Monitoring agricultural land-use change in Palaran Subdistrict, Samarinda City, East Kalimantan Province in 2006, 2014, and 2020

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Abstract. Land-use change is a regional development process and one type of land-use that has undergone many land-use changes in agriculture. Palaran Subdistrict, as one of the largest agricultural land in Samarinda City, has experienced an agricultural land conversion over the past 15 years, mainly caused by mining activities and thus led to the agricultural land reduction. This study aims to analyze agricultural land-use changes in 2006, 2014, and 2020 in Palaran Subdistrict, Samarinda City. The method used in this study is a spatial comparison of agricultural land-use in 2006 and 2014; also between 2014 and 2020 using Land Change Modeler tools in Idrisi Selva 17. Land-use obtained from manual digitation based on Landsat 5 imagery in 2006, Landsat 8 imagery in 2014, and Sentinel-2a imagery in 2020. This study's results indicate agricultural land-use change in the northern part of the Palaran Subdistrict that changed into a settlement. In the middle of the Palaran Subdistrict, that changed into a bare land area.

1. Introduction

Land-use refers to the purposes used on land, for example, recreation, wildlife habitat, or agriculture, emphasizing the functional role of land for economic activities [1,2]. The difference between land cover and land-use is that land cover shows the types of features on the earth's surface, while land-use is related to human activities in a land [3,4].

Humans use the land to meet their daily needs in line with the development of human civilization. Existing land continues to be exploited even though the land is included in the category of limited resources, so the land can fulfill the potential that exists in each land. To complete this, the way to do this is to change the existing land use.

Land-use change is a change in land-use type because of land-use change. Land-use change changes various land use types and results from interactions between humans and the physical environment [5,6]. Changes in land-use can occur anywhere from villages, big cities, and suburban areas [7]. In urban areas, what commonly happens is the land-use changes in non-built areas into the built-up area. The non-built site that changes their function the most is the agricultural area.

Changes in land-use, especially agriculture, are something that cannot be avoided in the development process. Many types of agricultural land-use have changed into developed land. Although agriculture is more sustainable in its ability to guarantee farmers' lives, it can only provide a
few material or financial benefits compared to the industrial, residential, and other service sectors. The conversion of agriculture cannot be prevented [8,9].

Palaran Subdistrict is one of the subdistricts in Samarinda City, an agricultural area [10]. Even though it is an agricultural area, agricultural land in Palaran Subdistrict has decreased from year to year [11]. The cause of the reduction in agricultural land in Palaran Subdistrict itself is due to mining activities that continue to develop and land fires that occur every year [12].

The mining industry's development in the Palaran Subdistrict has put the local agricultural sector in a difficult situation. Besides the agricultural land is decreasing, the remaining agricultural land is also damaged. It becomes less fertile due to a lack of nutrient content in the soil due to mining industry activities [11]. In line with this, several commodities' agricultural output has been decreased, such as rubber, rice field, and secondary crops [13]. Furthermore, the mining industry's development has also reduced the local people's welfare, causing them to sell their agricultural land [11]. Also, mining goods transporting has caused damage to the road that is usually traversed by the local people because the road was crossed by a heavy vehicle every day.

The agricultural land has changed massively from years to years, as seen from imagery. Based on that, it is needed to analyze agricultural land-use changes in Palaran Subdistrict, Samarinda City, to give people and stakeholders information about how agricultural land use has changed. To analyze changes in agricultural land-use using the spatial comparison method that is resulting land-use change map. It is expected that this research will be useful for the local government regarding spatial planning that pays attention to the impact on the surrounding environment.

2. Method
The method includes a description of the case study location and period. The exact location and period are chosen due to the theoretical need. Finally, the method also includes data collection and processing.

2.1. Case study location and period
This research is in Palaran Subdistrict, Samarinda City. Palaran Subdistrict is one of the subdistricts in Samarinda City. It had the second-largest area in Samarinda City after North Samarinda Subdistrict with a site according to the Samarinda City Central Bureau of Statistics in 2019 is 221.29 km² or 31 percent of the total area of Samarinda City. Palaran Subdistrict consists of five villages, namely Simpang Pasir Village, Handil Bakti Village, Rawa Makmur Village, Bukuan Village, and Bantuas Village. The years for land-use analysis were chosen based on the data availability of imagery. For a good result of land-use interpretation, the cloud cover on the imagery must be below 20 percent.

2.2. Data collection and processing
The workflow of this research represents in Figure 1. It begins with the processing of Landsat images in 2006 and 2014, which is has been done with Layer Stacking to each Landsat imagery to produce a composite file for each imagery. Furthermore, the composite file of Landsat imagery and 2020 Sentinel-2a imagery were cropped based on the Palaran Subdistrict area. The cropped imagery is corrected with a radiometric and geometric correction process to clarify the imagery's appearance and improve its pixel value. The imagery is conditioned in a true color composition band according to each type of imagery. It can then be digitized with Rupa Bumi Indonesia (RBI) map data to obtain agricultural land-use data in 2006, 2014, and 2020.

After obtaining land-use data, it is then tested using Kappa Accuracy to determine the digitized land-use results' accuracy. If the result is above 0.75, then the land-use is valid and used [14]. Land-use data is then compared and intersected between agricultural land-use between 2006 and 2014. In 2014 and 2020, Land Change Modeler tools in Idrisi Selva 17 to make an agricultural land-use change map.
3. Results and discussion

3.1. Agricultural land-use in 2006

![Figure 2. Land-use in 2006 (Source: Data processing, 2020)]
Figure 2 is the land-use condition in Palaran Subdistrict in 2006 with an accuracy level of 0.9285, which indicates that the land-use is valid. In 2006, Palaran Subdistrict was dominated by plantation, followed by the field. Simpang Pasir Village was dominated by plantation, followed by settlements in the north and east and the area in the south. Handil Bakti Village was dominated by plantation, followed by settlement in the north and south and then the West's field. Rawa Makmur Village was dominated by settlement in the north, followed by plantation in the south. Bukuan Village was dominated by plantation in the middle part, followed by field in the east and south, then settled in the west and north. Bantuas Village is dominated by plantation, followed by field in the north, middle, and south and then irrigated rice field in the north. Agricultural land-use in 2006 was dominated by plantation with an area of 98.61 km$^2$ or 64 percent of the total agricultural land area. The land-use site in 2006 can be seen in Table 1.

### Table 1. Land-use area in 2006.

| Land-use Type       | Area (km$^2$) |
|---------------------|---------------|
| Rainfed Rice Field  | 1.14          |
| Irrigated Rice Field| 5.86          |
| Plantation          | 98.61         |
| Field               | 47.73         |
| Settlement          | 25.84         |
| Mining              | 2.00          |
| Water Body          | 10.89         |

3.2. Agricultural land-use in 2014

![Figure 3. Land-use in 2014 (Source: Data processing, 2020).](image-url)
Figure 3 is the land-use in Palaran Subdistrict in 2014 with an accuracy level of 0.9285, which indicates that the land-use is valid. In 2014, Palaran Subdistrict was dominated by plantation, followed by the field. Also in this year, the mining area has increased massively in the middle of Palaran Subdistrict. Simpang Pasir Village was dominated by plantation, followed by settlements in the north and east, then mining in the west and south. Handil Bakti Village was dominated by plantation, followed by mining that spread in the middle and southern parts and then in the west. Rawa Makmur Village was dominated by settlement in the north, followed by plantation in the south. Bukuan Village was dominated by plantation in the middle and eastern parts, followed by settlements in the west and north, then mining in the central and southern regions. Bantuas Village was dominated by plantation, followed by field in the north, middle, and south, then mining in the northern part. Agricultural land-use in 2014 was dominated by the plantation with an area of 85.88 km$^2$ or 68 percent of the total area of agricultural land, and the rainfed rice field was the least with an area of 1.15 km$^2$ or one percent of the total agricultural land area. The land-use site in 2014 can be seen in Table 2.

| Land-use Type         | Area (km$^2$) |
|-----------------------|---------------|
| Rainfed Rice Field    | 1.15          |
| Irrigated Rice Field  | 5.75          |
| Plantation            | 85.88         |
| Field                 | 34.40         |
| Settlement            | 25.06         |
| Mining                | 28.94         |
| Water Body            | 10.89         |

Table 2. Land-use area in 2014.

3.3. Agricultural land-use in 2020

Figure 4. Land-use in 2020 (Source: Data processing, 2020).
Figure 4 is the land-use in the Palaran Subdistrict in 2020 with an accuracy level of 0.8857, which indicates that land-use is valid. In 2020, Palaran Subdistrict is dominated by plantation, followed by mining. This year, the mining area has increased in the north, and settlements started to increase west of Palaran Subdistrict. Simpang Pasir Village is dominated by plantation in the middle part, followed by settlements in the north and then mining in the west. Handil Bakti Village is dominated by plantation, followed by mining that spread in the middle and southern parts and then in the west. Rawa Makmur Village is dominated by settlement in the north, followed by plantation in the south. Bukuan Village is dominated by mining in the middle and southern parts, followed by settlements in the western and northern parts and then irrigated rice fields in the northern part near the river. Bantua Village is dominated by plantation, followed by field in the north and south, then mining in the north. Agricultural land-use in 2020 was dominated by the plantation with an area of 72.38 km$^2$ or 69 percent of the total agricultural land area. The rainfed rice field is the smallest area with an area of 0.35 km$^2$ or less than one percent of the total agricultural land area. The land-use site in 2020 can be seen in Table 3.

| Land-use Type           | Area (km$^2$) |
|-------------------------|---------------|
| Rainfed Rice Field      | 0.35          |
| Irrigated Rice Field    | 3.01          |
| Plantation              | 72.38         |
| Field                   | 29.31         |
| Settlement              | 29.93         |
| Mining                  | 45.96         |
| Water Body              | 10.89         |

3.4. Agricultural land-use change in 2006 and 2014

Figure 5 represents the land-use change in Palaran Subdistrict in 2006 and 2014. Land-use change in 2006 and 2014 shows an increase in mining and a decrease in almost all agricultural land-use types. In Simpang Pasir Village, the plantation area has been reduced to mining in the middle and southern parts. Handil Bakti Village has experienced a reduction in its plantation land to mining in the eastern
part, and the settlement changes to mining in the middle and southern parts. In Rawa Makmur Village, there is no change in land-use. Bukuan Village has reduced the rainfed rice field to mining, plantation into mining in the south, and field to the plantation in the east and south. Bantuas Village has experienced a reduction in mining in the north, plantation to mining in the west, and plantation to settlement in the middle. The largest decrease occurred in plantation, which lost 12.73 km² during the period 2006 and 2014. Overall changes in land-use in Palaran Subdistrict in 2006 and 2014 can be seen in Table 4.

### Table 4. Land-use change in 2006 and 2014.

| Land-use Type          | 2006 Area (km²) | 2014 Area (km²) | Change Percentages (%) |
|------------------------|-----------------|-----------------|------------------------|
| Rainfed Rice Field     | 1.14            | 1.15            | 0                      |
| Irrigated Rice Field   | 5.86            | 5.75            | -4                     |
| Plantation             | 98.61           | 85.88           | -13                    |
| Field                  | 47.73           | 34.40           | -39                    |
| Settlement             | 25.84           | 25.06           | -3                     |
| Mining                 | 2.00            | 28.94           | +1,347                 |
| Water Body             | 10.89           | 10.89           | 0                      |

Agricultural land changes to other land-uses dominated Land-use changes in Palaran Subdistrict in 2006 and 2014 compared to agricultural land changes to another agricultural land. Supported by Google Earth data in 2006 and 2014, there were also many bare land area additions: mining areas and a few additional residential areas. Based on data from the Ministry of Energy and Mineral Resources, many mining industries currently operating in Palaran Subdistrict applied for mining permits in 2009. The bare land was agricultural before converted into a mining area. It states that mining is the main factor causing the land-use change in the Kalimantan region [15]. Based on the results of comparisons with the Ministry of Environment and Forestry's land cover data in 2006 and 2014, there was a reduction in agricultural land that turned into mining in the middle and southern parts of the Palaran Subdistrict.

### 3.5. Agricultural land-use change in 2014 and 2020

Figure 6 represents the land-use changes in Palaran Subdistrict in 2014 and 2020. It shows an increase in mining and settlement and a decrease in all types of agricultural land-use. Simpang Pasir Village has experienced a reduction in plantation, which changed to settlement in the northern part, plantation to mining in the middle, and the change of irrigated rice field to settlement in the middle part. Handil Bakti Village has experienced a reduction in the irrigated rice field, which changed to the west and plantation to mining in the middle and southern parts. Rawa Makmur Village has experienced a reduction in its plantation, which changed to settlement in the western part. In Bukuan Village, there is a reduction in plantation, which changed to an irrigated rice field in the north, plantation to mining in the middle part, and rainfed rice field into mining and field in the south. Bantuas Village has experienced a reduction in plantation, which changed to settlement in the middle part, field to mining in the eastern part, and irrigated rice field into plantation and mining in the northern part near the river. The largest decrease occurred in plantation, which lost 13.50 km² of land during 2014 and 2020. Overall changes in land-use in Palaran Subdistrict in 2014 and 2020 can be seen in Table 5.
Land-use changes that occurred in Palaran Subdistrict in 2014 and 2020 were classified as the same as land-use changes that occurred in 2006 and 2014, which were dominated by changes from agricultural land to other land-use compared to changes from agricultural land to another agricultural land. The difference is the rate of change is not as high as in 2006 and 2014. According to imagery data in 2014 and 2020, there are many additions to the bare land area and very little addition to the residential area. Furthermore, based on field verification results using Google Earth, it shows that the bare land area in Palaran Subdistrict is entirely mining. Its existence is around the agricultural area.

The mining industry is a serious threat to the existence of agricultural land in the Palaran Subdistrict. With the increasing number of exploration companies in the Palaran Subdistrict area, agricultural land is slowly experiencing damage. Furthermore, damaged agricultural land has the potential to experience land-use change because it doesn’t have the fertility level needed to carry out agricultural activities [11].
4. Conclusion
Based on the results, it can be concluded that spatially there has been a change in agricultural land-use in the Palaran Subdistrict, where most of the changes occur in the western, middle, and eastern parts of Palaran Subdistrict. The agricultural land-use has changed, mostly into mining and settlement, compared to change to another agricultural land, both in 2006 and 2014 and 2014 and 2020, with the biggest changes in the 2006 and 2014 periods. In 2006 and 2014, there is a conversion of agricultural land-use in the middle and western parts to the mining and the north into the settlement. Furthermore, in the period 2014 and 2020, there was a change in agricultural land-use into mining in the middle and eastern parts and settlements in the western region. The type of agricultural land-use that has undergone the most decreased area is a plantation, followed by irrigated rice fields and rainfed rice fields. Further improvements should focus on the effect of agricultural land-use change caused by mining activities on social, economic, and environmental sectors to know how far the land-use change has affected human life.

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