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ANALYSIS OF CHANGES IN TEMPORAL SPATIAL LAND USE, VEGETATION, AND BUILT LAND IN GROBOGAN REGENCY IN 2019-2023

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Abstract

Along with the increasing population in Grobogan Regency, the need for sufficient clothing and boards will increase. The Grobogan area is in a karst area with the agricultural and blasting sectors contributing the biggest sources of GRDP. Agriculture is dominated by dry farming. The area of forest land (vegetation is the second largest in Central Java. The study aimed to determine the dynamics of changes that occur in land cover (agricultural areas, vacant land, built-up areas, vegetation, and water bodies), focusing on built-up areas and vegetation. Data processing uses the help of sentinel imagery for the period 2019-2023 which is then processed using the maximum likelihood method which is then tested for accuracy to match the actual conditions on the ground Vegetation (forest) The second biggest change is the conversion to agricultural land. This is also marked by areas the area found which is indicated as an increasing settlement.

Keywords: Landcover, Vegetation, Built-up Area

1. INTRODUCTION

Over the past five years, the number of residents in Grobogan Regency has increased every year calculated from 2018-2022. An increase in population results in an increase in need. The increase in population is a new problem that makes it a challenge to meet the needs of food and the needs of facilities and infrastructure every year, which are increasing in number, (BPS, 2022). The increase in population is evidenced by the number of built-up areas every year for a period of five years that continues to grow.

The total population of Grobogan Regency is 1 501 145 people in 2022 spread across 19 sub-districts. The highest population density is in Purwodadi District with a population of 143021 people with a density of 1829/km2. Purwodadi District is a National Strategic Area from the point of view of economic interests referring to the Central Java Provincial Regulation No. 16 of 2019 which is expected to support socio-economic activities around it, (RPJMD Grobogan Regency 2021).

According to BPS data from the Grobogan Regency GDP which continues to increase every year, the largest contributor comes from the Agriculture and Forestry sector. It is stated that the forest area in Grobogan Regency is the second largest in Central Java Province with a total of 69,713 ha, (BPS, 2021)

Strong economic growth and high population growth have changed the views of the community and the government on the role of land as a source of production and the need for settlements. This encourages land use change into building and residential areas. However, in-depth studies on changes in land cover in Grobogan Regency are still minimal (Ali, 2023).

Rusanto's research on "Change in the Use of Rice Fields to Built Land in Gubug District, Grobogan Regency in 2000-2018" identified the main factors that caused the change. The low knowledge of the population about permits and the increasing need for land for settlements are the dominant factors. Lack of understanding of land change permits and population growth contributes to the conversion of paddy fields into built-up land. This study highlights the role of social factors and community needs in land use change. The next research was entitled Analysis of Changes in People's Forest Coverage in Geyer District, Grobogan Regency in 2010 and 2015 by Ardi Rimbawan, and Analysis of Land Use Change in Toroh District, Grobogan Regency in 2007 and 2017 by Ohdiyono in 2018.

The purpose of the study is to determine the magnitude of changes in vegetation land cover and built land in Grobogan Regency by the supervised maximum likehood

classification method with a Sentinel image database that is easily accessible and accessed for free and is a high-resolution image with a wide swath, revisited at the same location every 10 days (compared to Landsat which is once every 16 days) and can be used to Land cover monitoring studies, including vegetation, soil and water, as well as water networks and coastal areas. (Angga, 2021)

2. RESEARCH METHODS

2.1 Research Location

Based on Figure 1. The Administrative Map of Grobogan Regency presents the geographical location of Grobogan Regency as the location where this research was chosen.

Figure 1. Administrative Map of Grobogan Regency

Geographically located between 1100 15'E-111 ^{0} E and 7 ^{0} LS 30'LS which is bordered by Pati Regency to the north, Kudus Regency and Semarang Regency to the west, Blora Regency to the east, and Sragen Regency to the south.

Grobogan Regency is administratively divided into 19 sub-districts (Geyer, Toroh, Kradenan, Pulokulon, Gabus, Wirosari, Ngaringan, Kedungjati, Penawangan, Karangrayung, Grobogan, Tawangharjo, Gubug, Tegowanu, Klambu, Godong, Purwodadi, Brati, and Tanggungharjo). It has an area of 2035 km^2.

2.2 Tools and Materials

This research uses tools and materials to support the achievement of research objectives. The material is sourced from secondary data, land cover data and sentinel image data from Google Earth Engine (GGE).

Table 1. Research Tools and Materials

Tools and Materials	Kind	Uses	Source
Tool	ArcMap 10.8	Spatial data processing	ArcGIS Applications
Material	RBI Central Java Spatial Data	Spatial Data Processing	Geospatial Information Base
	Sentinel 2A image of Grobogan Regency with 2019 recording	Spatial Data Processing	United States Geological Survey (USGS)
	Sentinel 2A image in Grobogan Regency with 2020 recording	Spatial Data Processing	United States Geological Survey (USGS)
	Sentinel 2A image of the Grobogan Regency area	Spatial Data Processing	United States Geological Survey (USGS)

Tools and Materials	Kind	Uses	Source
	with 2022 recording		
	Sentinel 2A image of the Grobogan Regency area with 2023 recording	Spatial Data Processing	United States Geological Survey (USGS)

2.3 Data Processing and Analysis

Data processing is carried out first by making geometric corrections to the image to make it appear in accordance with the actual situation in the field, by eliminating noise, and sharpening the image. After that, atmospheric correction was made to the image data which aimed to reduce the reflectance of the object from the total TOA (Top of Atmospheric) radiation before cropping according to the research area.

The next stage is to classify the image using the multispectral supervised maximum likelihood classification method. The choice of this method is because in this method probability calculation is carried out and does not refer to the calculation of distance, so it is suitable for classifying land cover (vegetation). In conducting classification using ROI samples in each land cover class, referring to key interpretations, including colors, hues, patterns, etc. This is done to make it easier to interpret the Sentinel image. In this interpretation, the land cover class is divided into five classes, including vegetation, built land, vacant land, water bodies, and agricultural land.

The data analysis method uses the interpretation of remote sensing data that has previously been corrected. The results of the correction provide an overview of how the land cover condition in the Grobogan Regency area has changed over a period of 5 years (2019-2023), which is then carried out an

accuracy test using *the confusion matrix* method, namely by comparing the number of correct interpretation objects with the total number of samples taken. After that, an overlay was carried out to combine the components of land change during the 5-year period.

Research Flow Diagram

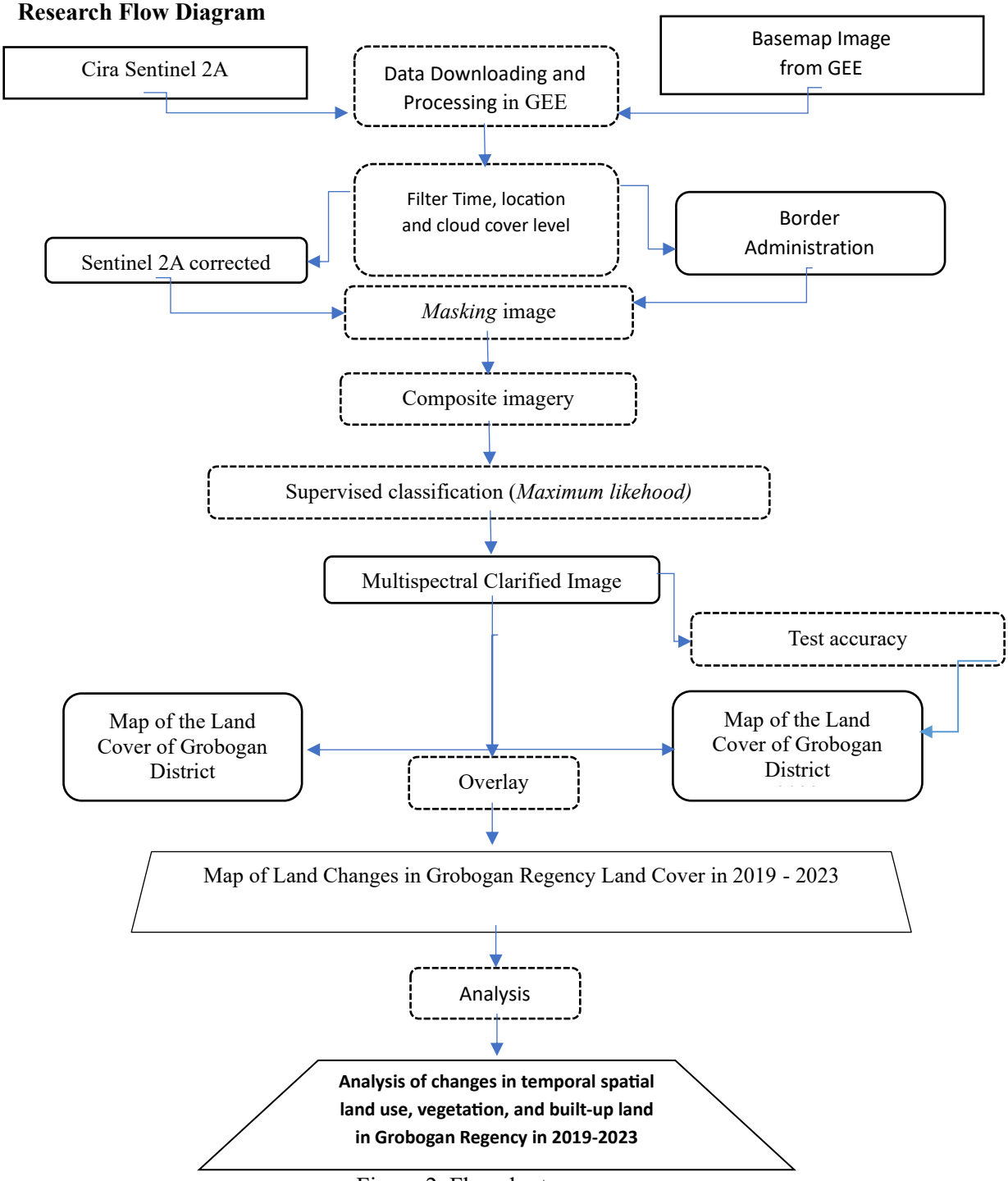

Figure 2. Flowchart

3. RESULTS AND DISCUSSION

The accuracy test of Sentinel's image interpretation was tested using the Kappa method, with 72 sample points in the field compared to the results of image interpretation. Sample points are selected based on accessibility. Discrepancies between interpretation and field results were identified. Kappa statistic was used to measure the determination of image interpretation, with a result of 0.928215354 for the 2023 Sentinel image. The high Kappa value indicates good accuracy between the image interpretation and the field conditions, making this image interpretation valid in recognizing land cover in the research area. The interpretation process is considered correct because it has met the accuracy tolerance of = 85% (Andreson, et al., 1976). The following is a table of the results of the Kappa accuracy test for this study:

Table 1 Image Accuracy Test

OBJECTID	ClassValue	Woke Areas	Vacant Land	Vegetation	Water Body	Farmland	Total	Accuracy	Kappa
1	Woke Areas	10	0	0	0	0	10	1	0
2	Vacant Land	1	9	0	0	0	10	0.9	0
3	Vegetation	0	0	19	0	1	20	0.95	0
4	Water Body	0	0	0	10	0	10	1	0
5	Farmland	0	0	1	1	20	22	0.909090909	0
6	Total	11	9	20	11	21	72	0	0
7	P_Accuracy	0.909090909	1	0.95	0.909090909	0.952380952	0	0.944444444	0
8	Kappa	0	0	0	0	0	0	0	**0.928215354**

Trends in Land Cover Change (2019-2023)

In the 2019-2023 period, there was a dynamic change in land cover in Grobogan Regency. There has been a dramatic decline in plantation forest land cover and dryland agriculture. This decline began in 2019 and continued into 2023. A significant decrease in plantation forest land cover and dryland agriculture is related to Zaini's 2018 findings. The northern area of Grobogan Regency, the majority of which is limestone hills, has low

fertility soil. These conditions may limit plant growth, so a dramatic decline in land cover occurs during that period.

Between 2019 and 2023, there was a decrease in the area of dry agricultural land and mixed shrub farming in the northern area of Grobogan Regency. This is because the majority of hilly land in the area is used for lime mining. Industries such as PT. Grobogan cement, which requires limestone as the main raw material, affects land use in Grobogan Regency. The impact is a change in land closure from agriculture to industry, which impacts local food supplies, farmers' livelihoods, and the environment. The importance of mitigation measures and collaboration among various parties to maintain a balance between industrial development and environmental conservation. Spatial distribution of changes in land cover in 2019-2020, 2020-2021, 2021-2022, 2022-2023.

Table 2. Land Closure Change Table 2019 - 2023

Yes	Country Cover	2019	(%)	2020	(%)	2021	(%)	2022	(%)	2023	(%)
1	Vacant Land	238.74	12%	177.75	9%	265.70	13%	211.26	10%	134.29	7%
2	Woke Areas	248.09	12%	198.42	10%	198.60	10%	184.93	9%	187.46	9%
3	Farmland	1092.70	54%	941.80	46%	800.88	39%	771.29	38%	895.00	44%
4	Water Body	6.16	0%	5.04	0%	2.12	0%	10.03	0%	7.84	0%
5	Vegetation	448.99	22%	711.64	35%	767.38	38%	857.20	42%	810.08	40%
Total		2034.679844	100%	2034.651955	100 %	2034.682518	100 %	2034.697667	100%	2034.671093	100 %

Period 2019-2020

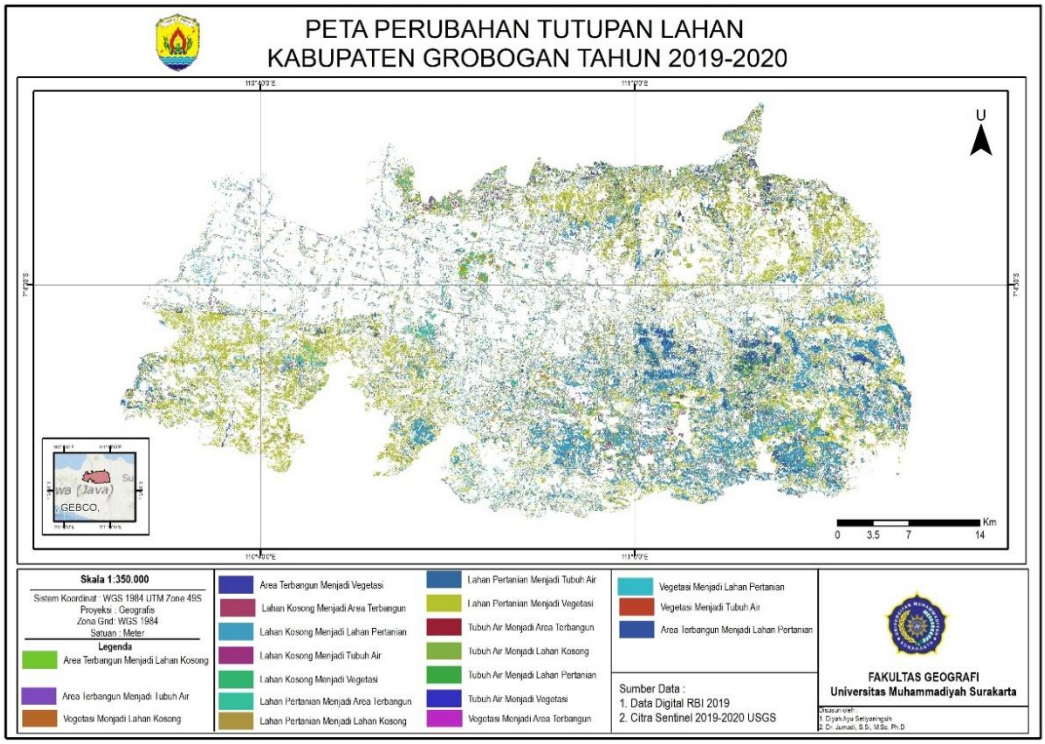

Figure 3. Landcover Change Map 2019-2020

Table 3. Landcover Area Change 2019-2020

Yes	Landcover 2019	Broad (km2)	Landcover 2020	Broad (km2)	Change	AreaChange (km2)
1	Vacant Land	238,7	Vegetation	711,6	Vacant Land Becomes Vegetation	10,8
2	Vacant Land	238,7	Farmland	941,8	Vacant Land Becomes Agricultural Land	124,6
3	Vacant Land	238,7	Woke Areas	198,4	Vacant Land Becomes Built Area	18,7
4	Vacant Land	238,7	Water Body	5,0	Vacant land becomes a body of water	0,8
5	Woke Areas	248,1	Vegetation	711,6	The area is built into vegetation	52,7
6	Woke Areas	248,1	Vacant Land	177,7	The area was built into empty land	25,1
7	Woke Areas	248,1	Farmland	941,8	The area was built into agricultural land	50,5
8	Woke Areas	248,1	Water Body	5,0	The area is built into a body of water	0,4

9	Farmland	1092,7	Vegetation	711,6	Agricultural Land Becomes Vegetation	248,1
10	Farmland	1092,7	Vacant Land	177,7	Agricultural Land Becomes Vacant Land	64,7
11	Farmland	1092,7	Woke Areas	198,4	Agricultural Land Becomes a Built Area	49,2
12	Farmland	1092,7	Water Body	5,0	Agricultural Land Becomes a Body of Water	0,9
13	Water Body	6,2	Vegetation	711,6	Water Bodies Become Vegetation	0,2
14	Water Body	6,2	Vacant Land	177,7	Water bodies become empty land	0,5
15	Water Body	6,2	Farmland	941,8	Water bodies become agricultural land	2,0
16	Water Body	6,2	Woke Areas	198,4	Water bodies become built-up areas	0,6
17	Vegetation	449,0	Vacant Land	177,7	Vegetation Becomes Empty Land	3,6
18	Vegetation	449,0	Farmland	941,8	Vegetation Becomes Agricultural Land	35,0
19	Vegetation	449,0	Woke Areas	198,4	Vegetation becomes a built area	10,6
20	Vegetation	449,0	Water Body	5,0	Vegetation Becomes Water Body	0,1

The largest change in land cover in this period was the convention of mixed agricultural land into vegetation covering an area of 248.1. In this period, the change in closure in several classes is indicated to have occurred during the classification process on *the google earth engine*, from which it occurred because there were clouds and cloud shadows in the 2019 Sentinel image which would affect the classification results.

Period 2020 – 2021

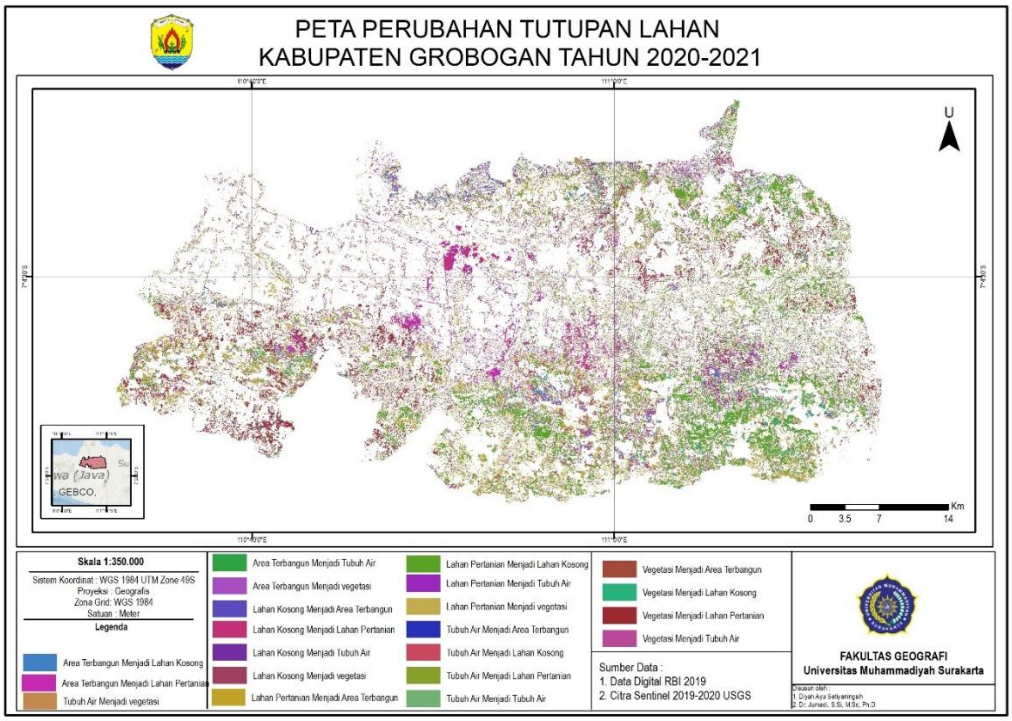

Figure 4. Landcover Change Map 2020-2021

Table 4. Landcover Area Change 2020-2021

Yes	Landcover 2020	Broad	Landcover 2021	Broad	Change	Scope of Change
1	Vegetation	711,6	Vacant Land	265,70	Vegetation Becomes Empty Land	20,79
3	Vegetation	711,6	Woke Areas	198,60	Vegetation becomes a built area	30,54
4	Vegetation	711,6	Farmland	800,88	Vegetation Becomes Agricultural Land	90,44
5	Vegetation	711,6	Water Body	2,12	Vegetation Becomes Water Body	0,03
7	Vacant Land	177,7	Vegetation	767,38	Vacant Land Becomes Vegetation	25,97
8	Vacant Land	177,7	Woke Areas	198,60	Vacant Land Becomes Built Area	19,04
9	Vacant Land	177,7	Farmland	800,88	Vacant Land Becomes Agricultural Land	43,55
10	Vacant Land	177,7	Water Body	2,12	Vacant land becomes a body of water	0,21
11	Farmland	941,8	Vacant Land	265,70	Agricultural Land Becomes Vacant Land	139,41
12	Farmland	941,8	Vegetation	767,38	Agricultural Land Becomes Vegetation	144,44
13	Farmland	941,8	Woke Areas	198,60	Agricultural Land Becomes a Built Area	18,40
15	Farmland	941,8	Water Body	2,12	Agricultural Land Becomes a Body of Water	0,16

16	Woke Areas	198,4	Vacant Land	265,70	The area was built into empty land	15,53
17	Woke Areas	198,4	Vegetation	767,38	Woken Up Area Becomes Vegetation	27,03
19	Woke Areas	198,4	Farmland	800,88	The area was built into agricultural land	25,76
20	Woke Areas	198,4	Water Body	2,12	The area is built into a body of water	0,33
21	Water Body	5,0	Vacant Land	265,70	Water bodies become empty land	0,95
22	Water Body	5,0	Vegetation	767,38	Water bodies become vegetation	0,10
23	Water Body	5,0	Woke Areas	198,60	Water bodies become built-up areas	0,83
24	Water Body	5,0	Farmland	800,88	Water bodies become agricultural land	1,76

During this period, the existing land cover in the Grobogan Regency area is still experiencing changes in increasing and decreasing in several classes of land cover. The land cover that has increased in this period is still dominated by agricultural and vegetation classes caused by differences in the use of images, namely the Sentinel image was used in 2020 and the Sentinel 2A image was used in 2021, from the difference in the image used caused an increase in area in several land cover classes that are classified as related classes. This is supported by the opinion (Suwargana 2019) which states that each image has a different sensor in capturing electromagnetic energy emitted by water, soil, and vegetation. Based on this opinion, it can be indicated that the decline in agricultural land class is caused by the difference in the sensor owned by each image used, namely on Sentinel 2A. Meanwhile, another type of land cover that has increased is the residential class. The class of built areas has increased due to the increase in population in the northern area of Grobogan Regency, based on (BPS 2021). This is also in line with the opinion expressed by (Liu et al. 2005) which states that the increase in population will be accompanied by the need for space for residential construction for humans themselves. The change in the cover of balingbesar is agricultural land to vegetation, in this case in line with the GDP of Grobongan Regency, which is the main contributor from the forestry sector.

Period 2021 – 2022

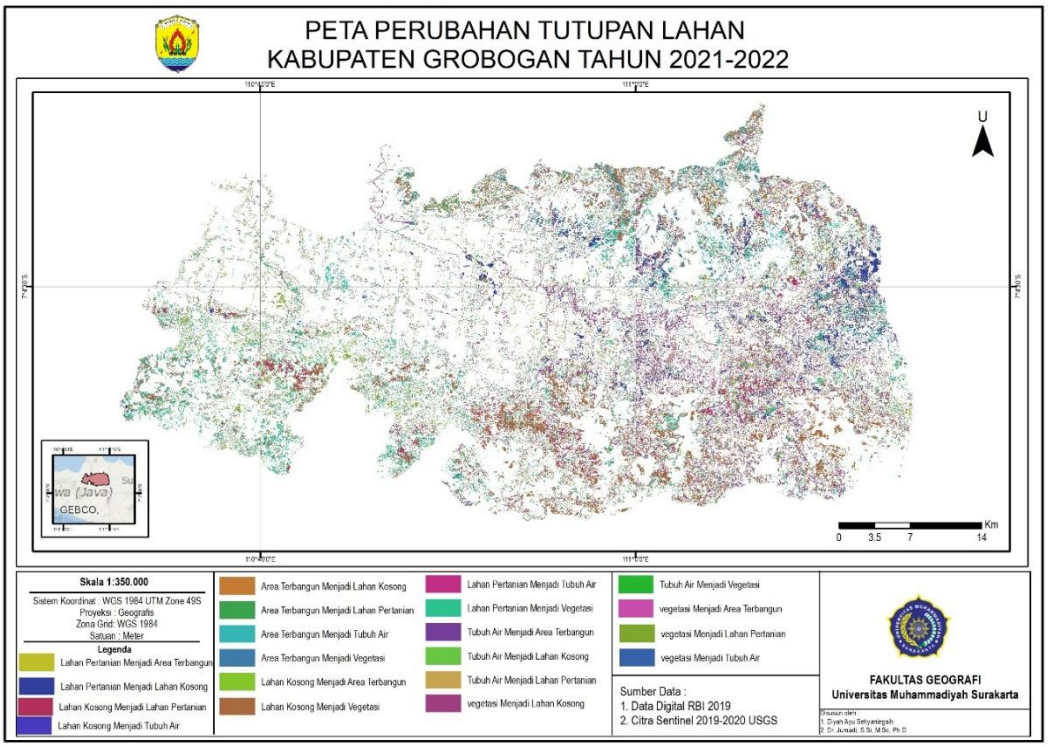

Figure 4. Landcover Change Map 2021-2022

During this period, the biggest change in land cover in this period was the conversion of agricultural land to mining grade. The emergence of the mining class in Grobogan Regency cannot be separated from the role of the government. This opinion is in line with research conducted by (Feintrenie, Schwarze, and Levang 2010) which states that the era of decentralization can cause local governments to develop their regional economies, one of which is by granting business licenses to companies that want to invest in the area. The increase in land cover is inseparable from human intervention, which is the conversion of land that was originally agricultural land into areas other than agricultural land, for example such as mining areas (Adhiatma, Widiatmaka, and Iskandar Lubis 2020). Meanwhile, in the agriculture class, there has been an increase in area. The increase is indicated to occur because during the rainy season the agricultural area will look slightly green and during the dry season the agricultural land will not look

as green as during the rainy season, so it will affect the electromagnetic energy captured by the sensor owned by the Sentinel 2A image and then result in the classification results. Therefore, spectral similarity occurs during the selection of object samples to establish specific rules between classes during the rainy season (Conchedda, Durieux, and Mayaux 2008). Meanwhile, other increases occurred in the rice field class, as well as settlements due to an increase in population from 2021 to 2022.

Period 2022 – 2023

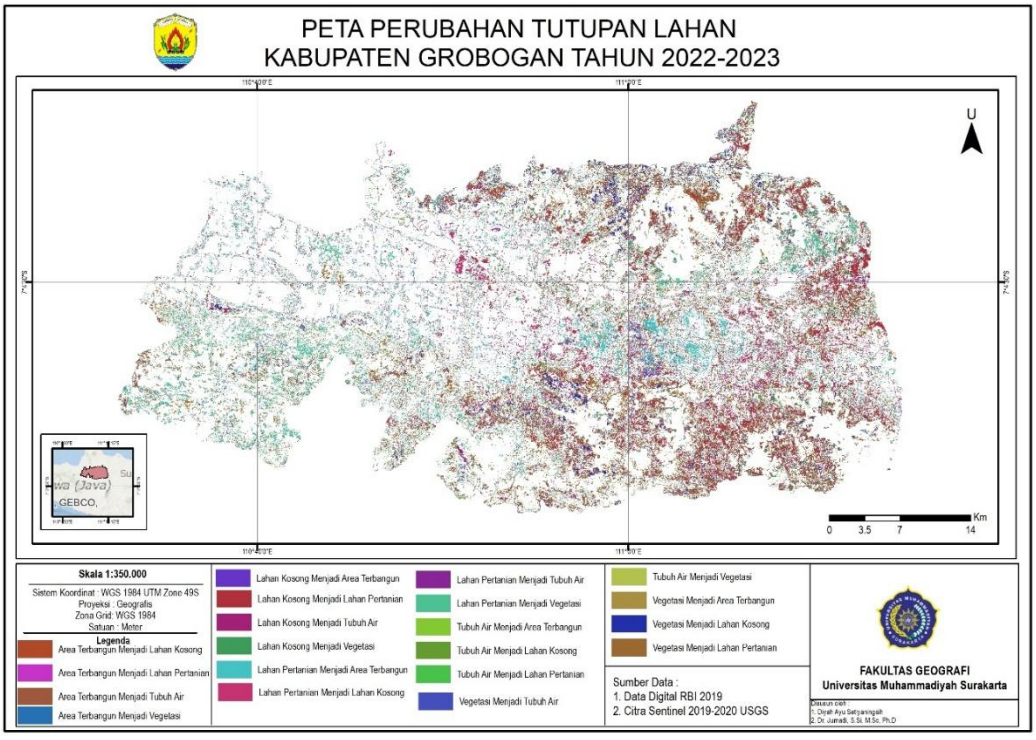

Figure 5. Landcover Change Map 2022-2023

Table 4. Landcover Change Area 2022-2023

No	Landcover 2022	broad	Landcover4	broad	Change	Scope of Change
1	Farmland	771,3	Vacant Land	134,3	Agricultural Land Becomes Vacant Land	32,3
2	Farmland	771,3	Vegetation	810,1	Agricultural Land Becomes Vegetation	89,2
3	Farmland	771,3	Farmland	895,0	Agricultural Land Becomes Agricultural Land	615,0

4	Farmland	771,3	Woke Areas	187,5	Agricultural Land Becomes a Built Area	32,0
5	Farmland	771,3	Water Body	7,8	Agricultural Land Becomes a Body of Water	2,5
6	Vegetation	857,2	Vacant Land	134,3	Vegetation Becomes Empty Land	32,2
7	Vegetation	857,2	Vegetation	810,1	Vegetation Becomes Vegetation	665,3
8	Vegetation	857,2	Farmland	895,0	Vegetation Becomes Agricultural Land	139,8
9	Vegetation	857,2	Woke Areas	187,5	Vegetation becomes a built area	19,4
10	Vegetation	857,2	Water Body	7,8	Vegetation Becomes Water Body	0,2
11	Vacant Land	211,3	Vacant Land	134,3	Vacant Land Becomes Vacant Land	51,2
12	Vacant Land	211,3	Vegetation	810,1	Vacant Land Becomes Vegetation	30,6
13	Vacant Land	211,3	Farmland	895,0	Vacant Land Becomes Agricultural Land	120,1
14	Vacant Land	211,3	Woke Areas	187,5	Vacant Land Becomes Built Area	7,9
15	Vacant Land	211,3	Water Body	7,8	Vacant land becomes a body of water	1,4
16	Woke Areas	184,9	Vacant Land	134,3	The area was built into empty land	16,3
17	Woke Areas	184,9	Vegetation	810,1	The area is built into vegetation	24,5
18	Woke Areas	184,9	Farmland	895,0	The area was built into agricultural land	16,1
19	Woke Areas	184,9	Woke Areas	187,5	Built-up areas become built-up areas	127,2
20	Woke Areas	184,9	Water Body	7,8	The area is built into a body of water	0,8
21	Water Body	10,0	Vacant Land	134,3	Water bodies become empty land	2,3
22	Water Body	10,0	Vegetation	810,1	Water Bodies Become Vegetation	0,2
23	Water Body	10,0	Farmland	895,0	Water bodies become agricultural land	3,7
24	Water Body	10,0	Woke Areas	187,5	Water bodies become built-up areas	1,0
25	Water Body	10,0	Water Body	7,8	Water bodies become water bodies	2,8

The largest change in land cover in this period was in the class of agricultural land areas, some areas of vegetation cover and vacant land

turned into corn farmland. This is to meet daily needs as a result of the increase in population.

Dynamics of Land Closure Causes from 2019 – 2023

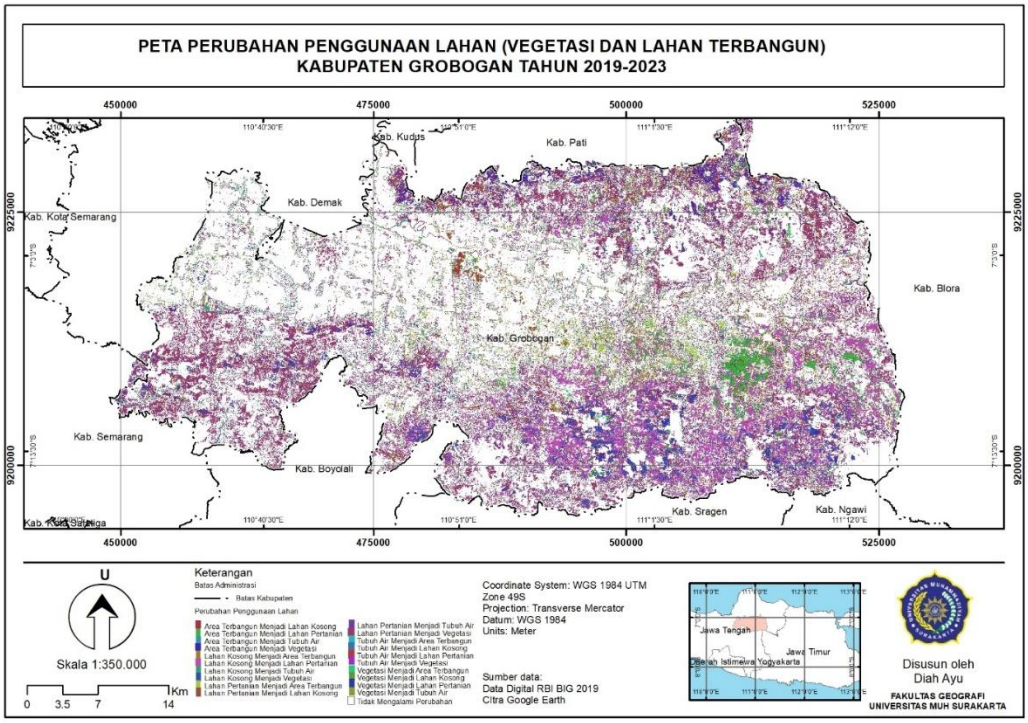

Figure 6. Landcover Change Map 2019-2023

In general, the area of Grobogan Regency is included in the hilly area. The type of hills in the Grobogan Regency area is a type of limestone hill, namely hills dominated by rocks that will later be used as limestone, bricks, and cement making. Grobogan low soil fertility rate Besides having benefits for humans, it can also pose a threat to the surrounding community whose notabene settles or lives in the Grobogan Regency area. It can be explained that in 2019 - an area of Grobogan Regency which includes Pulokulon, Geyer and Toroh Districts. dominated by agriculture, mixed shrub agriculture and plantation forests. However, in 2022 – land closures for vegetation classes as well as land agriculture and mixed shrub agriculture are decreasing along with the increase in population and land clearing for ports, industry, and mining

Table 5. Changes in Land Cover in Grobogan Regency for the 2019 - 2023 Period

Yes	Landcover	Change	Ket	Area (km2)	Percentage
1	Vacant Land	Vacant Land Becomes Vacant Land	Unchanged	57.32	3%
2	Vacant Land	Vacant Land Becomes Vegetation	Change	39.23	2%
3	Vacant Land	Vacant Land Becomes Agricultural Land	Change	125.59	6%
4	Vacant Land	Vacant Land Becomes Built Area	Change	14.56	1%
5	Vacant Land	Vacant land becomes a body of water	Change	1.98	0%
6	Woke Areas	The area was built into empty land	Change	21.80	1%
7	Woke Areas	The area is built into vegetation	Change	65.34	3%
8	Woke Areas	The area was built into agricultural land	Change	52.05	3%
9	Woke Areas	Built-up areas become built-up areas	Change	107.85	5%
10	Woke Areas	The area is built into a body of water	Change	0.96	0%
11	Farmland	Agricultural Land Becomes Vacant Land	Change	47.29	2%
12	Farmland	Agricultural Land Becomes Vegetation	Change	321.05	16%
13	Farmland	Agricultural Land Becomes Agricultural Land	Unchanged	672.14	33%
14	Farmland	Agricultural Land Becomes a Built Area	Change	48.89	2%
15	Farmland	Agricultural Land Becomes a Body of Water	Change	2.94	0%
16	Water Body	Water bodies become empty land	Change	1.54	0%
17	Water Body	Water Bodies Become Vegetation	Change	0.19	0%
18	Water Body	Water bodies become agricultural land	Change	2.18	0%
19	Water Body	Water bodies become built-up areas	Change	0.48	0%
20	Water Body	Water bodies become water bodies	Unchanged	1.74	0%
21	Vegetation	Vegetation Becomes Empty Land	Change	6.28	0%
22	Vegetation	Vegetation Becomes Vegetation	Unchanged	383.96	19%
23	Vegetation	Vegetation Becomes Agricultural Land	Change	42.76	2%
24	Vegetation	Vegetation becomes a built area	Change	15.64	1%
25	Vegetation	Vegetation Becomes Water Body	Change	0.19	0%

4. CONCLUSION

The amount of land cover change that occurred during the 5-year period (2019-2023) changed to vegetation (forest), this statement is supported by the fact that BPS states that the area of vegetation (forest) in the Grobogan area is the second largest in Central Java after Cilacap. The second biggest change is the change to agricultural land. This is also marked by the amount of built-up area which is indicated as an increasing settlement. The amount of change in area cover to agricultural land is one of the ways humans meet the need for clothing and board. Agricultural commodities in the Grobogan area are dominated by agriculture because the area is in the Karst area.

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