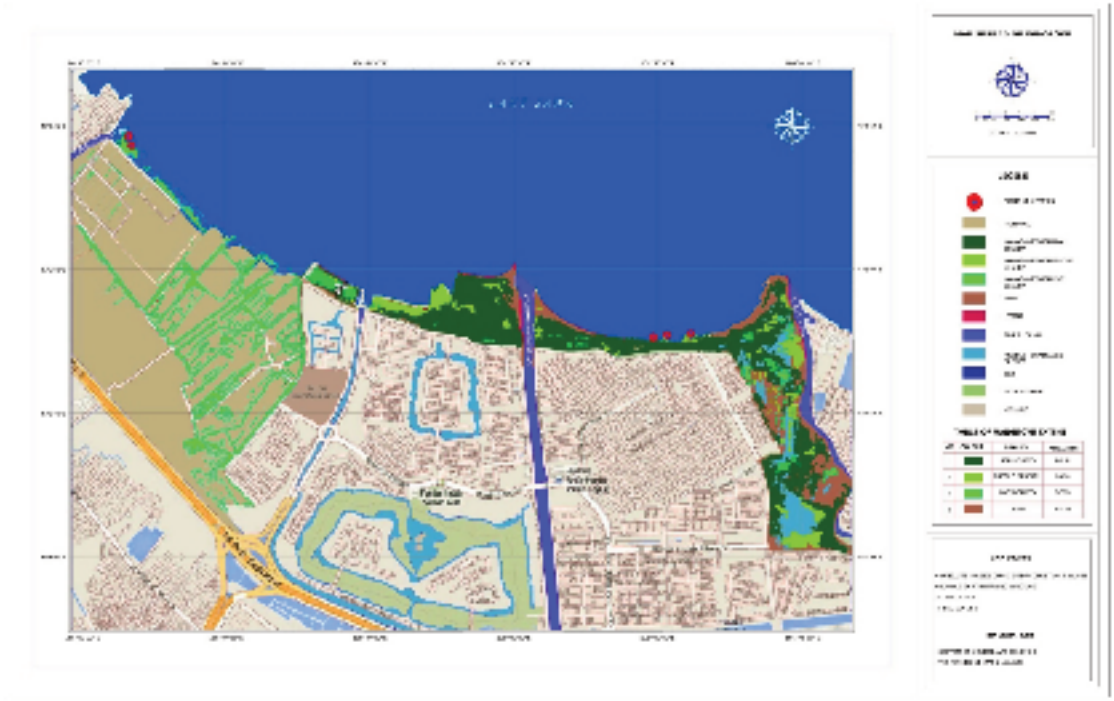

Figure 6 Distribution of mangrove in Indah Kapuk Beach Area, Jakarta.

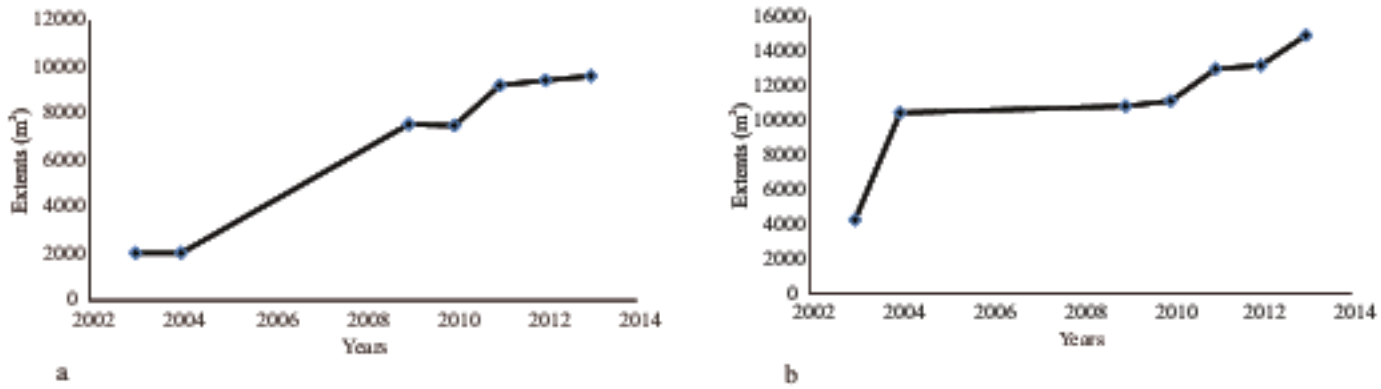

Figure 7 Development of mangrove extents at the Station. Station 1 and Station 2 (a), Station 3, Station 4, and Station 5 (b).

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Conclusion

The distribution of mangrove area from year to year continues to increase due to rehabilitation and replanting programs or growing by itself. The existing conditions of mangrove along 5 miles shoreline of research location did not grow freely without any hindrances from the breakwater, trash and fences. There were only 5 station points where *A. marina* mangroves were growing freely and still functioned as wave absorber. The changes in mangrove function in defending wave attenuation will always happen if there are not any changes of mangrove planting and maintenance procedures.

Acknowledgements

This research was supported by Department of Management Coastal Resources and Marine, Bogor Agricultural University.

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