

CONVERSION OF PRODUCTIVE AGRICULTURAL LAND WITH ANALYSIS OF GEOGRAPHICAL INFORMATION SYSTEMS IN DIBAL VILLAGE, 2010-2020

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ABSTRACT

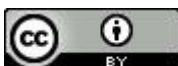
Land conversion will continue to occur over time. Population growth and regional development can cause land conversion. It is undeniable that land conversion will change vacant land, especially productive agricultural land, into built-up land. The purpose of this study is to determine the extent of changes in productive agricultural land and the conversion of productive agricultural land. Within 10 years Dibal Village has experienced many changes with the construction of toll roads and railroads. The variables for this study are land cover, built-up land and undeveloped land parameters. This study uses image interpretation analysis with Arcgis 10.3 and by doing a ground check to ensure the correctness of the interpretation. To test the accuracy of image interpretation is done with the overall accuracy confusion matrix with the kappa accuracy test results of 98.3% so that image interpretation can be trusted. This research is a qualitative research method with a descriptive approach. The results show that in a period of 10 years in Dibal Village there has been a decrease in productive agricultural land of around 9.69 hectares / 5.70%, while built-up land has increased by 9.69 hectares / 5.70%. The decrease in productive agricultural land consists of a decrease in rice fields and gardens. Productive agricultural land that has changed into built-up land includes rice fields and gardens that have turned into toll roads, railroads and community settlements.

Keywords: *Built-Up Land; Conversion; Productive Agricultural Land*

INTRODUCTION

Built-up land will be in line with population growth. Population growth causes the density of settlements in an area to be higher. Regions that have a business center, such as in a wide city, then development will spread to

suburban areas due to the limited availability of land in the city (Hadistian et al., 2021). Residents in an area will tend to look for a place to live as close to the city center as possible. This can lead to dense urban areas. For residents who



cannot find a place to live in the city center, they tend to look for suburban areas. (Hidayati & Kinseng, 2013).

The spread of population settlements in a city is influenced by the completeness of existing facilities in the city center, such as educational facilities, entertainment venues, hospitals, workplaces to easy accessibility such as roads and the internet network (Sasongko Wisnu et al., 2017). The construction of facilities in the suburban area will affect the use of the surrounding land. The area of land that has experienced the most significant reduction in area is productive agricultural land. (Wang et al., 2018; Janah et al., 2017; Paudel et al., 2019).

Dibal Village, which is administratively in the Ngemplak District, is one of the villages affected by the development of the Surakarta City area. The village has experienced many land-use changes in the last ten years. The population of Dibal Village in 2009 was 5,894 people (BPS Boyolali, 2009), and in 2019 there were 6,553 people (BPS Boyolali, 2019). In the last ten years, there has been an increase in the total population of around 659 people. As one of the areas on the outskirts of Surakarta City, this village has yet to be spared from the development of public facilities and new

settlements. This village is experiencing the construction of public facilities such as widening the airport, construction of a toll road, and construction of the airport railway to Solo Balapan Station, as well as the addition of new settlements. From this background, the research will focus on changing the use of productive agricultural land into built-up land in Dibal Village, Ngemplak District.

This research focuses on changes in land use in Dibal Village from 2010-2020 which are analyzed spatially using imagery and mapping to determine changes in area and land conversion. Compared to research (Sasongko Wisnu et al., 2017; Paudel et al., 2019) whose research leads to the use of existing land combined with ground checks and farmers' perceptions of changes in agricultural land. Likewise, research (Hidayati & Kinseng, 2013) does not explain real land conversion in the form of mapping or imagery and is only based on ground checks and data on changes in agricultural land ownership through surveys of land owners.

MATERIALS AND METHODS

This research is a qualitative research method with a descriptive approach. Data for changes in land use can be



obtained through RBI maps of Surakarta, interpretation of iconic imagery, land use area documentation in previous years, and ground checks or checks directly at the study site.

Analysis of changes in productive agricultural land use using ArcGIS software by overlaying image data with regional administrative maps and interpreting according to image interpretation rules (Hersperger et al., 2018; Janík & Romportl, 2018; Schulp et al., 2019). The validity of image interpretation tested it with the overall accuracy confusion matrix. Agricultural land conversion data analysis uses temporal image data using Google Earth imagery for 2010, 2015, and 2020. The variable for agricultural land conversion is land cover with built-up and non-built-up land parameters. The results of this analysis are Citra maps in 2010, 2015, and 2020 in Dibal Village, Ngemplak District.

RESULTS AND DISCUSSION

Dibal Village is one of the villages experiencing rapid land use changes. This village has three essential facilities that support the development center of Surakarta City. The three facilities

include Adi Sumarmo Airport, the Airport-Solo Balapan Railway, and the Solo-Kertosono Toll Road. In the last ten years, this village has experienced the construction of these three facilities, which displaced productive agricultural land. By interpreting iconic images from 2010, 2015, and 2020 and ground checks in Dibal Village, this research was then analyzed qualitatively about the land conversion and the validity of image interpretation tested it with the overall accuracy confusion matrix. The following are the results of the study:

Imegery Intrepretation

The interpretation of an image to find out the forms of land cover can be made by looking at the elements of image interpretation. Based on the land cover variable, it can distinguish by looking at the elements of image interpretation. According to (Sutanto, 1994), the elements of image interpretation consist of hue or color, shape, size, texture, spatial arrangement or pattern, site, shadow, and association. The image of Dibal Village is present in **Figure 1** below.



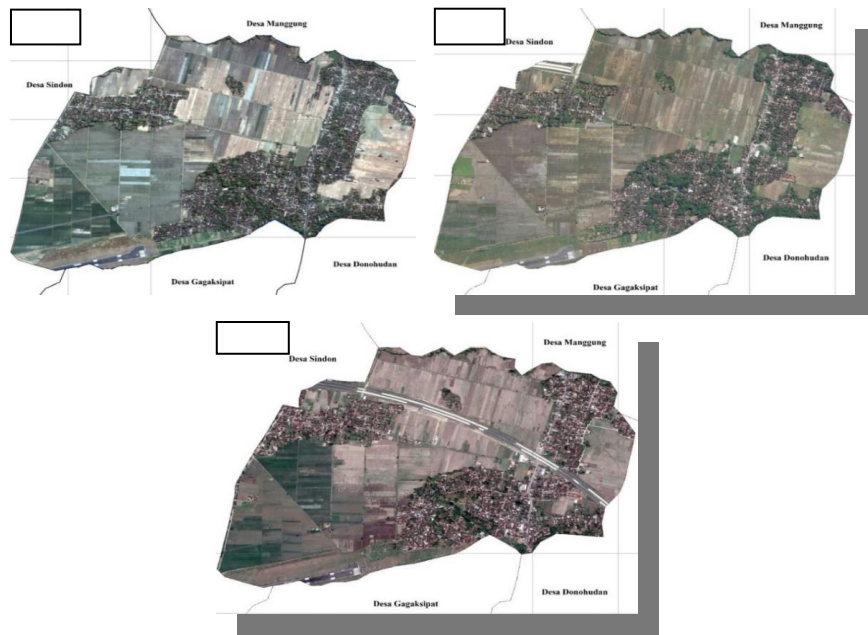


Figure 1. Imagery of Dibal Village in 2010, 2015 and 2020

Based on image interpretation According (Sutanto, 1994), **Table 1** below is the

result of the image interpretation of Dibal Village from 2010-2020.

Table 1. Imagery Interpretation of Dibal Village.

Color	Texture	Shape	Size	Pattern	Shadow	Association	Summary	Year
Dark brown	coarse	Irregular	small	Field, farm	-	Road	Settlement	2010
brown-bright green	smooth	Plaid	wide	settlement	-	Road, settlement	Dry field	2010
green	smooth	Plaid	wide	settlement	-	Road, settlement	Wet field	2010
Bright grey	smooth	Straight	small	elongated	-	settlement	Road	2010
Dark green	coarse	Irregular	medium	settlement, road	-	Settlement, road	Farm	2010
Grey	smooth	Straight, elongated	medium	field	-	field	Airport Area	2010
grey, white	smooth	Straight	wide	settlement, field	-		Toll road	2018
grey	smooth	straight	elongated	Toll Road	-	Toll Road	Railroad	2019

Data Analytics, 2021

To find out the validity of image interpretation, the researchers tested it with the overall accuracy confusion

matrix. The result is explaining this **Table 2** below:



Table 2. Confusion Matrix

Class/ Samples	Field	Farm	Settlement	Airport Area	Toll Road	Railway Road	Road	Sum
Field	85	1	0	1	0	0	0	88
Farm	0	51	0	0	0	0	0	51
Settlement	0	1	112	0	0	0	0	113
Airport area	0	0	0	1	0	0	0	1
Tollroad	0	0	0	0	1	0	0	1
Railway Road	0	0	0	0	0	1	0	1
road	0	0	0	0	0	0	70	70
sum	85	53	112	2	1	1	70	325

Data Analytics, 2021

With the above interpretation error table 3, user's accuracy 4, Overall matrix, calculations are carried out accuracy, and kappa accuracy as systematically with producer's accuracy follows:

Table 3. Producer's Accuracy

Land Use	Producer's Accuracy
Field	85/85 100%
Farm	51/53 96%
Settlement	112/112 100%
Airport area	1/2 50%
tollroad	1/1 100%
Railroad	1/1 100%
road	70/70 100%

Data Analytics, 2021

Table 4. User's Accuracy

Land Use	User's Accuracy
Field	85/88 96%
Farm	51/51 100%
Settlement	112/113 99%
Airport area	1/1 100%
Tollroad	1/1 100%
Railroad	1/1 100%
road	70/70 100%

Data Analytics, 2021

a. Overall Accuracy = $(85 \times 88) + (53 \times 51) + (112 \times 113) + (2 \times 1) + (1 \times 1) + (1 \times 1) + (70 \times 70) = 7.480 + 2.703 + 12.656 + 2 + 1 + 1 + 4900 = 27.743$

Overall accuracy = $(85 + 51 + 112 + 1 + 1 + 1 + 70) / 325 = 321 / 325 = 98,76\%$

b. Kappa Accuracy 2) Kappa Accuracy

1) Sample Cross Multiplication



$$\begin{aligned} &= \frac{(321 \times 325) - 27.743}{(325)^2 - 27.743} \times 100\% \\ &= \frac{(104.325) - 27.743}{105.625 - 27.743} \times 100\% \\ &= \frac{76.582}{77.882} \times 100\% \\ &= 98,3\% \end{aligned}$$

From the results of the accuracy test with the kappa test, an accuracy of 98.3% (coefficient 0.9) was obtained. The

accuracy is 98.3% which proves that image interpretation can be trusted.

The map of the imagery interpretation the village of Dibal can be seen in the **Figure 2.**

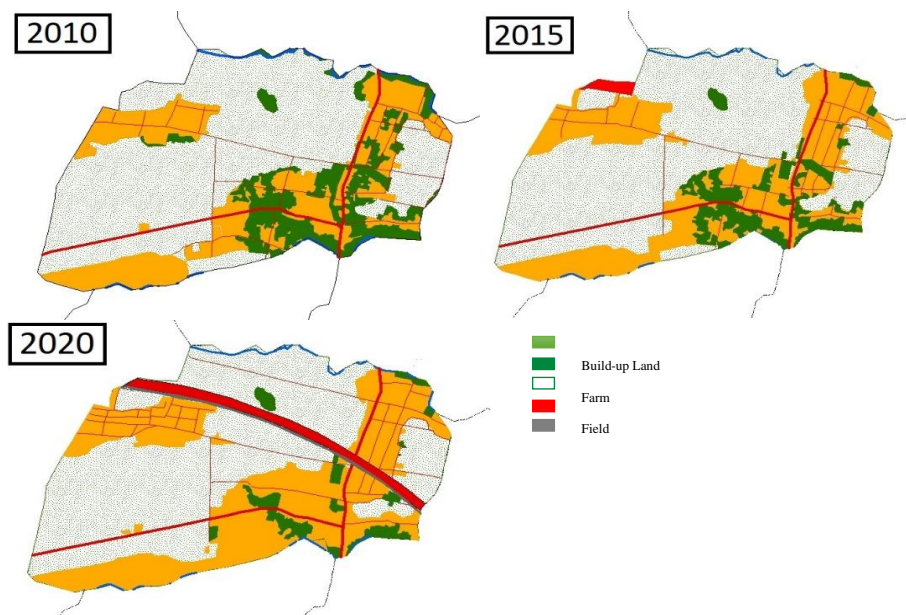


Figure 2. Maps of Dibal Village 2010, 2015, and 2020

Agricultural Land Conversion

Land use is all forms of human intervention on land to meet material and spiritual needs (Arsyad, S, 2012). Changes in land use are closely related to human activities and needs. One activity that is very influential on changes in land use is development. The construction of settlements, public facilities, and accessibility takes up more

and more land, incredibly productive agricultural land. The need for housing, public facilities, and accessibility also influenced the development of Dibal Village.

Changes in land use that have occurred in the last ten years have experienced changes in the extent and function of land use. Changes in the area of built-up land and undeveloped land are presented

in **Table 2** and **Figure 3** below. The following is a table of changes in land

use from 2010-2020:

Table 2. Changes in Area of Built-up Land and Undeveloped Land

No	Land Cover	2010		2015		2020		Conversion 2010-2020		Inf
		Wide Ha	Wide (%)	Wide Ha	Wide (%)	Wide Ha	Wide (%)	Wide Ha	Wide (%)	
1.	Productive Agricultural land	170,09	60,76	169,44	60,53	160,4	57,3	-9,69	-5,70	down
2.	Build-up land	109,85	39,24	110,5	39,48	119,54	42,70	9,69	5,70	up
		279,94	100	279,94	100	279,94	100	-	-	-

Source : ArcGIS Analysis, 2021

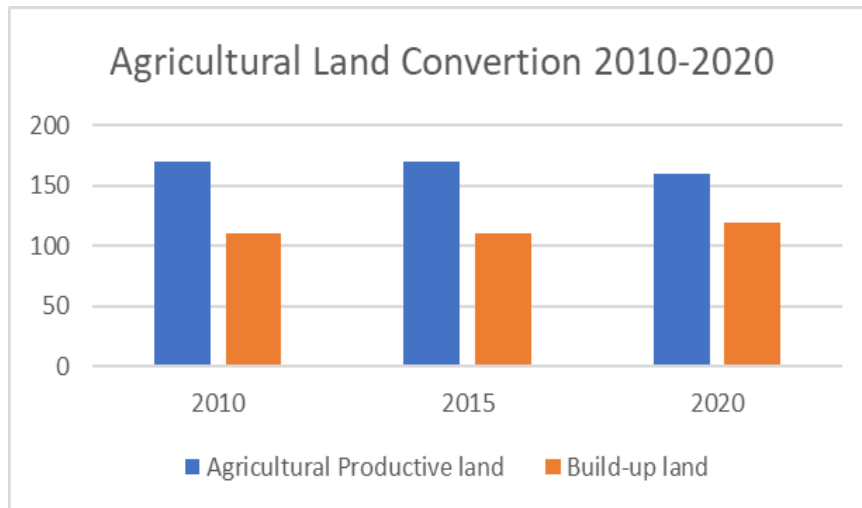


Figure 3. Land Conversion Diagram in Dibal Village for 2010-2020

Based on the diagram above, the area of agricultural land from 2010-2020 has decreased, while the area of built-up land has increased in the last ten years. Land use in 2010, 2015, and 2020 experienced changes in the area and several changes in land use. In 2010 Dibal Village experienced few changes, but in 2015 this village built several public facilities, namely widening the airport and a toll road. Also, in 2020, this village built a railroad that connects Adi Sumarmo

Airport with Solo Balapan Station. So in 2020, many changes have occurred in the last ten years. The area of productive agricultural land in the last ten years has decreased by 9.69 hectares or around 5.70%.

The land conversion occurs due to land conversion in the form of toll roads, widening airports, and a small amount of residential land that has experienced expansion. Based on the image interpretation, there is built-up land



cover and undeveloped land categorized as productive agricultural land, including paddy fields and gardens.

Field

The use of paddy fields still dominates in Dibal Village. More than 50% of the area of Dibal Village is paddy fields. It is because the village area is fertile and has sufficient groundwater reserves. In addition, the existence of the Cengklik

Reservoir also provides significant benefits because the rice fields are irrigated, which also flow from the Cengklik Reservoir. The rice fields in this village are usually planted with rice, which is more dominant. However, some people grow vegetables in the fields. **Figure 4** is productive agricultural land in Dibal Village, which is usually used for rice farming.



Figure 4. Productive Agricultural Land

Farm

Farm is a relatively large area of land in Dibal Village. This land use is the third largest land use in Dibal Village. The farm in Dibal Village has bamboo, kapok trees, fruit trees, and others.

While the results of the interpretation of built-up land include the following:

Settlement

Settlements in Dibal Village consist of houses, yards, and yards. The settlement

pattern in Dibal Village is still in groups. Residential land use in this village is obvious. Residential land use is the second largest land use after rice fields.

Airport Area

The Adi Sumarmo Airport area is located in Ngemplak District, more dominated by Ngesrep Village. However, Dibal Village is also one of the villages which is the land for the Adi Sumarmo Airport area (**Figure 5**). The

Adi Sumarmo Airport area in Gatun Hamlet and South Wangkis Hamlet is an aircraft crossing area that PT has fenced

off. Angkasa Pura. The airport area is also quite extensive in Dibal Village.



Figure 5. Airport Area

Road

Road land use is the main road that connects villages and sub-districts. Likewise, the road that connects between hamlets. Meanwhile, starting in 2009, the construction of the Solo-Kertosono toll road has begun.

Toll road

The toll road that passes through Dibal Village is the Solo-Kertosono Toll Road. Construction of this toll road began in

2010 and was completed in 2018. This toll road separates several villages in Ngemplak District, one of which is Dibal Village. The existence of this toll road has separated the hamlets in Dibal Village, so a through tunnel was built (**Figure 6**) to facilitate community access from one hamlet to another.



Figure 6. Toll Road Tunnel in Dibal Village

Railroad

The Adi Sumarmo Airport Railroad to Solo Balapan Station was inaugurated at the end of December 2019 (Humas DJKA, 2019). This building was built starting in 2018, which began with the acquisition of community land. This rail project was built to make it easier for tourists or visitors from afar to use airplane transportation to Surakarta City. Adi Sumarmo Airport is administratively located in Boyolali Regency, and the city center in Soloraya is Solo City, so this railroad was built from the airport to the train station.

CONCLUSIONS

Concluding is carried out by referring to the results of research and contained in the following points:

1. The most significant land conversion occurred in residential

land use, farm, and paddy fields. Changes in land use area have occurred in the last ten years. The change in an area that occurred the most was agricultural land which decreased by 9.69%.

2. Meanwhile, the land that is experiencing a function change is:
 - a. Some of the agricultural lands have turned into settlements, highways, railroads, and airport areas.
 - b. Settlements are partially turned into toll roads
 - c. Farm are partly turned into settlements, schools, airport areas.

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