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The GIS Application for Monitoring Spatially Changes of Mangrove Conservation Areas in the East Coast of Surabaya

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---ABSTRACT--

The aim of this study is intended to monitor spatially the changes of mangrove conservation area on the East Coast of Surabaya by using the technology of geographic information systems (GIS). The method used is a GIS analysis methods, such as: overlay. The results showed that the condition of mangrove conservation area changed due to accretion and aberration. The changes in the extent of accretion and erosion impact on the changes in the management boundary of the conservation area. In addition, changes occur in the number of farm plots that exist in the conservation area. From the satellite image, the observed number of farms plots in 2002, 2007 and 2014 respectively as 1743, 1707 and 1746 plots.

KEYWORDS *: GIS, conservation areas, mangrove*

I.   INTRODUCTION

East Coast of Surabaya (Pamurbaya) has a coastline of ± 14.4 km. Most beaches are allocated as conservation areas covering an area of 2503.9 ha of mangrove [1]. This mangrove conservation area began with the urgency of other activities that use, such as tourism and residential development and settlement residents / fisherman. On the other hand, in this region also occurs aberration events and beach accretion. With the many different uses and problems, pamurbaya area must be managed in an integrated and sustainable ways. With the sedimentation process that takes place in coastal areas caused shoreline changes that tend more towards the sea and was followed by changes in the condition of the mangrove. The emergence of new lands in Pamurbaya population utilized for various activities. Changes in mangrove areas, especially the shoreline that includes changes in land use and shoreline itself can be detected through satellite imagery and remote sensing one suitable tool to manage the spatial region is the use of GIS in monitoring the Pamurbaya region. Based on the above background, the research problem can be formulated as follows: (1). How GIS is used to monitor the condition and potential of coastal resources in Pamurbaya Mangrove Conservation Area ?, (2). How does the development of zoning in the Mangrove Conservation Area of Pamurbaya?. These quetions will be used to guide this research.

The specific objectives of this study were (1). identification of the type of coastal natural resources that exist in the current and potential utilized by people in Pamurbaya, (2). identification and analysis of changes in utilization of mangrove areas are spatially with GIS application. The benefits of this study were (1). Type of coastal natural resources will be clearly identified, either already used or that have the potential to be used by people in Pamurbaya, (2). The results of the analysis of coastal resource use, particularly mangroves, used for the determination of strategy development and management of mangrove areas.

II. RESEARCH METHODS

Research carried out for 10 months. Location of the study is the East Coast of Surabaya in position 7°12' - 7°21' South Lattitude and 112°36'- 127°54' East Longitude. Materials or data used in this study include: (1). Topographic maps scale 1: 25.000, (2). The satellite imagery of Surabaya in multi years**,** 2002, 2007, and 2013), and land use maps in Pamurbaya. The tools used in the data processing are the GPS unit, laptop as well as software Arc view 3.3. and Image Analysis 1.1. Flowchart of the study stated in Figure 1 below.

Identification Method of Mangrove : Determination of the station to the mangrove ecosystem using the plot of line transect method, a plot size of 10 x 10 m2. Plots were made square with a size of 10 mx 10 m using a rope rapia. In the mangrove data collection was conducted in two locations plot begins where the first plot of land near the mangrove areas and continues to move towards shore. Data collection was performed by observing mangrove vegetation within the vegetation plots were combing one by one, this is done to determine the type or species of mangrove, number of trees, saplings and seedlings of these species. The grouping is done by measuring the diameter and height of each of the mangrove trees. From the results of these measurements are grouped into the mangrove trees, seedlings and saplings. Regeneration size used in the analysis of the activities of mangrove forest vegetation sampling are as follows: (1). Semai, regeneration from seedling to seedling height less than 1 m; (2). Puppies, Regeneration with more than 1 m high with a diameter of less than 4 cm; (3). Trees, Trees with a height of more than 1 m and a diameter of more than 4 cm.

Mangroves across individuals in the plot calculated amount. With a record number of each species and mangrove vegetation (trees, saplings, and seedlings) contained in the observation plots will be known to the density of (In), Frequency type (Fi), The area closure (A) and the significance of the type (IVI) which observations contained in each plot. Data collection was performed by the method of mangrove biota transect squares. The method used is the method of determining station survey and purposive random sampling, so the set 5 stations in the plot. At each station which placed the pieces in a single transect transects made 5 main plot with a size of about 25 x 25 cm. Here is the position of the station in a plot measuring 10 x 10 m. Intake of mangrove litter carried on the end of the last transect closest beach. Litter is taken that the area of 625 cm2 area. Intake of mangrove litter in the form of trees, leaves and roots of each species of mangrove.
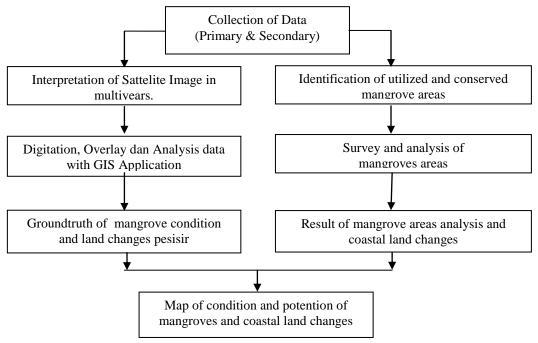

Figure 1. Flowchart of Research Methods

Analysis Methods of Geographic Information Systems (GIS) : Data spatial / spatial processed using ArcView 3.3 software. In principle the processing of data with geographic information systems (GIS) are data entry, data analysis and data display. Data entry associated with spatial data (spatial) and tabular data (textual). Spatial data is put through a process of scanning, digitizing or import data from existing digital maps. Textual data entry will follow the spatial data. Once the data is entered, the next step is to process spatial data in accordance with the needs, for example: overlay (overlay), buffering, counting area. The last stage is the data display. Display data can be in the form of maps, graphs, tables, or storage in electronic media, such as multimedia. Some of the important spatial data processing operations used in this research is the process of digitizing a map, making of the buffer, the overlay (overlay), the calculation of land area, and the process of making (layout) map. These analysis have been used in the previous researches [2], [3], [4], [5].

III. RESULT AND DISCUSSION
3.1. The result of surveying the Mangrove in Pamurbaya

Mangrove forest is a typical ecosystem that grows in coastal areas with sloping conditions periodically flooded, muddy substrates and have moderate to high salinity. Identification of mangrove ecosystems include species by category (trees and saplings seedlings) dominance, until vegetation density formations (parallel / perpendicular to the river or beach). In identifying some of these points, taken 6 (six) measuring station were determined by span beach between the two rivers. The mangrove vegetation are *Avicenia Marina sp., Rhizopora sp., Brugueira gymnorrhiza sp., Brugueira cylindrica sp.,* and *Nypa Fruticans, sp.* The results of the survey analysis of mangroves in six survey stations are shown in Table 1 below:

Table 1. Analysis of Mangroves in Pamurbaya

No	Survey Station	Index of Diversity (H')	Index of Dominance (D')	Covering (percent)	Density (Pohon/Ha)
1	Sukolilo	1.735986	0.184	53.255	2500
2	Mulyorejo 1	1.715056	0.096	56.867	2000
3	Rungkut (Wonorejo) 1	2.247928	0.1104	95.314	2500
4	Rungkut (Wonorejo) 2	2.321231	0.1152	79.494	2600
5	Gunung Anyar 1	2.425978	0.1312	82.580	2800
6	Gunung Anyar 2	2.530724	0.1472	85.211	3000

3.2. The Spatial Condition of the Mangrove Areas in Pamurbaya :
Determination and Change of Boundaries for Mangrove Areas : In 2007, the mangrove conservation area is determined by the Surabaya City Regulation No. 3 of 2007 with an area of 2541.8 hectares and the length of the circumference of 31022.102 m boundary region. In the year 2012, the region has turned into a long-2503.9 ha and the area around the limitations of 31741.179 m. The boundary changes in detail can be seen in Figure 2.
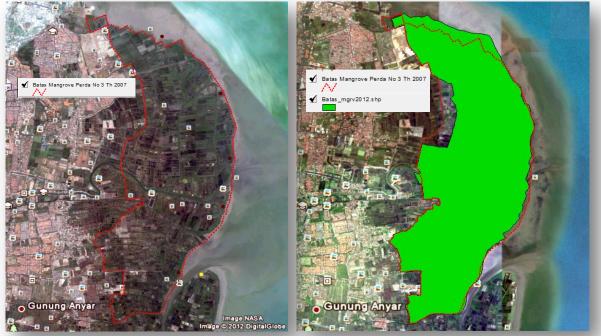

Figure 2. Boundary Changes of Mangrove Areas

The mangrove area boundary changes showed a lack of consistent of the manager in the mangrove areas. The amendment should also change the existing regulations. The amendment changed the boundary line west of Mangrove area and east side. This mangrove area boundaries used for the determination of zones of mangrove areas. Mangrove zoning is expanded. This is shown in Figure 3 below.
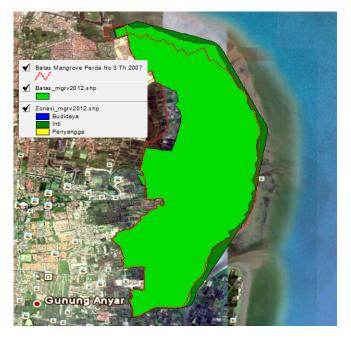
Figure 3. Overlay of area boundary of mangroves and the mangrove zoning

A.Zonation of Mangrove Areas in Pamurbaya : East Coast of Surabaya (Pamurbaya) is divided into three zones, namely: the primary protection zone, the zone limited utilization(cultivation), and a buffer zone/support **[1]**. Serves as the primary protection zone (1) spawning areas, spawning, the breeding, foraging and / or other aquatic biota, (2) maintain the integrity of the coastal ecosystem and the small islands around it. Zones limited function as (1) the protection of habitat and fish populations, (2) the tourism and recreation, (3) research and development, (4) education. Buffer Zone / Support serves as a rehabilitation zone and support zone activities in the protected zone of the main and restricted use. This zone can be seen in detail in Figure 4 below.
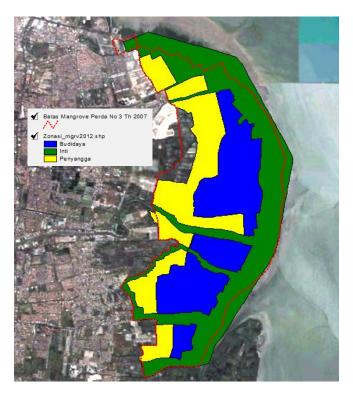

Figure 4. Area boundary of mangroves by zoning mangrove areas

Table 2. Area of Mangrove Area Zoning in Pamurbaya

Id	Shape	Zona	Luas(m2)	Total (m2)
1	Polygon	Buffer	637.516,744	
2	Polygon	Buffer	493.594,191	
3	Polygon	Buffer	526.631,155	
4	Polygon	Buffer	3.753.631,155	7.126.518,138
5	Polygon	Buffer	1.086.172,810	
6	Polygon	Buffer	628.972,083	
7	Polygon	Cultivation	491.206,649	
8	Polygon	Cultivation	2.406.140,409	8.374.598,059
9	Polygon	Cultivation	1.164.790,298	
10	Polygon	Cultivation	4.312.460,703	
11	Polygon	Core/Main	11.488.021,206	11.488.021,206
		Total of zonation areas		26.989.137,403

Buffer zone area of 712.65 hectares, 837.46 hectares area of cultivation zone and core zone covering an area of 1148.80 ha. The total area of mangrove zone at 2698.91 Ha.

B. Condition of Mangrove Areas in the years of 2002 and 2014 : Mangrove condition is strongly influenced by natural and human factors. Natural factors can include ocean currents caused by wind or tides may result in accretion and aberration on the east coast of Surabaya. While the human factor, can be caused by land use patterns and mangrove itself. In the east of mangrove areas, changes occur as a result of natural processes, while in the west the mangrove areas occur due to changes in the pattern of land use by the public. Both of these changes greatly affect the mangrove area management. In detail, these changes can be seen in Figure 5 below.
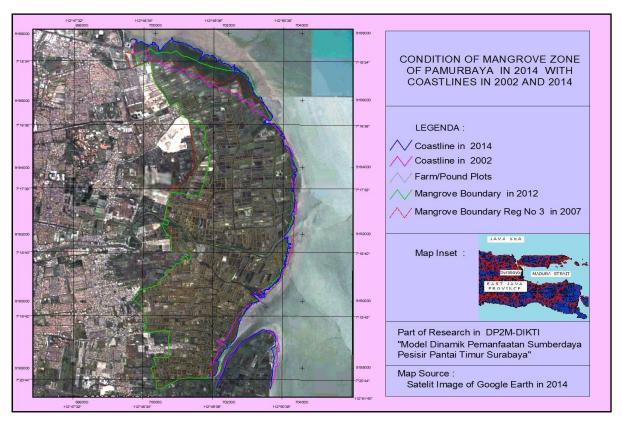

Figure 5. Comparison of mangrove conditions in the year 2002 and 2014.

Actually, in the mangrove conservation zone there are many plots of utilization land, such as: plots of farm. From the satellite image, the observed number of farms plots in 2002, 2007 and 2014 respectively as 1743, 1707 and 1746 plots. Each farm plot has area and perimeter. The means of areas and perimeters are shown in the Table 13 below. The farm plots are not only in the cultivation zone but also in the buffer zone and even in the main zone. They are shown in Figure 6. Some problems occur when the farm plots in the main zone because they are prohibited. The government try to give compensation the people who have the plots in that zone and leave them.

Table 3. Number, area mean, and perimeter mean of plots
in mangrove conservation areas of Pamurbaya

No.	Parameter	Year 2002	Year 2007	Year 2014
1.	Number of Plots	1743	1707	1746
2.	Area Mean of Plots (m²)	11452,21	11974,15	11569,39
3.	Perimeter Mean of Plots (m)	457,52	474,79	461,23

Because the mangrove conservation zones are near the urban development area, the boundaries of the zones have changed. They have been shown the Red circle in Figure 6. There are three main changes, ie.: in the North, in the middle, and in the South. The changes in the North are because of the natural changes, for example: abrasion and acresion. The changes in the middle are because of the residential development. The changes in the South are because of buffer zone expansion. All changes can be monitored spatially with utilized GIS.
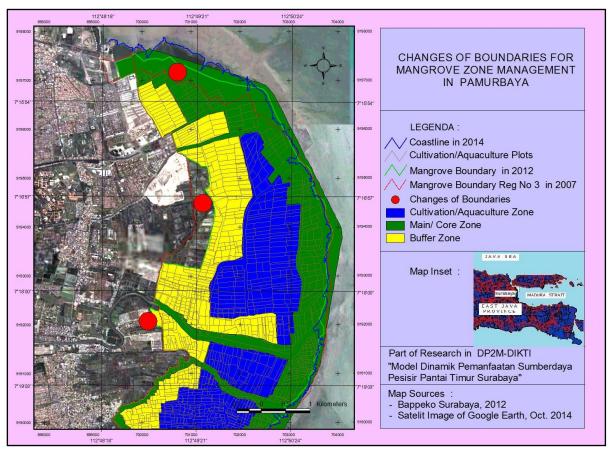

Figure 6. Farm Plots in the cultivation and buffer zones.

IV. CONCLUSION AND SUGGESTION

From this research, it can be concluded, as follows : (1). The GIS application is efective for monitoring the Mangrove Areas, especialy the Mangrove areas which have been changed by nature and human activities; (2). The highest index of dominance in the location of Gunung Anyar with index of diversity 2.4259 and 2.5307; (3). Naturally process of accretion and aberration have occured in Surabaya East Coast so the function of mangrove is more mud trapped; (4). Boundaries of mangrove areas have changed because of accretion occurred on the east side and on the West side, they have been changed by the public and / or government; (5). Division of zones is more theoretical than based on the conditions that exist in the Pamurbaya because in the core / main area have existed farm plots.The suggestion is as follows: (1). Boundaries of mangrove areas in the western region should not be changed because of this zone as a counterweight to the city of Surabaya in order to function as a green land which serves to reduce the impact of flooding; (2). Reality on the ground, not only the buffer zone, the core area also has many farm plots so that if the region is defined as the core zone, the Surabaya city government should replant (reforestation) and negate mangrove patches and restore the pond to their natural habitat.

ACKNOWLEDGEMENTS

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