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# Mapping The Rate Of Deforestation In South Kalimantan Using Landsat Imagery

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## ABSTRACT

South Kalimantan Province is an area that has a very large forest area, but this forest continues to decrease due to deforestation. Deforestation continues to be one of the factors causing flooding. Flooding in this area is a recurring disaster that must be overcome. For this reason, it is necessary to calculate changes in forest area so that forest processing can be carried out properly and that banners can be overcome. In this study, the rate of deforestation was calculated using a map of land use change in South Kalimantan Province through the google earth engine platform using Landsat imagery. The method in this research is supervised classification, which is taking polygon samples in land use classification. The image classification algorithm with javascript on the google earth engine platform will classify the same pixel values into the same classification based on the samples that have been made. Through this platform, images in geo.tif format will be obtained. then the image is processed using ArcGIS software to process the image into a map and the area of each classification. This map was then overlaid between 2015, 2018, and 2020 to see the changes. Based on the results of the study, it was found that there was a change in land use, especially in the forest class and community plantations. Forests decreased to 311,255 hectares with a decreasing rate of 62,251 hectares every year, while community plantations increased by 328,858 hectares with an increase of 65,771 hectares every year.

**INDEX TERMS** *Deforestation, Land Use, South Kalimantan.*

## I. INTRODUCTION

Indonesia has a fairly large forest area, which is around 120.35 million hectares with the availability of very abundant forest resources in the form of wood or tree trunks which have very promising economic value [1] [2] [3] [4]. However, timber exploitation and community intervention can lead to deforestation [5] [6]. One of the areas experiencing deforestation is the forest in South Kalimantan [7]. The decreasing forest area continuously affects the water catchment area. The less forest area, the less water catchment area [8] [9] [10]. This reduction in forest area is a serious problem because it can cause natural disasters such as floods [11] [12]. Floods in South Kalimantan are a recurring disaster [13] [14]. Data from the BNPB show that this province has experienced severe flooding on multiple occasions, which has led to a number of fatalities and destroyed homes. A total of 111 floods occurred in this area between 2015 and 2020, with 38 of the worst occurring in 2020. From this data, it is noted that floods often occur in

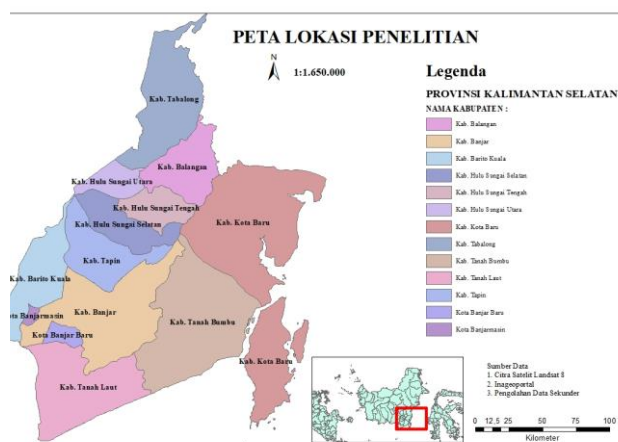
January, namely 54 times. In January 2021, floods also occurred in Kalimantan, one of which was in South Kalimantan Province which inundated 7 of the 11 regencies/cities in this region [15].

Topographically, the South Kalimantan Province is a lowland area with an average height of 17 meters above sea level. The low location of the Province of South Kalimantan from sea level causes the flow of water on the land surface to be less smooth [16]. The existence of forests, especially forests in South Kalimantan, plays a very important role in reducing flooding that often occurs in this region. Therefore, it is necessary to calculate the forest area in a time series so that forest processing can be carried out properly. In this study, the rate of deforestation was calculated based on land use maps (physical classes of land such as forest, shrubs, rice fields, etc) using remote sensing methods, namely the research was carried out without direct contact with the obje-

ct [17][18]. For a large research area, including the province needed that allows users not to download the data. For this reason, the author uses Google's cloud computing-based repository service, known as the Google Earth Engine. The Google earth engine provides features designed to help researchers, policymakers, field workers, and even the general public and allows for land use classification using programming algorithms. Once the algorithm is developed on the google earth engine, users can generate systematic data products or implement interactive applications powered by the google earth engine resources [19] [20] [21]. Through this platform, land use classifications will be obtained in a geo.tif format. Furthermore, the data is processed in the ArcGIS software to create a map and the area of each classification so that the changes can be analyzed by overlaying the 2015 map, 2018, and 2020. From the results of this study, it can be seen that the color difference on the land use map for 2015 to 2020, namely in 2015 the land use map is dominated by green (forest), then in 2018 it began to decrease to light green (bushes), and until 2020 it was more dominated by purple (people's plantations). This land use change map was analyzed based on changes in the area of each land use classification and the rate of deforestation in South Kalimantan from 2015 to 2020 was 62,251 hectares every year.

### II. BACKGROUND OF STUDY AREA

South Kalimantan Province is located at a position of 1° 21' 49" - 4° 10' 14" at south latitude and 114° 19' 13" - 116° 33' 28" at east longitude with an area of 38,744.23 km<sup>2</sup> consisting of 11 regencies and 2 cities (Central Bureau of Statistics of South Kalimantan Province, 2022). The map of research area are shown in Figure 1.



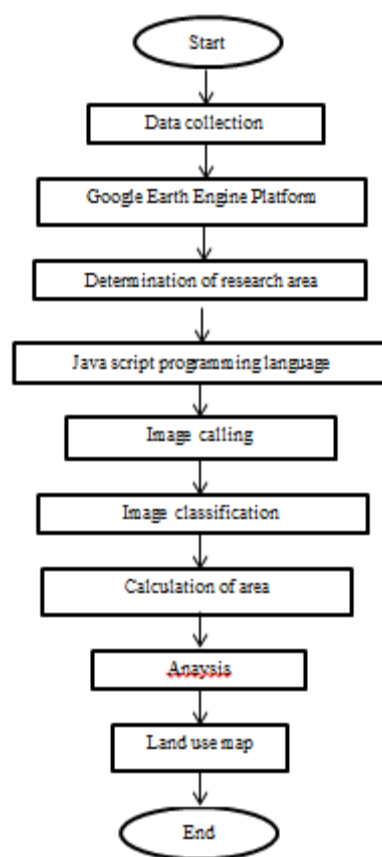
**Figure 1. Research Site Map**

The topography of the South Kalimantan Province is lowland with an average height of 17 meters above sea level (asl). The low location of this area from sea level causes the flow of water on the land surface to be less smooth. As a result, some areas are always inundated and some are periodically inundated. The pattern of land use in South

of South Kalimantan, software or a platform is Kalimantan Province is divided into built-up areas such as settlements, agriculture, plantations, road networks, and undeveloped areas such as vacant land, shrubs, forests, and watersheds. The pattern of land use in this area causes deforestation which has an impact on water catchment areas.

### III. METHODOLOGY

This study makes use of Landsat 8 imagery for its imaging. Images were employed for imaging. The purpose of this research is to produce a land-use map to see the rate of deforestation. This research is expected to produce information in the form of areas that have the potential for flooding based on changes in forest areas caused by changes in other land uses. The research procedure is depicted in a flowchart in Figure 2.



**Figure 2. Flowchart Research**

Based on Figure 2, the procedures carried out in this study are :

- a. Image Acquisition Stage
 

The initial step in obtaining Landsat imagery is to access it from the Google Earth Engine (GEE) website, which is Landsat imagery for 2015 to 2020.
- b. Determination Of Research Area
 

Determination of the image area on the Google Earth Engine platform is carried out to limit the recorded image at

the location of the research to be carried out. Determination of this area using the administrative map of the province of South Kalimantan.

c. Image Band Calling

Given that each band in a Landsat image has a distinct function, Landsat imagery that can be accessed through the Google Earth Engine platform is available. Therefore, it is necessary to combine the image bands first to carry out further data analysis. Atmospheric correction is a relatively new radiometric correction algorithm. This correction is carried out by considering various atmospheric parameters in the correction process, including seasonal factors and climatic conditions at the location of the image recording. Radiometric correction is carried out to eliminate interference in the image due to the influence of the atmosphere. In calling the image through the google earth engine using the Landsat Top of Atmospheric (TOA) image, which means the image has been automatically radiometrically corrected or clean of disturbances in the air such as clouds.

d. Image Classification

Image This classification uses the supervised classification method, which is a method that is guided and controlled by researchers in the classification process. Supervised classification is carried out based on land cover classification analysis guidelines by making polygon samples on land use classes. The image classification algorithm used is maximum likelihood with the help of javascript which is run through the google earth engine platform. Maximum likelihood classification classifies pixel values based on the probability of a pixel value against a certain class in the existing pixel sample.

e. Area Calculation

Calculation of the area is carried out for all image classifications. The difference between each picture classification's coverage area and its rate of use change is calculated.

f. Output (Map Layout)

The final process of image interpretation is making the final result (output) in the form of a map of land use changes, either in the form of softcopy or hardcopy (printout).

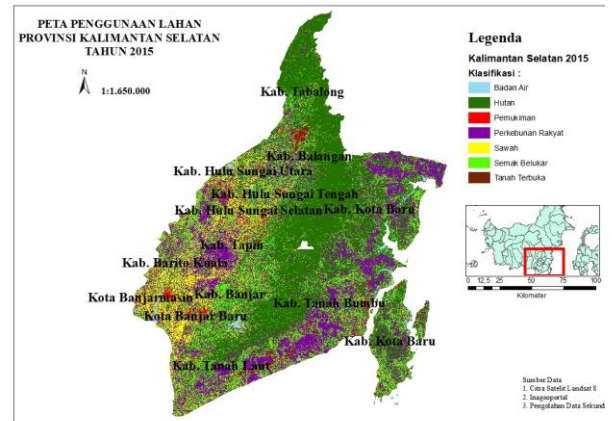
**IV. RESULTS AND DISCUSSION**

Mapping the rate of deforestation in South Kalimantan is a type of applied research. This research uses Landsat 8 satellite imagery as the imaging. The purpose of this research is to produce a map of the decline in forest area caused by deforestation. This research is expected to produce information in the form of areas that have the potential for flooding based on the rate of decline in forest areas in South Kalimantan Province caused by forest deforestation. The

process of mapping the rate of deforestation is carried out based on changes in land use. Changes in forest land use were obtained from the results of overlaying land change maps from 2015 to 2020.

1. Land Use Of South Kalimantan Province In 2015

For South Kalimantan, the land use map in 2015 are shown in Figure 3.



**Figure 3. Land Use Of South Kalimantan Province In 2015**

Based on Figure 3, the results of the interpretation of Landsat imagery in South Kalimantan consisted of seven land use classifications. The land use is given different colors, namely: 1) dark green is forest, 2) red is settlements, 3) purple is community plantations, 4) yellow is rice fields, 5) light green is shrubs, 6) brown is open land and 8) blue is water bodies. South Kalimantan land use map in 2015 is dominated by forest (dark green). Details of an area of each classification are shown in Table 1.

TABLE 1  
 DETAIL OF AREA OF EACH CLASSIFICATION

No	Classification	Large (Ha)
1.	Waterbody	8.404
2.	Forest	175.270
3.	Settlement	5.541
4.	People's plantation	97.470
5.	Ricefield	74.852
6.	Shrubs	103.914
7.	Open land	5.903

Based on Table 1, it can be seen the largest land use is a forest which is 1,431,528 Ha. Other land uses are water bodies in the form of rivers, lakes, reservoirs, and others amounting to 56,379 hectares, settlements of 48,307 hectares, people's plantations of 929,255 hectares, rice fields of 364,763 hectares, shrubs of 709,393 hectares, and open land of 62,031 hectares. These results are then compared with the results in 2018.

2. Land Use Of South Kalimantan Province In 2018

For Banjar District land use map in 2018 is shown in Figure 4.

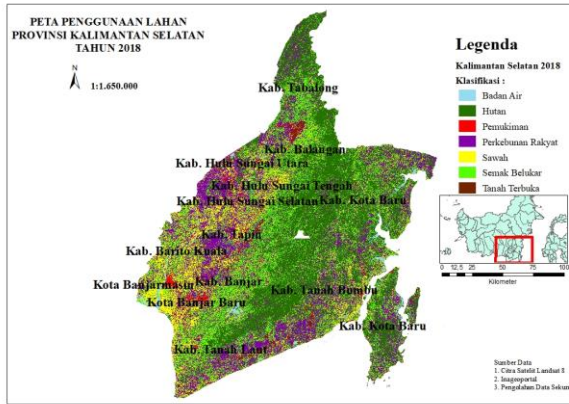


Figure 4. Land Use Of South Kalimantan Province In 2018

Based on Figure 4, it can be seen that the area is green land use is starting to change to light green (shrubs), and the purple color (people’s plantation) has increase. Details of an area of each classification are show in Table 2.

TABLE 2  
 DETAIL OF AREA OF EACH CLASSIFICATION

No	Classification	Large (Ha)
1.	Waterbody	8.328
2.	Forest	130.452
3.	Settlement	6.121
4.	People’s plantation	101.617
5.	Ricefield	61.249
6.	Shrubs	125.771
7.	Open land	10.601

Based on Table 2 It can be seen the means that the forest area has decreased to 1,249,406 Ha. This decline in forest area was followed by changes in other land uses, namely community plantations increasing to 1,017,795 Ha, open land increasing to 135,784 Ha, and residential areas increasing to 49,166 Ha. For land use of water bodies, rice fields and shrubs are still fairly the same.

3. Land Use Of South Kalimantan Province In 2020

For Banjar District land use map in 2020 is shown in Figure 5.

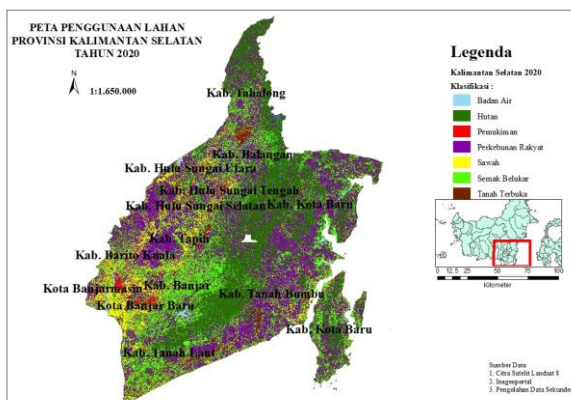


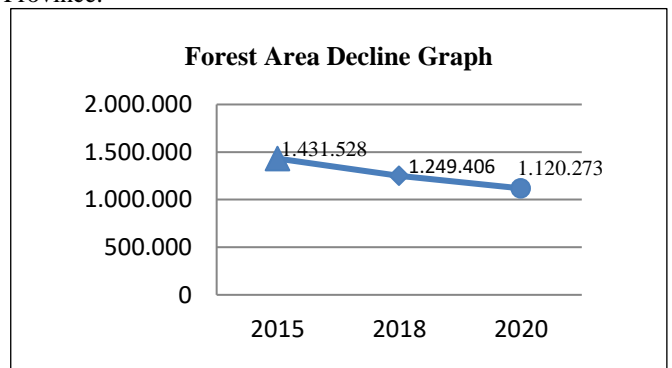
Figure 5. Land Use Of South Kalimantan Province In 2020

Based on Figure 5, it can be seen that the land use map in 2020 is dominated by purple (people’s plantation) and light green (shrubs). Details of an area of each classification are show in Table 3.

TABLE 3  
 DETAIL OF AREA OF EACH CLASSIFICATION

No	Classification	Large (Ha)
1.	Waterbody	8.120
2.	Forest	123.720
3.	Settlement	6.454
4.	People’s plantation	105.810
5.	Ricefield	51.805
6.	Shrubs	147.189
7.	Open land	14.652

Based on Table 3. It can be seen the means that the community plantations increased to 1,258,113 Ha, forests decreased to 1,120,273 Ha, shrubs rose to 896,724 Ha, and settlements also increased to 54,639 Ha. Meanwhile, the use of land for water bodies, rice fields, shrubs, and open land is the same as the previous year. The results of land use are overlaid to see the deforestation that occurs. The following is a graph of changes in forest land use in South Kalimantan Province:



From the graph, it can be seen that the forest in South Kalimantan Province is decreasing. From 2015 to 2020 the forest in this area decreased by 311,255 Ha, with the rate of decline being 62,251 Ha every year. This decrease in forest area was followed by an increase in other land uses especially plantations, which increased rapidly.

V. CONCLUSION

Based on the research conducted, it can be concluded that The rate of forest area decline in South Kalimantan Province is 62,251 Ha per year. The large decrease in forest area in this area is caused by the increase in other land uses, especially smallholder plantations, which are increasing rapidly. The rate of deforestation in South Kalimantan was obtained based on a map of land use change. The analysis was carried out by comparing the map of changes in land use per year, 2015, 2018, and 2020, it was found that there was a significant color change from dark green to purple. The

change was that 1,431,528 Ha of forest decreased to 1,120,273 Ha, while people's plantations of 929,255 Ha increased to 1,258,113 Ha.

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