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Analysis of Forest Function Transfer to Oil Palm Plantation in Parenggean District with the Remote Sensing Approach and Geographic Information System

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Abstract: The island of Kalimantan is one of the islands that has a vast forest. Kalimantan Island is also the most important island for Indonesia, even the world. Parenggean is one of the sub-districts located in Kotawaringin Timur Regency, Central Kalimantan Province. Parenggean sub-district with an area of 493.15 km² is one of the sub-districts in East Kotawaringin Regency which has a very large oil palm plantation. This study will present data on the amount of forest land cover that has been converted. To get extensive forest conversion, this research uses the Remote Sensing and Geographic Information Systems approach. The result of research this proves there have been over the function forests became oil palm plantation in Parenggean District. The area of forest that was converted into oil palm plantation in the research area is 5,143.15 hectares in 1990-2000 and 17,560.45 hectares in 2000-2010.

Keywords: Remote Sensing, Geographic Information System, Forest Conversion, Oil Palm, Parenggean

1. Introduction

Transfer of land functions in Law No. 41 of 1999 article 19 is known as a change in the designation and function of forest areas. In this definition, forest conversion can be said to be a change in forest areas that are focused on supporting interests outside of forestry, both for the benefit of residents' homes or others (Student, 2017).

The conversion of forests can have a negative impact on all living things, including reducing the quality of Oxygen (O2) caused by the reduced number of plants in the forest, so that less oxygen is produced. When the rainy season arrives it results in the arrival of floods, the number of trees that are little able to absorb rainwater. Conversely, during the dry season, the drought will hit, as a result of the number of trees that absorb very little water, so that the water in the soil is also small. Plants and trees in the forest area reinforce the soil structure, so when there is heavy rain, the water does not directly hit the ground, because the trees will hold back, as well as absorbing rainwater, but with very little forest conditions, causing rainwater to directly hit the ground, so can cause landslides (PKK, 2016).

According to data released by the Ministry of Forestry, deforestation rates in Kalimantan from 2000 to 2005 reached around 1.23 million hectares. This means that around 673 hectares of forests in Kalimantan experience deforestation every day in that period. According to Greenpeace, only 25.5 million forests in Kalimantan remain in 2010 (Profauna, 2011). The expansion of large investments in East Kotawaringin is indeed quite fast. The negative impact of this massive expansion is the reduction in forest area (Wardani, 2015).

One of the major investment expansions occurred in the Parenggean Subdistrict area, which is the field of oil palm plantations. The area of oil palm plantations in Parenggean District is 5,833.33 hectares according to BPS Kotawaringin Timur (BPS, 2015). However, this number is smaller than Parenggean District, which is 49,315 hectares. Including the remaining ones. With such extensive coconut plantations, it is very strange during the dry season of the Parenggean Sub-district community that it is difficult to find clean water (Norjani, 2015). To see the actual area of forest and oil palm, it is necessary to analyze the transfer function using the remote sensing and geographic information system approach with the unsupervised classification method in the Parenggean District,

Kotawaringin Timur District, Central Kalimantan Province.

The purpose of this research in the Parenggean sub-district is to find the area of forest land cover that has been converted into an oil palm plantation. The method used to obtain this area is the remote sensing method. Thus, the benefits obtained from this research are knowing forest conversion over a period of 20 years (1990, 2000, and 2010).

2. Literature Reviews

2.1 Previous Research

As a reference for this study, using previous research, namely from a journal with the title "Estimation of Changes in Rice Fields with Classification Unsupervised of Evi Modis Image in West Java Province". This research was carried out, because of changes in rice fields into non-rice fields in West Java Province (Sampurno, Bunyamin, & Herwanto, 2017).

The second previous study, namely "Analysis of Forest Function Transfer to Plantation Land Through Landsat Satellite Image Data with Supervised Classification Method" (Hanindito, Sediyono, & Setiawan, 2017). The research was carried out on the basis of the occurrence of large land clearing for coconut plantation so that the land which constituted the forest became increasingly diminished.

The third previous study, namely "Analysis of Transfer of Functions of Gardens and Trees into Urban Areas in Salatiga City, Central Java Province with Remote Sensing and Geographic Information System Approach" (Yosafat & Papilaya, 2017). This research was conducted on the problem of population density in Salatiga City. So that the effect on the area of the garden and trees becomes increasingly reduced, while the area of urban is increasing.

The fourth previous study, namely "Analysis of Changes in the Coverage of Forest Land and Plantations in Jambi Province Period 2000 - 2008" (Muttaqin & Aini, 2011). This research was conducted on the basis of the vast extent of forests in Indonesia. so that the extent and condition of the forests that still exist in Indonesia are difficult to know from government-issued statistics.

2.2 Theoretical Basis

Remote sensing

Remote sensing is one method of observing or measuring the spatial elements of the earth's surface (Eddy, 2008). Remote sensing in this study was conducted to determine the extent of forests that were converted into oil palm plantations. Remote sensing data consists of a matrix of images known as pixels (picture element). Pixel is the smallest unit of satellite imagery. The spatial accuracy of an image is expressed by the number of pixels per millimetre. Image spatial accuracy (image resolution) is expressed as the area of the ground surface covered by one pixel. Each pixel in the image states an area of the surface of the earth (Indarto, 2017).

Image Interpretation

The study was conducted by classifying Landsat 5 satellite images in 1990, 2000, and 2010. Image classification is a process of compiling, sorting, or grouping all pixels into several classes, based on a criterion or object category, to produce a "thematic map" in raster form. The type of classification used is the unsupervised classification. Non-guided classification (also called non-supervised classification) is a method needed to transform multi-spectral image data into thematic information classes. Thus, this classification process is carried out assuming that the relevant image data consists of several bands (multi-spectral) imagery (Eddy, 2008).

The method used in non-guided classification is the K-Means clustering method, in this method the researcher requires to select the number of classes located in the data, then the system will group the data into predetermined group classes (Geospasial, 2014).

K-Means is used with the assumption that the number of clusters is known (Wiguna, 2017). The K-Means algorithm is used in this study because the K-Means algorithm can partition data into clusters so that data with the same characteristics are entered into the same group and data with different characteristics are grouped into other groups.

There are advantages and disadvantages to the unsupervised classification method.

- The advantages of the unsupervised classification method are:
  1. Does not require knowledge or introduction to the area under study.
  2. Possible errors because human factors can be minimized.
  3. The operator simply determines the number of classes that he wants to make.
- The lack of the unsupervised classification method, namely:
  1. More due to the difficulty in connecting between groups of pixels that are natural with the class of information you want to make.
  2. Non-guided classification will identify a homogeneous spectral class between data that is not always related to the class of information we want.
  3. Operators have limited control to control class menus and special identities, and the spectral properties for certain classes of information can change over time (Indarto, 2017).

Band Combination

The band combination in Landsat 5 used in this study is 742. Band 7 is a band for observing vegetation humidity, band 4 is used to define land-water boundaries and vegetation type/class, then band 2 is used to observe greenness vegetation (Eddy, 2008). Each band used has a wavelength that varies with the same spatial accuracy. For band 7 has a wavelength of 2.08-2.35 micrometres with a spatial accuracy of 30 meters, band 4 has a wavelength of 0.76-0.90 micrometres with a spatial accuracy of 30 meters, then band 2 has a wavelength of 0.52-0.60 with a spatial accuracy of 30 meters (Indarto, 2017).

Spatial Analyst

Spatial analysis is a set of techniques that can be used in processing GIS data. Spatial analysis can be interpreted as techniques which are used to research and explore data from a spatial perspective. All

mathematical calculation techniques or approaches related to spatial data are perf (IPB, 2016).

In this study, the spatial analysis used is a type of spatial analysis of broad measurements and alteration of spatial elements (split or clip). The function of spatial analysis of the type of broad measurement is used to calculate the area of a spatial element, the region can be either a polygon (vector) or a region of a raster type. Changing spatial elements with split or clip aims to produce new spatial elements by cutting them from other spatial elements (IPB, 2016).

3. Literature Reviews

This research uses quantitative methods. The quantitative research method is a method used to answer research problems related to data in the form of numbers and statistical programs. In quantitative research, researchers are not required to attend and meet directly with research respondents (researchers can use or use other people to collect data) (Sugiyono, 2011).

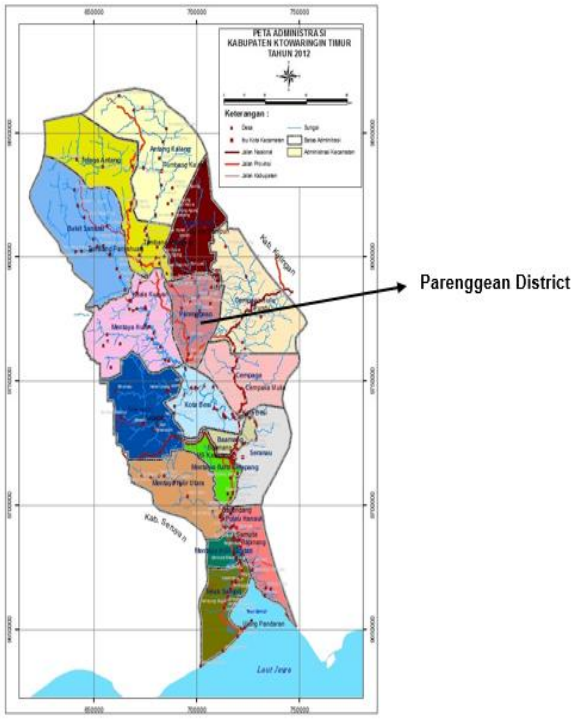


Fig 1. Study Area: Parenggean District

The location used for forest conversion research is the Parenggean District of East Kotawaringin Regency, Central Kalimantan Province. Parenggean sub-district has an area of 493.15 km² if converted to hectares, which is equal to 49,315 hectares. Parenggean sub-district is one of the sub-districts that has the largest oil palm plantation in Kotawaringin Timur district (BPS, 2018).

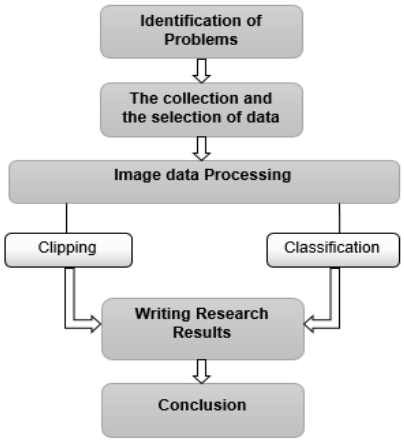


Fig 2. Research flow

The research was carried out through the steps in Figure 2 (1) Identification of the dangerous problems of forest conversion into oil palm plantations, (2) conducting data collection for research in the form of Landsat imagery and research area maps, (3) processing image data by doing Clip imagery and cover classification land, (4) writing reports from the results of research that has been done, and (5) concluding the results of the study.

Image data collection is done by documentation, which is downloading image on the *earthexplorer.usgs.gov* website. The data used in this study are Landsat image data with the acquisition of different times. Retrieving image data by considering cloud cover or cloud cover at the location after cutting according to the area for the study. The less cloud cover, the easier the analysis process will be.

Table 1. Characteristics of data used

Satellite	Date of Acquisition	Cloud Cover
Landsat 5	June 18, 1990	< 10 %
Landsat 5	March 9, 2000	< 10 %
Landsat 5	January 16, 2010	< 10 %

Table 1 shows the three pieces of Landsat 5 satellite image data used for this study. The three images of the Landsat 5 satellite have different acquisitions. With cloud cover rates of less than 10 percent (<10 %).

In the research made using digital image processing methods. The accuracy of the digital image is determined by sampling (when converting analog to digital signals). This data (digital image/softcopy) can also be converted into images or analog images (imagery) as well as photos or maps (hardcopy).

Fig 3. Sorting of the classification process

Image classification (in digital images) is a process of composing, sorting, or grouping all pixels (contained within the relevant image bands) into several classes (groups) based on criteria or Each pixel contained in each of these classes (classification results) is assumed to have homogeneous characteristics. The purpose of this process is to extract the spectral response patterns (especially the dominant ones) contained in the image itself, generally in the form of land cover classes (Eddy, 2008).

4. Literature Reviews

Band Combination

Color classification in bands 7,4,2 in Landsat 5. This band combination is used to show "natural likes".

- Dark green forests tend to be dark and there are/do not have logged marks.
- Bush shrubs are light green and have logged marks.
- Empty land is pink to dark red.
- Water is Blue.
- Oil palm plantations have clear and regular boundaries.

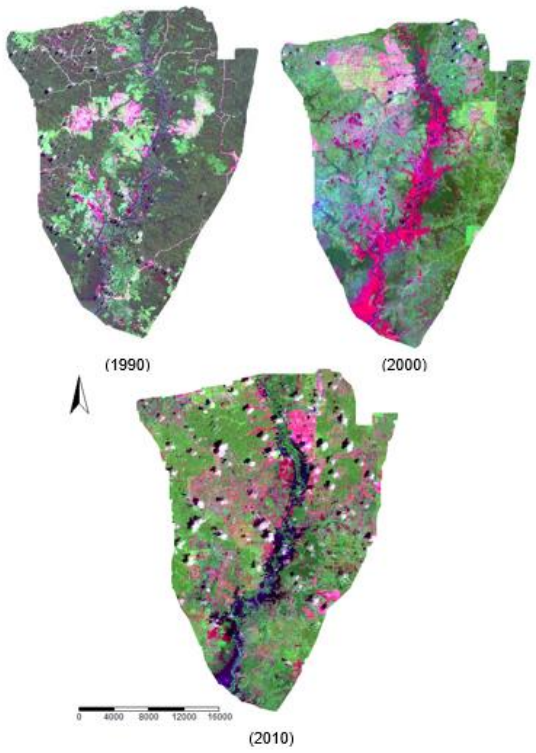


Fig 4. Band Combination Results

Through analysis of Landsat 5 TM satellite imagery, using an unsupervised classification method, the resulting 742 band combination is obtained in figure 4. Judging from each year there is a clearly visible change that occurs over 10 years, from 1990 until 2000 and changes from 2000 to 2010. These changes can be observed based on the colors that appear from the three images above.

Figure 4 of 1990 shows that dark green dominates compared to other colors, indicating that in 1990 the forest in Parenggean sub-district was still maintained. Figure 4 in 2000 dark green began to decrease and oil palm land began to appear, indicating that the forest area in the Parenggean sub-district had decreased. Figure 4 in 2010, dark green is almost non-existent, even the area of oil palm plantations is increasingly widespread, so the forest is almost non-existent.

Classification

The results of the cover classification and analysis of land use conversion in the Parenggean sub-district were obtained that in the span of each 10 years, namely from 1990 to 2000 and in the years 2000-2010, the function of forest land became oil palm plantations. For several classes, namely dense forests, medium forests, shrubs, empty land, water bodies, and oil palm.

Table 2. Land cover areas in Parenggean District

Class	The area in Years (Hectares)		
	1990	2000	2010
Water	586.44	620.19	4,677.03
Forest	43,388.68	25,162.69	7,658.19
Oil Palm	0	5,753.25	27,623.88
Empty land	3,420.20	10,494.09	3,738.42
Shrubs	1,919.68	7,284.78	5,617.44
Total	49,315.00	49,315.00	49,315.00

Table 2 is the calculation results obtained from the classification of Landsat 5 images in 1990, 2000, and 2010. In the table, the area of each class has been presented, based on the year calculated by area in hectares.

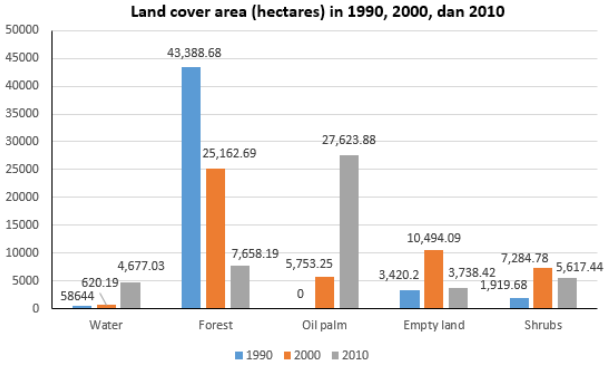


Diagram 1. Comparison of land cover area

In diagram 1, it can be seen that the area of the water body continues to increase in a row in 1990-2010 which is equal to 586.44 hectares, 620.19 hectares, and 4,677.03 hectares. From the data from 1990-2000, the area of water bodies increased by 0.1% from the area of Parenggean District. Then in the year 2000-2010 again there was an increase in the area of water bodies by 8 %.

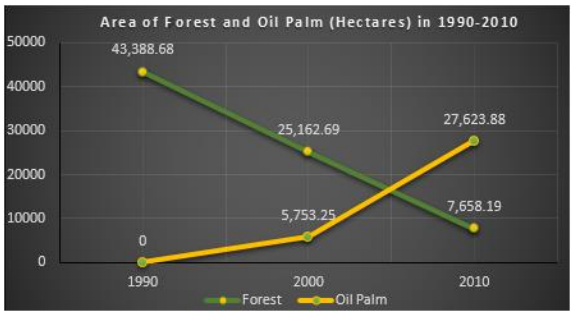
Forest area in a row from 1990-2010 was 43,388.68 hectares, 25,162.69 hectares, and 7,658.19 hectares. From these data in 1990-2000, the forest area decreased by 37 %. Then in 2000-2010 again there was a decline in forest area by 35 %.

The area of oil palm plantations from 1990-2010 continued to increase, which in 1990 there were no oil palm plantations, but in 2000 there were oil palm plantations with an area of 5,753.25 hectares or 12 %. For 2010 the area of oil palm plantations was

27,623.88 hectares. In 2000-2010 there was an increase in the area of oil palm plantations, which amounted to 42 %.

In 1990 empty land area of 3,420.20 hectares, in 2000 amounted to 10,494.09 hectares, and in 2010 amounted to 3,738.42 hectares. From the data from 1990-2000, the area of vacant land increased by 14%. Then in 2000-2010, there was a decrease in the area of vacant land which was equal to 13 %.

In 1990 extensive shrubs amounted to 1,919.68 hectares, in 2000 amounted to 7,284.78 hectares, and in 2010 amounted to 5,617.44 hectares. From the data in 1990-2000, the area of shrubs increased by 10.93 %. Then in 2000-2010, there was a decline of 3%.



Graph 1. Statistics on the extent of forest and oil palm

It can be seen in graph 1 that the forest area from 1990 to 2010 has decreased so high. The forest area in 1990 was 43,388.68 or 84 % of the area of Parenggean District. Then in 2000, it dropped to 25,162.65 hectares (49 %), the decline in forest area continued until 2010, namely the remaining 7,658.19 hectares (15 %).

In contrast to the forest area that has declined from year to year, the area of oil palm plantations has actually experienced a very significant increase. In 1990 there were initially no oil palm plantations, the longer it began to show very clear changes in 2000 there were oil palm plantations of 5,753.25 hectares or 11% of the area of Parenggean sub-district, then in 2010, the area of oil palm plantations rose to 27,623.88 hectares or 45 %.

Figure 5 is the land cover of Parenggean sub-districts in 1990, 2000, and 2010. In figure 5 a, in 1990 forest land cover was very dominant compared to other land covers. This dominance was caused because in 1990 there was not much forest clearing for plantations or anything else.

In figure 5 b, the dominance of the forest (green) in 2000 is clearly reduced. This is because land clearing in that year has begun to occur. Marked by the emergence of oil palm plantations (purple) and other land cover has expanded compared to 1990 (white). In figure 5 c, the dominance of forest land cover has decreased very high even the forest is almost invisible. This is due to land clearing for oil palm plantations on a large scale. This is indicated by the dominance of purple land cover which is the land cover for oil palm plantations.

Confusion Matrix

Table 3. Confusion Matrix 1990-2000 (Hectares)

Year		2000				
	Class	Forest	Empty land	Water	Shrubs	Oil palm
1	Forest	25,000.11	10,100.00	42.00	3,103.42	5,143.15
9	Empty Land	1.25	98.10	29.82	2,681.00	610.03
9	Water	8.38	55.74	520.43	1.84	0.05
0	Shrubs	152.91	240.25	27.94	1,498.52	0.06

Table 3 is the area of land use change based on the 1990 confusion matrix to 2000. The largest conversion of forest functions is to become vacant land of 10,100.00 hectares. This can be estimated in 2000 when clearing land was cleared for the preparation of oil palm plantations. Then for vacant land to become its own forest which is equal to 1.25 hectares, it is estimated that this happened because of the emergence of forest management by the local community.

Then the change in forest land is quite large after the vacant land is to become an oil palm plantation which is equal to 5,143.15 hectares. This can occur because of the entry of oil palm plantation companies in the Parenggean region.

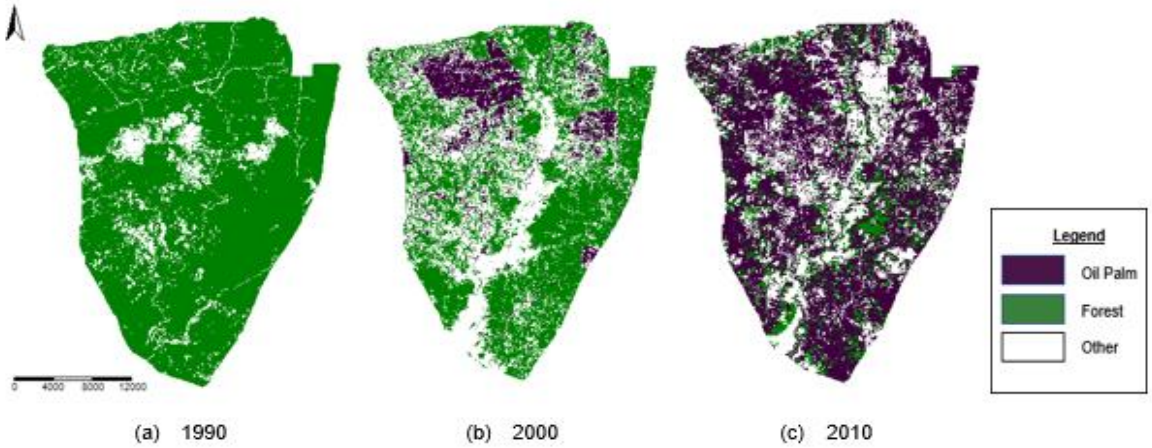


Fig 5. Map of Classification Results

Table 4. Confusion Matrix 1990-2000

Year		2010				
	Class	Forest	Empty land	Water	Shrubs	Oil palm
2	Forest	5,505.10	723.20	1,086.73	287.21	17,560.45
0	Empty Land	112.47	1,223.75	2,467.39	5,239.19	1,451.29
0	Water	534.44	17.96	48.60	7.75	11.44
0	Shrubs	1,505.66	1,772.50	1,073.60	82.21	2,850.81
	Oil Palm	0.52	1.01	0.71	1.08	5,749.93

Table 4 is the area of land conversion based on the 2000 confusion matrix to 2010. The biggest change in forest land is to become an oil palm plantation of 17,560.45 hectares. This can be expected due to the addition of the oil palm plantation area by companies in the Parenggean area. Meanwhile, the area of oil palm plantations that turned into forests alone was only 0.52 hectares. This is possible because there is no maintenance, so that wild trees grow in the area.

Then the biggest change after forest land into oil palm plantations is the change from vacant land to shrubs which is equal to 5,239.19 hectares. This can be estimated because the land is intended for oil palm plantations. However, it has not been planted, so it becomes shrubland.

5. Conclusion

Based on the research conducted, it was concluded that the conversion of forest land into oil palm plantations in Parenggean District was growing very rapidly. This has been proven based on research through an analysis of Landsat satellite images in the period 1990 to 2010.

Analysis of changes in forests to oil palm plantations in Parenggean sub-district was carried out using three remote sensing data, namely Landsat 5 satellite images in 1990, 2000, and in 2010. Through analysis of satellite images using the unsupervised classification method, it was found that oil palm plantations more increasing. It is inversely proportional to forest land which actually experienced a very high decline. This is expected to be a special concern for the threat of forest destruction in Parenggean District.

6. Disadvantages and Recommendations

From this study there are deficiencies, namely using the unsupervised classification method, whereby using this method, for cloud cover on Landsat images is detected to be a class of water bodies. Because researchers cannot determine their own class. From the shortcomings of this study, for the sake of suggestions for further research, researchers are expected to use the supervised classification method. Because with this method, researchers can determine their own class.

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