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Analysis and Identification of Landuse on the Coastal Environment of South Sumatra using GIS

Yuanita Windusari[#], Laila Hanum[#], and Margareta Sri Lestari[#]

[#]*Biology Department, Mathematic and Natural Sciences Faculty, Sriwijaya University, South Sumatra*
E-mail: ywindusari@yahoo.com; lailahanum@ymail.com

***Abstract*— Analysis and identification of land use in coastal areas to study the coastal environment Sembilang National Park in South Sumatra using remote sensing system (Geographical Information System) has been conducted from June until November 2014. The objective to study the changes that occur in the coastal environment as well as to identify and estimate the area use change existing mangrove areas in Region I of the Section of Sembilang National Park Management, South Sumatra. Methods for the analysis and identification based on Landsat image data 8 in 2013 using ENVI 4.3 and Arc GIS 9.3 software as well as the conversion of ground check. The results showed the use of land in the mangrove areas in the region I of the Section of Sembilang National Park Management classified into 5 classes, namely mangrove, water area, mangrove shrubs, mainland mud, and ponds areas. The area of each class were observed in sequence as follows 8921.19 ha (41.69%) as mangrove area; 3934.3 ha (23.28%) as water areas; 3.608,52 ha (17.41%) as area of mangrove shrubs; 1.649,11 ha (9.05%) as mainland mud and settlement area; and 1.561,04 ha (8.57%) as the ponds area. The percentage of the class obtained as a result of the conversion of ground check, and it is based on the land use map data over the total area observed.**

***Keywords*— coastal environment; GIS; land use; Sembilang National Park**

I. INTRODUCTION

Mapping vegetation through remotely sensed images provides a description of the characteristics of spectral, spatial, radioactive, and temporal about mapping vegetation cover at a community level or species level [1]. Forest land cover change is an important input for modeling ecological and environmental processes at various scales [2].

Banyuasin is one district in the province of South Sumatra. This district is a division of Musi Banyuasin formed in 2002.The district name comes from the name Banyuasin River, which crosses the district and Musi Banyuasin. Banyuasin own words derived from Javanese term *banyu* (water) and *asin* (salty), referring to the quality of the river water is salty tastes, especially towards the beach. Sembilang National Park (SNP) is an area consisting of peat swamp forest, freshwater swamp forest, and riparian forest. This area is located in the coastal area in South Sumatra Province with an area of 2,051 km². This area is designated as a national park by the Minister of Forestry of the Republic of Indonesia No. 95 / Kpts-II / 2003 dated March 19, 2003, with an area of ± 202,896.31 ha. The administration includes the District Banyuasin II, Banyuasin, South Sumatra Province [3].

Sembilang National Park is divided into three sections management areas, namely Regions 1 SPTN Sungsang, Region 2 SPTN Sembilang and Region 3 SPTN Tanah Pilih. Region 1 SPTN Sembilang National Park covers an area of Solok Buntu and Lalan. The average salinity of the water is 10-20 ‰, pH 6 to 7 and humidity (Rh) ranges from 10-30% [4]. Important factors that need to be examined in ecology and environmental modelling process is the change in forest cover [2]. Natural disasters and human activities (such as cleaning the pond) put pressure on the mangrove areas and lead the region to become degraded gradually and continuously. One of the causes of land cover change in SNP is a change in the function of the coastal area into the pool by the locals. The same thing expressed by [5] that high human activity (anthropogenic) in a region can lead to changes in land cover

The increasing utilization of coastal areas has disrupted the balance of coastal ecosystems, mainly due to sedimentation [6]. The transformation of natural habitat by human activities such as logging, crop cultivation, and urban expansion poses the single most important threat to biodiversity [7]. Land cover refers to the suite of natural and man-made features that cover the earth's surface. Thus, it is essential to accurately map land

cover in an effort to understand the human land uses that threaten natural habitat [8]. Deforestation affects biological diversity through habitat destruction, fragmentation of former contiguous habitat [8] and edge effects within forest boundaries [9]

Data in 1993 showed Banyuasin has extensive coastal mangrove forests around 856.134ha, but the mangrove forest area decreased to only about 260.001ha in 2003. Image analysis and conversion of ground check on the condition of mangrove forests in the coastal Banyuasin published by [10]. It showed that approximately 70% of mangrove forest in the coastal region Banyuasin lost due to natural disturbances which about 18% of this land are lost due to forest fires that occurred in 2003. Data Japan International Cooperation Agency or JICA [11] shows that during the period 2001-2009, there was a reduction land in this coastal region to reach 3.552ha. As described by [3] degradation of mangrove forests in the coastal region of Banyuasin especially in areas Sungai Barong Kecil, Sungai Barong Besar, and the Sembilang National Park caused by the conversion of mangrove areas into a ponds area and the local community settlement or immigrants. Land conversion causing ecological functions of the mangrove areas declined.

Factors tidal and stable high water causes intense coastal erosion and increases the amount of silt carried up to the ocean [12]. Natural phenomena that occur are repeatedly. Transverse, and tend seasonal cycle as a beach (beach cycle) has resulted in the decline of or alteration of shoreline coastal areas. Wave motion perpendicular to the shoreline and continued for a relatively long period of time causes the erosion of the beach.

The position of the shoreline in coastal Banyuasin observed by Landsat imagery in 2013 was more extensive than the previous 5 years. High sedimentation rate and tidal influence in the region suspected to alter the position of the shoreline [13]. Therefore it is necessary to do the analysis and identification of land use in the coastal environments of South Sumatra using GIS.

Information on land use and its changes have an important role in determining the dynamics of land use change. The approach used to analyze changes in an area is to utilize Geographical Information System (GIS). According to [14], GIS is a collection of software's that allows you to create, visualize, query and analyse geographic data.

GIS has advantages over conventional methods for integrating various data sources, performing spatial analysis, modeling spatial process, and mapping the results in land-use change studies. This study focuses on the land-use change and its impacts. The overall purpose is to understand better the process of coastal land-use change and its consequences in order to minimize negative impacts and to sustain coastal resources and development around nearby wetlands [15].

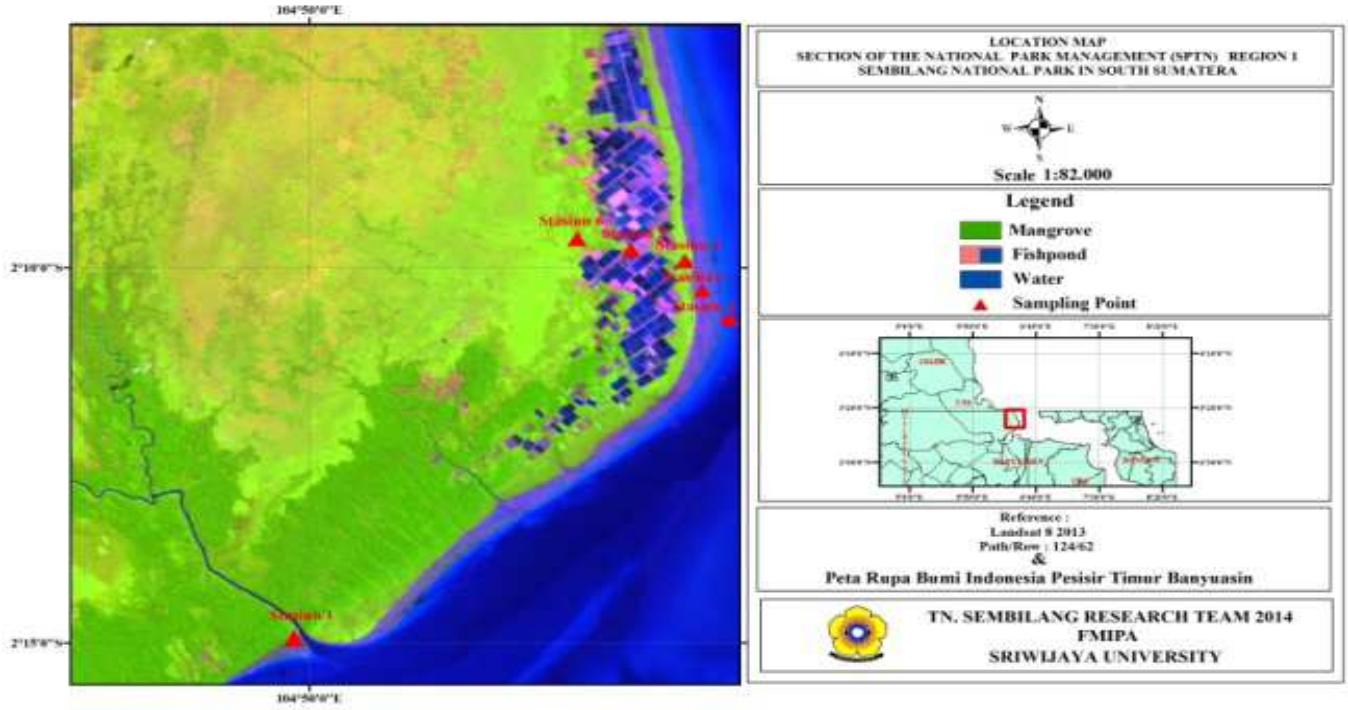

Fig. 1 Banyuasin coast area a South Sumatera and ordinate of research location

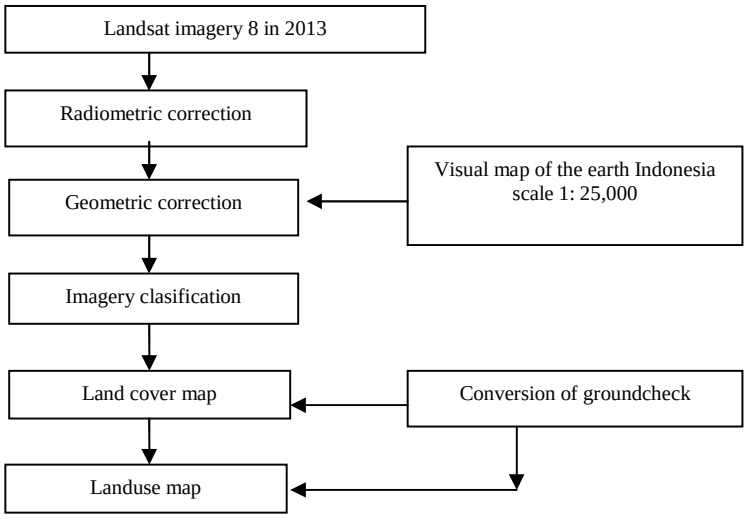

Fig. 2 Flowchart of the process of identification of land use

II. MATERIAL AND METHOD

The research was conducted during March until November 2014 at Region 1 of the Sembilang National Park Management Section, South Sumatra with ordinate as in Table 1. Identification process was using *Landsat* 8 in 2013 and ENVI 4.3 and Arc GIS 9.3 Software and adjusted for conditions of the ground check.

III. RESULT AND DISCUSSION

A. *Identification* of Mangrove Land Use

The results of the classification of Landsat 8 in 2013 with a band combination 654 using RGB (Red, Green, Blue) format for a supervised classification is known classes of land use in the Region 1 in SPTN has a class suitability of land use after conversion ground check. According to [16] observations in the field is considered complete if every class or color differences in interpretation have been observed, in check, and believed to be true so that no land use classes that do not observed. Identification of land use in the mangrove areas (see Table 1) is determined based on the color display that appears on the temporary land use map and used as a reference for the identification of the type of land use actual. Determination of land use classes in mangrove areas based on visual appearance of color and spectral reflectance characteristics or value of the digital number [17].

Imagery data and ground check conversion of mangrove areas in the region I SPTN indicate that there are 5 classes of land use : 1) mangrove area, 2) shrubs of mangroves, 3) pond area, 4) land of mud, and 5) waters area. Settlement area is part of the mainland mud. It is due to the residential areas in the mangrove area are only as a small part of mangrove area, it is not represented as a class separately. Classification of land use in coastal areas of Banyuasin especially in region I of SPTN in Sembilang National Park is described as follows;

1) Mangroves Area

This area is located along the coast, and the growth of mangrove very influenced by the physical environment and tidal conditions.

2) The Area of Mangrove Shrubs

This area is occupied and dominated by shrub vegetation identified as mangrove shrubs.

3) Ponds Area

This area is located in the mangrove area and into an open area used for fish or shrimp. Results of monitoring and ground check showed mostly open land had been restored and others still remain as wastelands. Commonly ponds area are found in the region of Resort Solok Buntu .

4) Mainland Mud

This land is formed as a result of coastal erosion, the presence of high sedimentation, the influence of the tides, as well as the destruction of mangrove forests. The formations of sludge land affect the natural revegetation process of mangrove. Which tends to cause the solid ground of this area is preferred by the community to build settlements so that more settlements identified in this region.

5) Waters Area

This area is the most extensive area identified in the image, and the conversion of ground check showed almost the entire region tidally influenced.

TABLE 1
ORDINATE OF MONITORING AND CHARACTERISTIC OF RESEARCH AREA

Location	Ordinate	Location characteristic by	
		Satelite	Ground check
1	02°09'50,1" LS 104°54'17,3" BT	Mangrove	Mangrove
2	02°09'50,1" LS 104°54'16,6" BT	Mangrove	Mangrove
3	02°09'49" LS 104o54'02,2" BT	Mangrove	mangrove
4	02°087',6" LS 104°54'02,2" BT	mangrove	Mangrove
5	02°08'8,2" LS 104°54'20,6" BT	Mangrove	Mangrove
6	02°08'07,9" LS 104°54'1,3" BT	Mangrove	Mangrove
7	02°09'46,4" LS 104°53'38,8" BT	Ponds	Ponds areas
8	02°10'18,8" LS 104°53'3,4" BT	Ponds areas	Ponds areas
9	02°10'39,5" LS 104°54'35,9" BT	Ponds areas	Ponds areas
10	02°10'9,7" LS 104°53'1,9" BT	Mangrove shrubs	Mangrove shrubs
11	02°09'50,1" LS 104°54'16,6" BT	setlement	setlement
12	02°14,9'13" LS 104°49,9'58" BT	mud	Mud
13	02°09'57,7" LS 104°54'41,34" BT	Water areas	Water areas

The green color on the geometric correction map (see Fig. 3) shows the area of the mangrove forest. The mangrove forests are the largest area and dominate the coastal areas of Banyuasin. Identification of green color as the vegetation region amplified by several studies [16], [17], [18] and [19] who states the color green to dark green on the imagery data is prove the existence of the vegetation on conversion ground check.

The results showed an area of green in the image is the reflectance of vegetation. Reflectance is clearly visible in the images in the infrared channel. Areas of light green color in the map view of land use in the mangrove areas indicate the presence of mangrove shrubs. Conversion ground check showed that 42.69% of the region 1 of SPTN is mangrove areas and 17,41% is mangrove shrubs. Types of mangrove shrubs dominate the region and identified is *Acrostichum speciosum*, *Acrostichum aureum* and *Derris trifoliata.*

Acrostichum sp is a shrub that grows only in mangrove areas are disturbed. The mangrove shrubs have relatively fast growth and can grow up to 4 m. These bushes can interfere with the growth of mangroves. *Derris trifoliata* mangrove shrub types that grow in mangrove succession areas, so that these types are found in mangrove area that has been burnt [20].

The dark blue color on a geometric map is indicated as the area of marine waters, while the light blue area is the area of the pond. The results of image enhancement have shown that the bund and checkered with black to dark blue identified as a water region and ponds or open land [18], [21], [22].

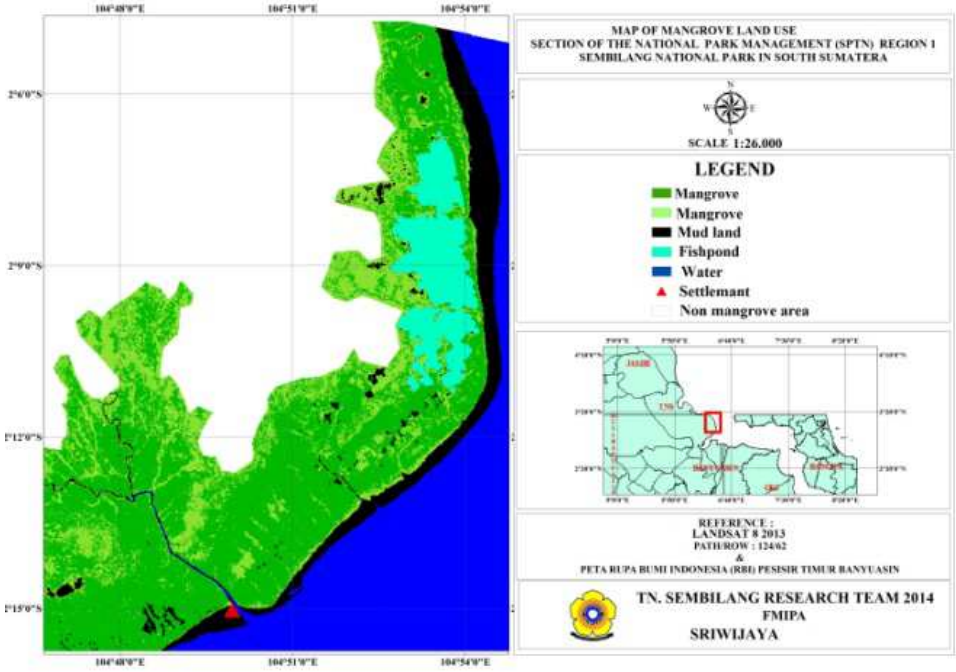

Fig. 3 Map of mangrove land use in Region 1 of the National Park Management Section (SPTN) in Sembilang National Park, South Sumatra

Black spots on a map were shown as depicting land use area of the former farm. This area has been abandoned and has not been restored. Black areas along the coast of the mainland mud were formed by the influence of the tides, sedimentation, and erosion in coastal areas.

Tidal and abrasion effect on the rate of increase of sludge land along the coast and caused the shifting shoreline. Described by [23] shift of the shoreline is strongly influenced by the rate of coastal erosion and accretion (sedimentation). Abrasion is the process of erosion of the coastline due to high tides and strong ocean currents, while accretion (sedimentation) is the process of the presence or addition of a land area for sediments carried by sea water [24].

Sedimentation and abrasion that occurs in mangrove areas disrupt local ecosystems. Excessive sedimentation causes a rise in the ground and reduces the influence of the tide. In addition, high sedimentation resulted in the closing of the mangrove roots and interferes with the growth of mangroves [25].

Orange triangle symbol is shown on the maps depicting land use for settlement areas and identified in the waters of the Muara of Bungin river. The settlement occupied by fishermen or also just a stopover for fishermen who come from outside the region. The results of the conversion of ground check for classification on land use maps of mangrove areas in Region 1 TNS SPTN shows the area of mangrove class is 7.595,11 ha (42.69%), mangrove shrub is 3171.83 ha (17.41%), ponds areas is 1.561,04 ha (8:57%), waters area is 4.240,77 ha (23.28%), and mainland of mud is 1.649,11 ha (9.05%). The percentage of the area obtained as a result of the conversion of the total area observed in the study.

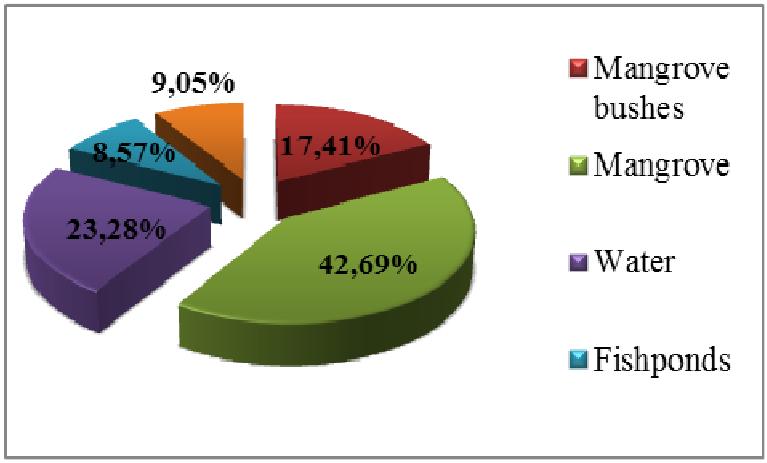

Fig. 4 Percentage of land use in the mangrove areas in SPTN Territory Sembilang National Park, South Sumatera

Lost and increase of agricultural land is directly proportional to the decline of fish, shrimp, and crab. It is associated with the reduced function of the mangrove forest as a refuge and breeding ground for several species of fish, shrimp, and crabs [20]. Reduction of mangrove forest land due to anthropogenic activities such as land conversion into settlement area, agricultural areas, and industrial causes increased levels of pollution in water [23]. Socio-economic impacts, loss of mangrove forests reduce the income of coastal communities. Data from Department of Forestry 2008 [24] showed cause of the damage to the economy and well-being of coastal communities was the loss of mangrove forests or coastal ecosystems.

The decrease in mangrove forest and farmland increased proportionally to the reduction in the population of fish, shrimp, and crab [21]. This relates to the function of mangrove forests as a refuge and breeding sites of some species of fish, shrimp, and crab. Reduction in mangrove forest land due to anthropogenic activities such as land conversion into residential areas of agriculture, industry led to increasing levels of pollution in the waters [25].

Changes in land use impacts are not good for mangrove forests. The impact of the destruction of mangrove forests can be viewed in terms of ecological and social-economic. In terms of ecological, land-use change caused coastal erosion, storms and declining population of aquatic species such as fish, shrimp, and crab. Socio-economic, mangrove forest loss lowers income of coastal communities. Based on information from Department of Forestry in 2008, it is showed that the cause of the deterioration of the economy and the welfare of coastal communities is the mangrove forest loss or damage to coastal ecosystems [26].

Fig. 5 Condition of Banyuasin coastal areas in South Sumatra (A) Mangrove, (B) mangrove shrub, (C) Pond, (D) Waters area, (E) Mainland of mud and settlement area

To determine the condition of mangrove land-use area of the ground check can be seen in Figure 5 and to map mangrove land-use areas in this study can be seen in Figure 2. The condition of ground check results in the study area is shown in the following pictures.

Changes in land use in the mangrove area may occur as a result of or in anthropogenic sedimentation caused by the opening of the pond. The opening of the pond leads to reduce the diversity in the mangrove forest. In addition, it causes the decline of mangrove forest ecological functions. The sedimentation and erosion that occurred in the area of mangrove forest can cause interference in the region. Excessive sedimentation commonly led to a rise in the ground and reduced the influence of the tide. Any high rates of sedimentation resulted in the closing of the roots of mangroves and mangrove growth disruption [23].

IV. Conclusion

The land use in the mangrove areas in the National Park Management Section Region 1 in Sembilang National Park South Sumatera was observed. The results of the analysis and identification were performed by classified the mangrove areas into five classes, namely class mangrove, waters area, mangrove shrubs, mainland mud, and ponds areas. The classified and each area were measured respectively as follow; mangrove class 7.595,11 ha (42.69%), mangrove shrub 3171.83 ha (17.41%), ponds areas 1.561,04 ha (8.57%), water area 4.240,77 ha (23.28%), and mainland mud 1.649,11 ha (9.05%). Percentage of the area obtained as a result of the conversion of the total area observed in the study.

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REFERENCES

[1] Y. Xie, Z. Sha, and M. Yu, "Remote Sensing Imagery In Vegetation Mapping: a review", J Plant Ecol (2008) 1 (1): 9-23.

[2] S.A. Sader, and S. Jin. "Feasibility And Accuracy Of Modis 250m Imagery For Forest Disturbance Monitoring" in ASPRS 2006 Annual Conference Reno, Nevada May 1-5, 2006.

[3] Y. Handayani, S.Bambang, and M. Maya, "Potential of Fisheries and Marine Resources in the East Coast Banyuasin And Management Efforts To Increase Farmers And Fishermen Welfare," M.Si., thesis, Sriwijaya University, Palembang, Indonesia, 2007.

[4] Y.Windusari, E.Saleh, and Sarno, "Modelling of sedimentation patterns in the eastern coastal region Banyuasin in South Sumatra and the detection of landscapes changes in mangrove forest based on Landsat data," Final Report of Fundamental Research of Sriwijaya University, unpublished, 2014.

[5] M. G. Abdullahi, M. K. A. Kamarudin, R. Umar, A. Endut, S. I. Khalit, H. Juahir. "Night Sky Brightness Assessment in Nigeria Using Environmetric and GIS Technique", IJASEIT Vol.7 No. 1 ISSN: 2088-5334, 2017

[6] A.A.Affandi, I. Iskandar., and H. Surbakti, "Assessment of risk and adaptation fishing pond against global climate improvement in coastal areas Banyuasin to support the food security program," Final Report of Fundamentals Research of Sriwijaya University, unpublished, 2012.

[7] Wessels, K.J., R.S. De Fries, J. Dempewolf, L.O. Anderson, A.J. Hansen, S.L. Powell, and E.F. Moran. "Mapping regional land cover with MODIS data for biological conservation: Examples from the Greater Yellowstone Ecosystem, USA and Para´ State, Brazil". Remote Sensing of Environment 92: 67 – 83, 2004.

[8] Laurance, W. F., Lovejoy, T. E., Vasconcelos, H. L., Bruna, E. M., Didham, R. K., Stouffer, P. C., Gascon, C., Bierregaard, R. O., Laurance, S. G., & Sampaio, E. Ecosystem decay of Amazonian forest fragments: A 22-year investigation. Conservation Biology, 16, 605 – 618. (2002).

[9] Laurance, W. F., Gascon, C., Lovejoy, T. E., Laurance, S. G., Ferreira, L. V., & Rankin-De Merona, J. M. Biomass collapse in Amazonian forest fragments. Science, 278, 1117 – 1118. (1997).

[10] Japan Internasional Cooperation Agency [JICA], "Project Capacity Building For Restoration of Ecosystems in Conservation Areas," http://www.jica.go.ip/project/Indonesian/Indonesia/008/materials/pdf/leaflet2.pdf. [21 April 2014]

[11] Y.Windusari, Edward Saleh, Sarno, and Laila Hanum, "Substrate characteristic and its impact on distribution of mangrove species : A case study in Sungai Barong Kecil in the Sembilang National Park at Banyuasin, South Sumatera," Journal of Biological Researches, Vol. 19, pp. 82-86, 2014.

[12] I.S Arifin, "Identification of Land Use by Using Landsat Thematic Mapper", Bulletin of Agricultural Engineering 8 (2): 54 p., 2003.

[13] M.F.Januardi, "Mangrove Vegetation Biomass Estimation Using Landsat Thematic Mapper Data (Case Study in the concession area of PT. Bina Leston, Indragiri Hilir, Riau)," [thesis]. Bogor: Forest Management Department, Faculty of Forestry, 1998.

[14] K. Hafeez and M.A.U Khan. Application of Geographic Information System for the Installation of Surge Arrestors on over head 132 k-v Power Line. IJASEIT Vol 12 No 6. ISSN : 2088-5334, 2017.

[15] J.S. Allen, K.S. Lu, and T.D. Pott, "A Gis-Based Analysis And Prediction Of Land-Use Change In A Coastal Tourism Destination Area".pp. 287-297, 1999.

[16] Y.Windusari, and S.P.Sari, "Change detectin of vegetation using landsat imagery in modified Ajkwa deposition area (Mod-ADA) at Freeport Indonesia Ltd in Papua Indonesia," Proceedings of the 9th International Symposium on Lowland Technology, pp. 593-596, ISSN 4-921090-06-8, September 2014.

[17] L.Novianti, "Land Cover Change Analysis Area of East Coast Banyuasin with Change Vector Analysis Method," [thesis]. Semarang: Diponegoro University, Graduate Programme, 2012.

[18] A, Ismail, "The Effects of Land Use Change on Watershed Hydrology Characteristics Darma, Kuningan regency, West Java province," [thesis]. Jakarta. Faculty of Mathematics and Natural Sciences, ost Graduate Programme in Geography, University of Indonesia, 2009.

[19] Y.S.Noor, M. Khazali, and F.I.N.N. Suryadiputra, "Guide Introduction of Mangroves in Indonesia," PKA Department of Forestry and Wetlands International Indonesia Programme, p. 217, 1999.

[20] A.Putthividhya, S.Jirasirilak, A.Amto, And S.Petra, "GIS-Based Statistical Analyses Of Direct Surface Water-Groundwater Correlations In Thailand," Proceedings Of The 9th International Symposium On Lowland Technology, pp. 496-503, ISSN 4-921090-06-8, September 2014.

[21] N.Suwargana, "Analysis of Changes in Mangrove Forest Using Remote Sensing Data in Pantai Bahagia, Muara Gembong, Bekasi," Journal of Remote Sensing 5, pp. 64-74, 2008.

[22] A.Taofiqurohman and M.F.A.Ismail, Coastline Changes in the Coastal Subang regency, West Java. Journal of Tropical Marine Science and Technology Vol.4 No.2, pp. 280-289, 2012.

[23] R.Dahuri, J. Rais, S.P. Ginting and M.J. Sitepu, "Management of Coastal and Marine Resources", Bogor Agriculture Institute, p. 328, 2004.

[24] C. Saparinto, "Utilization of Mangrove Ecosystems," Semarang: Dahara Prize, p. 236, 2007.

[25] R. E. Arhatin, "Study of Mangrove detection Using RADARSAT in the region of Cita Benoa, Bali," [thesis]. Faculty of Fisheries and Marine Sciences, Bogor Agricultural Institute, Department of Marine Sciences and Technology, p. 112, 2000.

[26] A.Atmanegara, "Applications of Remote Sensing and GIS for Land Use Mangrove in Serdang Bedagai, North Sumatra province, Indonesia" [thesis]. Terrain: Department of Forestry, Faculty of Agriculture, University of North Sumatra, 2010