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THE USE OF SENTINEL-2A IMAGERY FOR MAPPING THE CONVERSION OF AGRICULTURAL LAND INTO DEVELOPED LAND USING THE OBIA METHOD IN BATANG ANAI DISTRICT 2017 AND 2022

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ABSTRACT: Indonesia is a developing country with a population growth rate of 1.38%. Due to the relatively strong population growth every year, this greatly affects land change. Therefore, the phenomenon of land use change emerged. In general, the rate of population growth correlates with the rate of land use change, which results in increased satisfaction of land-use needs such as settlements and public facilities. This study aims to determine the Change in Land Cover resulting from the Change of Agricultural Land Function into developed land and where the direction of changing agricultural land to developed land in Batang Anai District. This study uses a quantitative approach by utilizing Remote Sensing using Object-Based Classification (OBIA). Based on the interpretation results on Sentinel-2A images in 2017 and 2022, 8 land cover classes were found with an Overall Accuracy of 91% and a Kappa Index of 89.80%. Agricultural land in Batang Anai District has undergone land conversion into built-up land of 304.2 Ha or 8.70% of the agricultural land area in Batang Anai District with a total of 3499.16 Ha so that the remaining agricultural land area in 2022 is 3194.96 Ha. As a result of the land use change, there was a development of built-up land which was converted into housing development, public facilities and the Padang-Pekanbaru toll road leading from South to North.

Keywords: land use conversion, agricultural land, OBIA, Sentinel-2A, land cover.

1. INTRODUCTION

Indonesia is a developing country with a population growth rate of 1.38%. (BPS, 2017). Due to the relatively strong population growth every year, this greatly affects land change. Because of the fact that the increasing population in an area will affect the increasing need for land. Along with the increasing need for land and the increasing need for residential areas, the phenomenon of land use change has emerged. One of those affected by land use change is agricultural areas. Agricultural land conversion is the process of changing the purpose of agricultural land from one use to another, often having a severe effect on the environment. In general, the rate of population growth is correlated with the rate of land use change which results in increased satisfaction of land use needs such as settlements and other public facilities (Janah et al, .2017).

According to data from the Padang Pariaman Statistic Central Agency, the population of Batang Anai District seen from 2022 is 53.039 people. The stunning urban character of the region, as well as its strategic proximity to the city of Padang have also contributed to the increase in the population of this sub-district. The need for shelter and land is increasing along with the increasing population. Due to population growth that exceeds land availability, many people use land for settlement, resulting in a shift in land use from agricultural land and other non-developed land to built-up land.

This study examines the Utilization of Sentinel-2A Imagery which is a medium resolution image to identify the conversion of agricultural land into developed land using object-based classification (OBIA) in Batang Anai District, Padang Pariaman Regency. This study aims to determine Land Cover Change or Conversion of Agricultural Land into developed land and find out where the direction of agricultural land change to built-up land in 2017 and 2022.

2. RESEARCH METHODS

2.1 Research Location

This research is located in Batang Anai District, Padang Pariaman Regency, West Sumatra Province, with a geographical location of 0^0 50' 30" South Latitude and 100^0 27' 00" East Longitude.

2.2 Tools and Materials

The type used in this study is quantitative research. The data used are Sentinel-2A images for 2017 and 2022 downloaded from the Sentinel Hub site and Administrative Boundary Maps downloaded from the Ina-Geoportal site.

2.3 Pre-Processing Data

2.3.1. Atmospheric Correction

At this stage the Sentinel-2A image will go through image correction, that is, atmospheric correction. After normalizing the lighting and eliminating atmospheric effects, *the Dark Object Substation* process is carried out which aims to eliminate emission errors recorded in the image due to atmospheric scattering (path radiance*) and reduce the reflectance of objects from the total radiance* TOA.

2.3.2 Composite Band Imagery

Composite bands are the process of combining bands to obtain a multispectral image where the DN (*Digital Number*) value of three bands becomes one. The image composite process is useful for combining multiple bands on sentinel-2A images in 2017 and 2022. The bands used are bands 4,3,2 (Natural color), 12,8,4 (SWIR) to classify vegetation areas especially wet agricultural land and 12,11,8A (Atmospheric Penetration) to make it easier to classify open land so that it can classify land use clearly.

2.3.3 Image Cropping

Image cropping on sentinel-2A is useful for image cropping carried out in order to be able to classify Land Cover in accordance with the boundaries of the research area, namely Batang Anai sub-district.

2.4 Data Processing

2.4.1 OBIA segmentation

Segmentation is the process of obtaining the territory or object needed in an image by dividing the area or object based on its base. The purpose of segmentation is to collect object pixels in one area to represent an object based on spectral value, shape, and color. The amount of parameters is obtained from the results of experiments when processing where there are 3 parameters, namely scale, shape, and compactness parameters.

2.4.2 OBIA classification

OBIA classification is a method that plays a role in categorizing various types of land cover in a particular area that not only considers hue and texture or spatial aspects but based on unity by conducting a land cover sampling process and then processing using the *Nearest Neighbor algorithm*.

2.4.3 Dissolve

At this stage, 2017 and 2022 image data are carried out by combining the same objects in each land cover class.

2.4.4 Data Overlay

After classifying, land cover results in 2017 and 2022, an *overlapping process (Intersect*) was carried out in order to see land cover changes clearly.

2.5 Post-Data Processing

2.5.1 Sample point calculation

Sampling using *Purposive Random Sampling* calculation with *Fitzpatrick Lins formula.* The sampling formula used is as follows:

$$N = Z^2 (p)(q)/E^2$$

Information:
N = number of samples
Z = Normal standard deviation whose value is 2
p = expected accuracy
q = 100 – p
E = Error received.

In this study it was set for a accuracy level of 85% and an error rate of 15%.

2.5.2 Field Survey

Field surveys are used to match and confirm the accuracy of Land Cover interpretations. This strategy involves random field sampling based on land use class. To conduct field sample tests carried out after calculating the sample values in each class, you can use the GPS application, namely Avenza maps.

2.5.3 Accuracy Test

The Accuracy Test serves as a comparison of the proximity value of the classification results with actual data in the field as evidenced by an error matrix or *Confusion Matrix* which compares image data with data obtained in the field. The error matrix can calculate the magnitude of the maker's accuracy, user accuracy, overall accuracy, and kappa accuracy (Arisondang. et al, 2015).

2.6 Flow Chart

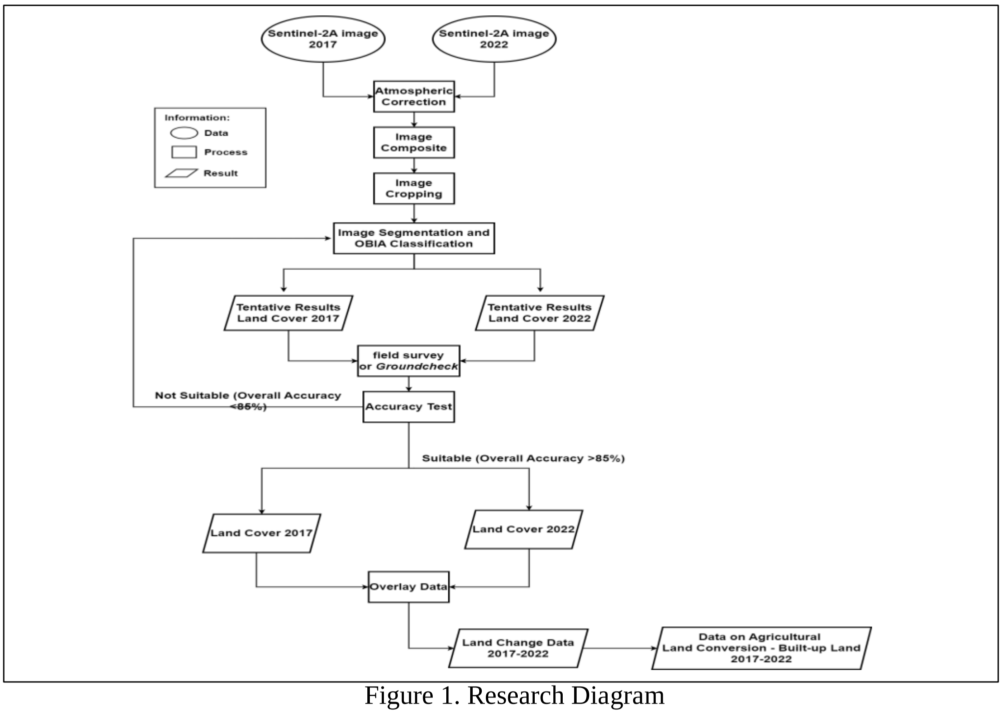

Figure 1. Research Diagram

3. RESULTS AND DISCUSSION

3.1 Image Segmentation

In this stage, the segmentation process is carried out using eCognition Developer software by grouping a set of objects into the same segment based on spectral values, shapes, and colors. The algorithm used is Multiresolution Segmentation because it can be considered flexible in the segmentation process that adjusts the shape of objects. The amount of parameters obtained from the results of the experiment The amount of parameters obtained from

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the results of experiments when processing is carried out where the process is based on 3 segmentation parameters, namely scale, shape, and compactness parameters.

Table 1. Segmentation Parameters

Year	Scale Parameters	Shape	Compactness	Result
2017	400	0.1	0.5	
2022	200	0.1	0.5	

Source: Data Processing, 2023

3.2 OBIA classification

From the segmentation results, an object-based classification process (OBIA) was carried out *with the Nearest Neighbor* algorithm with the classification results obtained as many as 8 classes such as: Forests, Mixed Gardens, Built-up Land, Open Land, Built-up Land, Dryland Agriculture, Wetland Agriculture, Bush / Shrubs, Water Bodies.

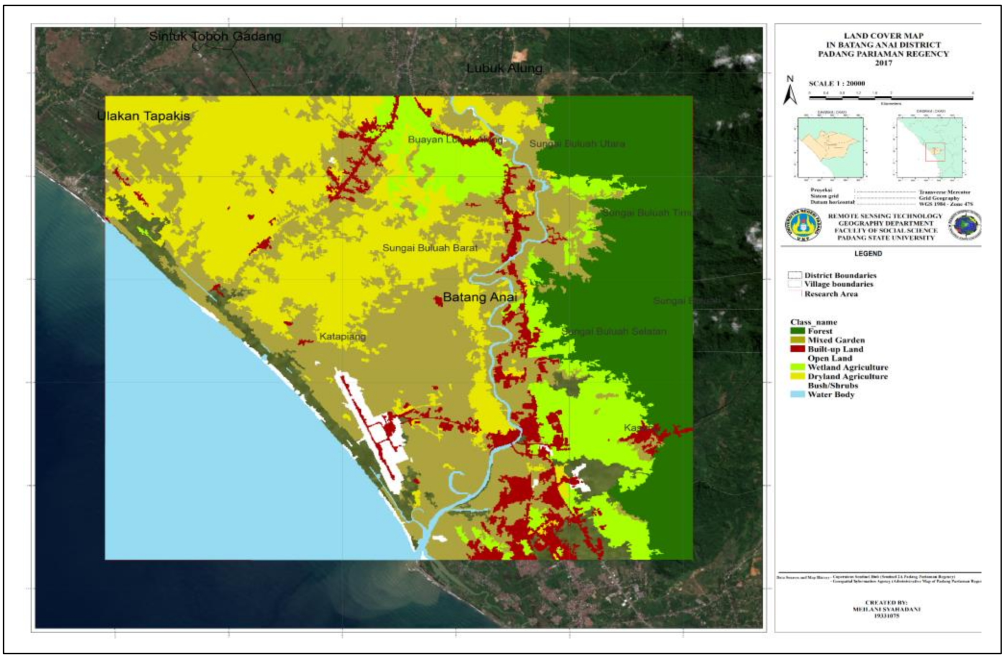

Figure 2. Land Cover Map 2017

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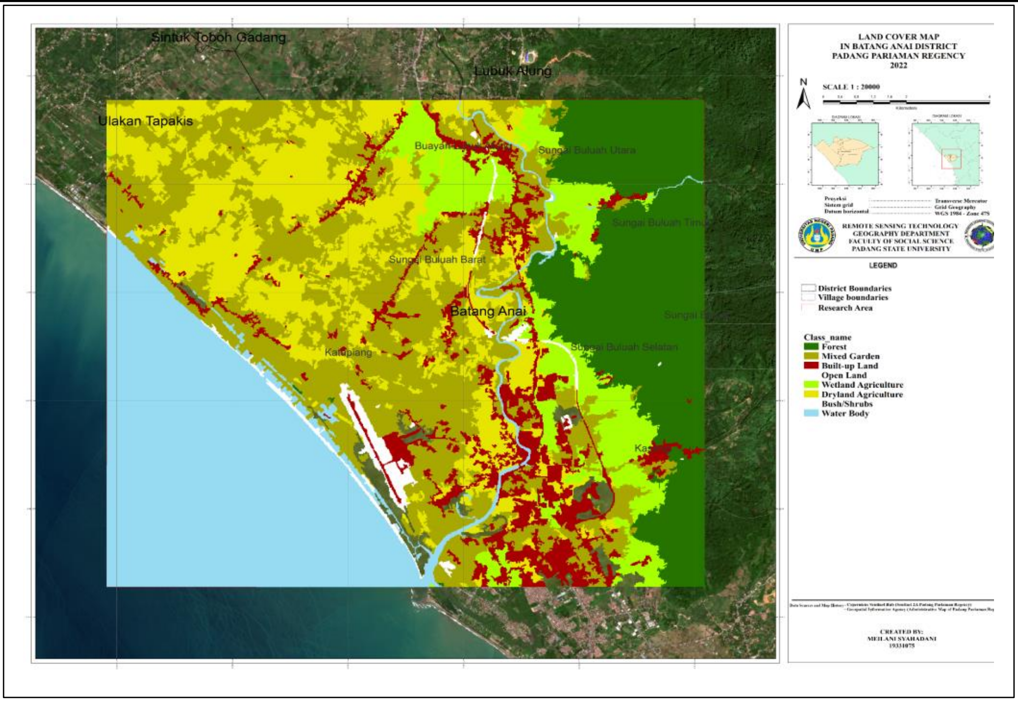

Figure 3. Land Cover Map 2022

Table 2. Land Cover Area in 2017 and 2022

No	Land Use	Area (Ha)	
		2017	2022
1	Forest	2886,04	2850,48
2	Mixed Garden	4698,72	4339,56
3	Built-up Land	816,24	1595,6
4	Open Land	216,96	236,52
5	Wetland Agriculture	1352,76	1557,04
6	Dryland Agriculture	3497	2930,24
7	Shrubs	366,2	245,32
8	Water Body	4079,08	4158,24
	Total	17913	17913

Source: Data Processing, 2023

3.3 Land Cover Change

From the results of land cover identification in 2017 and 2022, it is known that the land cover that has increased is built-up land, open land, wetland agriculture, and water bodies. Meanwhile, land use that has been reduced is Forest, Mixed Garden, Dryland Agriculture, and Shrubland. In 2022, forests decreased by 35.56 Ha, then mixed gardens also decreased by 359.16 Ha, then dryland agriculture decreased by 566.76 Ha, and shrubs by 120.88 Ha. while Built-up Land increased by 779.36 Ha, open land by 19.56 Ha, Wetland Agriculture increased by 204.28 Ha and Water Body increased by 79.16 Ha. The following is a matrix table of land cover change:

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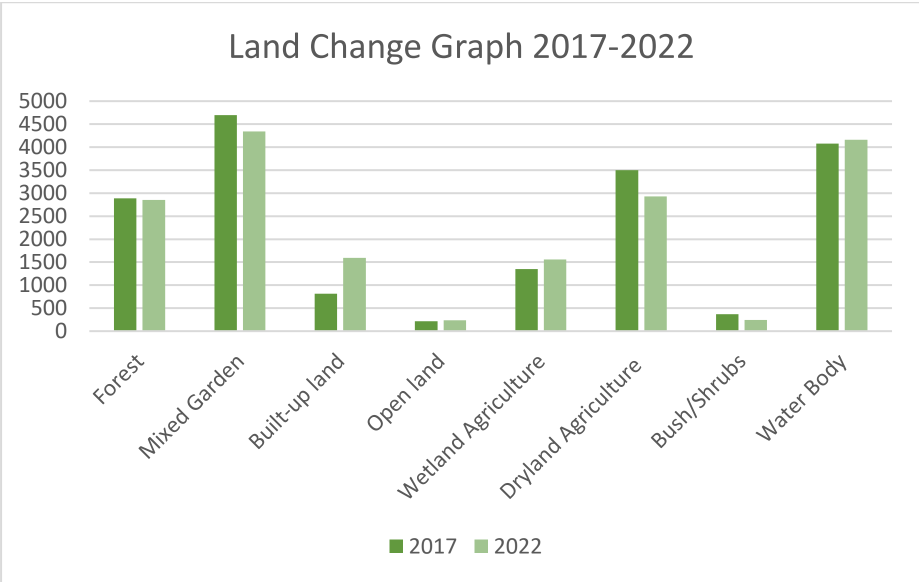
Table 3. Land Change in 2017 and 2022

		2022								
		Forest	Mixed Garden	Built-up Land	Open Land	Wetland Agriculture	Dryland Agriculture	Bush /Shrubs	Water Body	Grand Total
2017	Forest	2850,48	32,92		2,64					2886,04
	Mixed Garden		3078,32	356,64	25,64	252,92	943,2		42,0	4698,72
	Built-up Land			816,24						816,24
	Open Land			55,64	135,96		4,48		20,88	216,96
	Wetland Agriculture			117,44	22,92	1212,4				1352,76
	Dryland Agriculture		1228,32	186,76	7,64	91,72	1982,56			3497
	Bush/Shrubs			62,88				235,08	68,24	366,2
	Water Body				41,72			10,24	4027,12	4079,08
	Grand Total	2850,48	4339,56	1595,6	236,52	1557,04	2930,24	245,32	4158,24	17913

Source: Data Processing, 2023



Graph . Land Cover Change 2017-2022

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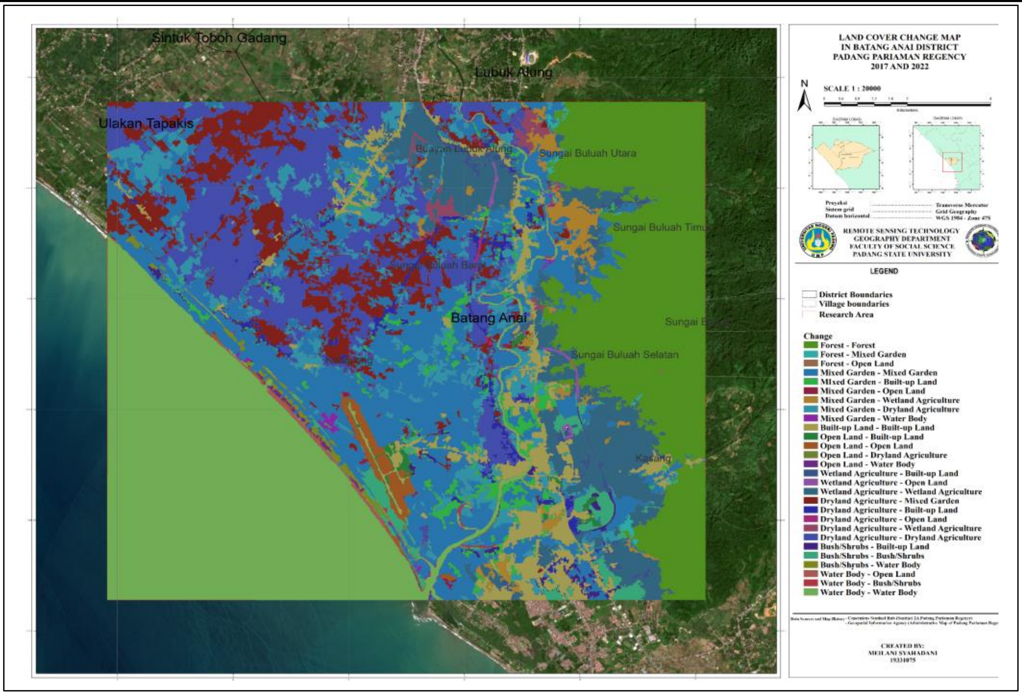

Figure 4. Land Cover Change Map 2017-2022

3.4 Accuracy Test

A fusion matrix is a method that can be used to measure the performance of a classification system. Basically, the fusion matrix contains information that compares the results of system design with the corresponding design results (Solichin, 2017). In the sampling process using the random sampling method with the Fitzpatrick Lins formula. The results of these calculations are expected to represent each class of land cover. The number of sample points calculated using the formula (McCoy, 2005) is as follows:

$$N=\frac{2^2\times 85\times 15}{15^2}=23$$

Table 4. Distribution of land cover sample points

No	Land Cover	Sample Point
1	Forest	2
2	Mixed Garden	3
3	Built-up Land	4
4	Open Land	2
5	Wetland Agriculture	5
6	Dryland Agriculture	4
7	Bush/Shrubs	2
8	Water Body	1
Total		23

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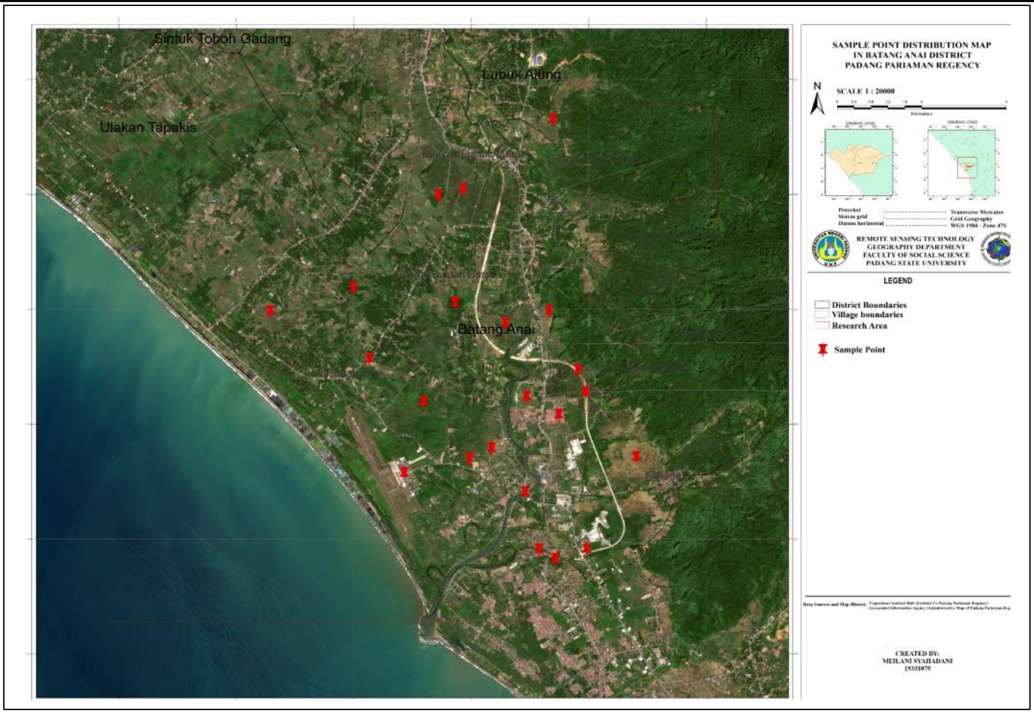

Figure 5. Sample Point Distribution Map

After conducting a groundcheck, out of a total of 23 points, there were 21 correct points and 2 wrong points. The following is the calculation of the accuracy test:

Table 5. Error Matrix

Class	Forest	Mixed Garden	Built-up Land	Open Land	Wetland Agriculture	Dryland Agriculture	Bush /Shrubs	Water Body	Producer Accuracy
Forest	2	0	0	0	0	0	0	0	2
Mixed Garden	0	3	0	0	0	0	0	0	3
Built-up Land	0	0	4	0	0	0	0	0	4
Open Land	0	0	0	1	0	0	1	0	2
Wetland Agriculture	0	0	0	0	5	0	0	0	5
Dryland Agriculture	0	1	0	0	0	3	0	0	4
Shrubs/Shrubs	0	0	0	0	0	0	2	0	2
Water Body	0	0	0	0	0	0	0	1	1
User Accuracy	2	4	4	1	5	3	3	1	23

From the overall accuracy calculation, a value of 91% was obtained and the calculation of the kappa accuracy test obtained a value of 89.80%.

3.5 Conversion of Agricultural Land into Built-up Land 2017-2022

From the results of processing land cover data using the Sentinel-2A image of the OBIA method for 2017-2022, agricultural land conversion data was obtained. The conversion of agricultural land occurred due to development developments caused by the construction of housing, public facilities, and the construction of the Padang-Pekanbaru toll road through Batang Anai sub-district leading from South to North so that many agricultural lands were converted into built-up land.

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Table. 3 Area of Agricultural Land and conversion of agricultural land into built-up land

No	Class	Broad (Ha)	Percentage (%)
1	Wetland Agriculture	1212,4	34,65%
2	Conversion of Wetland Agriculture	117,44	3.36%
3	Dryland Agriculture	1982,56	56,66%
4	Conversion of Dryland Agriculture	186,76	5.34%
	Total	3499,16	100%

Source: Data Processing

Based on the table above in 2017-2022, agricultural land has decreased by 117.44 Ha from wetland agriculture and 186.76 Ha from dryland agriculture caused by land conversion into built-up land so that agricultural land in 2022 will remain at 3194.96 Ha.

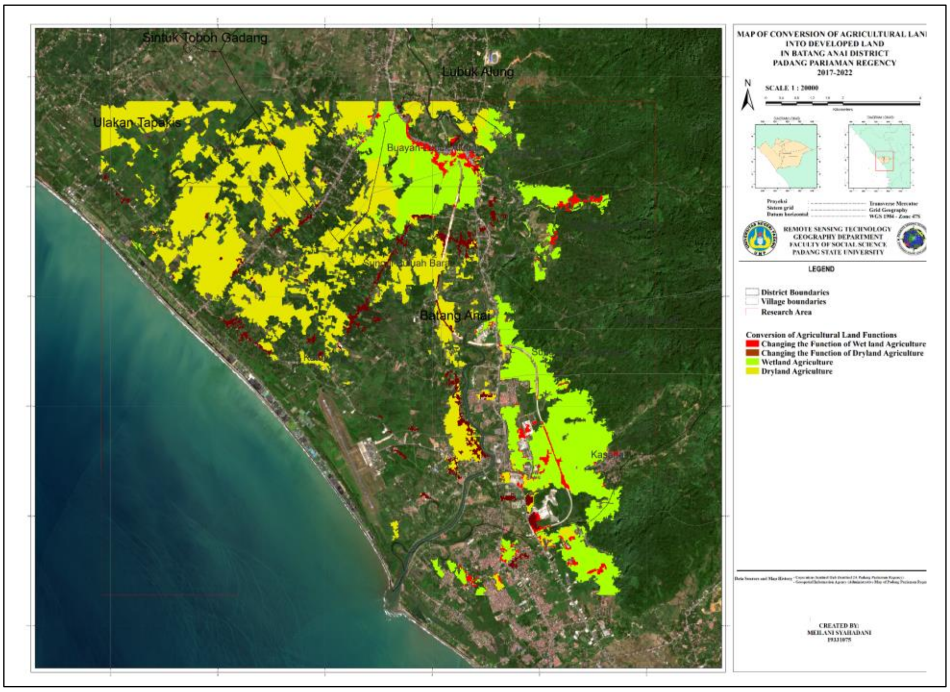

Figure 5. Map Of Conversion of Agricultural Land into Developed Land

4. CONCLUSION

Based on the interpretation results on Sentinel-2A images in 2017 and 2022, 8 land cover classes were found with an Overall Accuracy of 91% and a Kappa Index of 89.80%. Agricultural land in Batang Anai District has undergone land conversion into built-up land of 304.2 Ha or 8.70% of the agricultural land area in Batang Anai District with a total of 3499.16 Ha so that the remaining agricultural land area in 2022 is 3194.96 Ha. As a result of agricultural land that has been converted into built-up land, there has been a development of built-up land caused by the rampant development of housing, public facilities and the Padang-Pekanbaru toll road through Batang Anai sub-district leading from South to North. This happened due to the proximity to the provincial capital, namely the city of Padang, which is the center of government and the development of public infrastructure facilities.

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