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Land Use Conversion Pattern and Food Security for Sustainable Food Land Direction in Karanganyar Regency, Indonesia

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Karanganyar Regency is a food granary (rice surplus area), however at the moment, a large portion of agricultural land is undergoing land-use conversion, which may result in a drop in rice output and, if not regulated, a negative impact on food security. The research purpose is to analyze the distribution pattern of land use conversion and the level of food security in Karanganyar Regency, Central Java Province, to determine a sustainable food land direction. The distribution pattern of agricultural land conversion to non-agriculture was examined using the average closest neighbor (ANN=z-score), while data on agricultural land conversion to non-agriculture were gathered using LANDSAT satellite imagery. Due to the fact that the population is distributed over all sub-districts, all sub-districts are observed as study units (survey method). The study's findings are based on the fact that the z-score value (nearest neighbor spread index) from the ANN analysis is -2.553, indicating that the pattern of land-use conversion at the regency level is clustered, whereas at the sub-district level, there are three clustered sub-districts (clustered), three random sub-districts (random), and eleven dispersed sub-districts. At the regency level, Karanganyar Regency was a rice surplus area till 2019, with a population of 886519 people and a capacity to eat food (padi = rice) of up to 939795 people, leaving 53276 persons (939795-886519). (surplus area). Six sub-districts have a large surplus, eight have a modest surplus, and three at the sub-district level. The research results indicate that three sub-districts are appropriate for conversion to regional development areas, while rice barns are located in eight sub-districts and the remainder as buffer areas in as many as six sub-districts. A buffer zone is an area (district) that can be transformed under highly rigorous conditions to achieve long-term food security.

Keywords: land-use conversion, rice surplus, food consumption

I. INTRODUCTION

The land is the primary driver of regional development. As an agricultural country with a more significant proportion of agricultural land and workforce than other sectors, Indonesia is a cornerstone of national agriculture growth, particularly food supply. To achieve national food security, the availability of locally grown food (regional food security) is critical. The route to national food security is becoming increasingly challenging due to population expansion, increased economic activity, and rising food consumption in numerous regions. Additionally, it can be noted that there are still many locations that are unable to offer or meet their local food needs. This is due to various variables, including land conversion, population density, and agricultural production. 2020 (Karjoko, Winarno, Rosidah, & Handayani, 2020).

Land-use conversion is a frequent occurrence in contemporary human life; it occurs because humans, in addition to requiring food, require land to sustain habitation (Satria, Falatehan, & Beik, 2018). The requirement for land as part of the available space for human habitation on earth enables humans to carry out their activities. The land is a fundamental requirement for human survival on biological (biotic) and physical (abiotic) levels, as well as for sustainable development (Soemarwoto, 1995). Human beings require land to produce plants to meet their food requirements, but the land is also needed for the board (housing). Food and board are two conflicting variables in demand for land, as food sustainability is always degraded by the need for shelter (housing).

The most important difficulty confronting agriculture is the loss of agricultural land owing to human activities, particularly settlement and infrastructure expansion in houses, roads, dams, and industrial regions, to name a few (Sudarwanto & Handayani, 2019). Continuous development results in agricultural land being converted to non-agricultural use. Conversion of land use is occurring at an alarming rate throughout Indonesia, including Bali (Akhmaddhian, Hartiwiningsih, & Handayani, 2017). Such land conversion will result in a loss of agricultural land, as the conversion process is more concerned with sustaining Indonesia's infrastructure than maintaining agricultural land (Soediro, Handayani, & Karjoko, 2020). The conversion of agricultural land in Indonesia is quite concerning, as it tends to increase year after year, resulting in a decrease in agricultural land. For example, in 2012, Indonesia had 40,157,738 hectares of agricultural land, which was reduced to 39,475,694 hectares, or a 1.69 percent decrease, in 2013 (Leonard, Pakpahan, Heriyati, & Handayani, 2020).

Existing agricultural land for food crops, particularly rice fields, is critical to meeting the food needs of Indonesia's 258.7 million people in 2017, despite the country's population growing at a rate of about 3.4 million people per year and rice fields being converted to non-agricultural land at a rate of about 96500 ha per year (Mulyani, Nursyamsi, & Syakir, 2017). With the growth of Indonesia's population, the demand for land has increased for various purposes, including food production and shelter. Increased population pressure and economic and industrial growth have resulted in unregulated land-use competition in various sectors, including agriculture. This underlines the importance of planning and managing land resources rationally and sustainably following their carrying capacity.

Agricultural land resources are incredibly beneficial on a socio-economic and environmental level. As a result, the conversion of agricultural land to non-agricultural uses will affect numerous facets of development. The benefits of agricultural land can be broadly classified into two categories: There are two types of benefits: indirect and direct. Indirect benefits refer to various activities that occur as a result of landowners' exploitation activities. One example is the preservation of biodiversity or the existence of particular types of plants whose benefits are unknown but will be critical in meeting human needs in the future (natural and environmental conservation). Direct benefits are also known as usage values. These advantages are generated from exploitation or farming activities on agricultural land resources and so reflect the area's socio-economic existence. However, the desire of humans to increase their economic well-being does not imply that they should forgo natural conservation (Juhadi, 2007; Munasinghe, 1992).

Agricultural cultivation (land productivity) is the safest land use because it maintains the environmental ecosystem; nonetheless, several environmental constraints must be considered for regional development to be sustainable. Avoiding environmental change through land-use conversion is likely to slow urbanization. In rural areas, farmers' lack of work opportunities might stimulate urbanization, which frequently results in various socio-economic problems and ultimately encourages land-use conversion (Soerjani, Ahmad, & Munir, 2001).

Land as a physical entity is separated into two (two) components, those about the (legal) rights to land and those about its usage (its breadth). If a transaction is conducted on the property in terms of location, numerous other characteristics (in addition to the area) are required to represent the land as a requirement for housing. Rapid development and population increase are driving forces behind the increasing demand for land in both urban and rural areas, which would result in a reduction in food security in the area. Numerous studies have demonstrated that the conversion of agricultural land influences the deterioration in food security to non-agricultural land and that the more area converted, the lower the food security (Astuti, 2011; Irawan, 2005; Sihaloho, Dharmawan, & Rusli, 2007).

The majority of land required for development is gained through the conversion of agricultural land. Land that has been converted to non-agricultural uses tends to lose productivity, which negatively influences food security. Numerous factors, including population density, land area, and accessibility, all contribute to reducing food security. Food security is ultimately determined by the pattern of land conversion from agriculture to non-agricultural. Land conversion from agriculture to non-agriculture is typically grouped in Indonesia, as most land conversions from agriculture to non-agricultural are infectious or follow-up in nature. Food security has a significant impact on the conversion of agricultural land to non-agricultural land, as illustrated by the following trend (Irawan, 2005). Land conversion from agriculture to non-agricultural on a random and regular basis tends to have a lower level of food security than those in groups.

Generally, as a result of development, available land in urban and rural areas is becoming increasingly scarce. This exacerbates urban and rural land problems, including an uncontrollable decline in food security and the emergence of conflicts of interest. The requirement for land for industry and numerous economic activities clashes with the increasing demand for dwellings, which results in a decline in food security (Sari, Nugroho, Hendriawaty, & Ginting, 2010).

The rate of environmental development in Karanganyar Regency affects land use conversion, particularly agricultural land conversion to non-agricultural land. Ritohardoyo (2009) asserts that the environment is identical to land. Human activities are inextricably linked to land, both for agricultural agriculture and settlement and industrial. Human actions to meet food demands are the primary factor, but land-use conversion constantly occurs on agrarian production land.

The government's development plan is fundamentally an endeavor to manage natural resources and the environment thoughtfully and prudently, with the intention that no human action causes environmental damage. However, the conversion of agricultural land to other uses harms the environment, resulting in a decline in food security. Natural resources, such as land and available water, can be leveraged to increase agricultural production, particularly rice, through expansion or intensification. Karanganyar Regency does not allow for agricultural growth by extensification, as the population is concentrated in a fairly small region (National Land Agency of the Republic of Indonesia, 2009). The most likely strategy for increasing agricultural production in Karanganyar Regency is intensification, which may be accomplished in several ways through careful land-use planning to maximize land productivity.

Because agricultural land ownership does not guarantee farmers can maintain their families, many farmers sell the property due to its high value. Many farmers change careers due to the high value of their land; buyers frequently convert agricultural land to non-agricultural land. According to some perspectives, land-use conversion from agriculture to non-agriculture is a follow-up process, which means that if a location's land use is converted, it will be followed by several subsequent conversions. There is a positive relationship between land conversion from agricultural to non-agricultural land and land converted to agriculture. Food security will deteriorate if agriculture is replaced by non-agriculture (Astuti, 2011; Irawan, 2005). One of Indonesia's development challenges is the annual population increase, notably in Karanganyar Regency. These issues indirectly contribute to land conversion due to inhabitants' land needs. The population growth has led to a surge in housing and industrial development. Simultaneous increase of housing and industry would erode food security when agricultural land is converted to non-agricultural land.

The research area is the administrative area of Karanganyar Regency; geographically, Karanganyar Regency is located between $07^0 00'28"$ to $07^0 00'46"$ South Latitude and $110^0 00'40$ to $110^0 00'70"$ East Longitude with the following limits.

1. Sragen Regency borders north.
2. It is bordered by Boyolali Regency, Surakarta City, and Sukoharjo Regency in the east.
3. To the south, Wonogiri Regency borders it.
4. In the west it is bordered by East Java Province.

The research area is the administrative work area of Karanganyar Regency, for more detail, the research area can be seen in Figure 1.

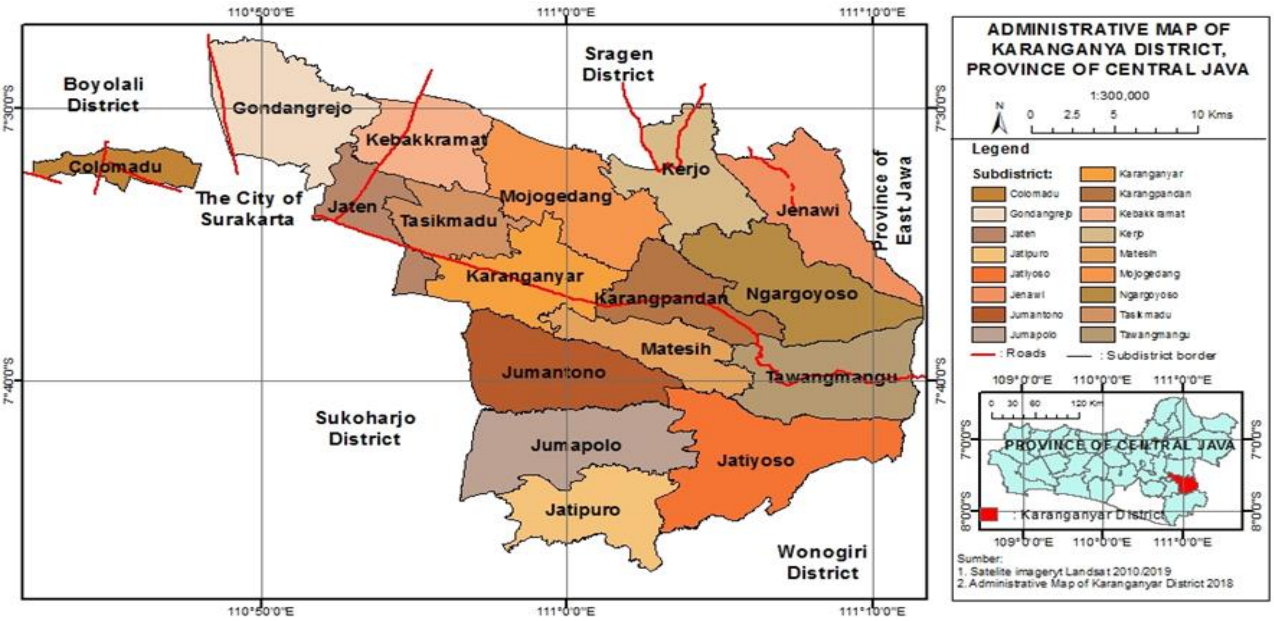


Figure 1. Karanganyar Regency Administration Map

According to the description above, the research objectives are as follows: (1) to analyze the pattern of agricultural land conversion to non-agriculture in Karanganyar Regency; and (2) to analyze the level of food security in Karanganyar Regency using the criteria of surplus food security, low food security, and minus food security, which is all taken into account in this study when determining land use direction in Karanganyar Regency.

II. RESEARCH METHOD

Karanganyar Regency is the subject of the research. To identify the population and research sample, support from LANDSAT Satellite Imagery is required, with a spatial resolution of 15 to 30 meters and accurate enough to map the earth's surface at a scale of 1: 25000 or less (Jalzarika, 2008). Between 2009 and 2019, all sub-districts in Karanganyar Regency witnessed the land-use conversion to non-agriculture. As a consideration of the research region, Karanganyar Regency has a relatively high rate of agricultural land conversion due to its proximity to metropolitan areas (Surakarta City). Census sampling is used in this study, meaning the entire research population is taken/observed as the research sample.

Karanganyar Regency's agricultural lands play a critical role in sustaining food productivity. Additionally, agricultural land in Karanganyar Regency is complex regarding land physical qualities, socio-economic conditions, and society. This is assumed to be influenced by the shift of agricultural land to non-agricultural uses.

The data analysis performed in this study is divided into two (two) categories based on the research objectives.

1. Pattern of land conversion

The pattern of agricultural land conversion in Karanganyar Regency is determined by calculating the distance between each location of land conversion using a land-use conversion map derived from LANDSAT satellite imagery interpretation. Then, using Average Nearest Neighbor (ANN) Analysis, the data was evaluated. The term "land conversion" refers only to converting agricultural land to non-agricultural land.

In this study, we employ closest neighbor analysis to assess whether the distribution pattern of land use conversion in Karanganyar Regency is clustered, random, or uniform, as indicated by the value of the Average Nearest Neighbor (Novio, Mariya, & Wijayanto, 2020). The outcome of this analysis provides an overview of the relationship between a land-use conversion pattern and the value of ANN, which is calculated using the following formula:

The Average Nearest Neighbor (ANN=z-score) ratio is given as :

$$ANN = \frac{\bar{D}_O}{\bar{D}_E} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Where Do is the observed mean distance between each feature and nearest neighbor

$$\bar{D}_O = \frac{\sum_{i=1}^{n} d_i}{n}$$

and D_E is the expected mean distance for the feature given a random pattern :

$$\bar{D}_E = \frac{0.5}{\sqrt{n/A}}$$

In the previous equations, d_i equals the distance between feature *i* and its nearest feature, *n* corresponds to the total number of features and *A* the total study area.

In conducting the nearest neighbor analysis, it is necessary to pay attention to the following essential steps:

a. determine the boundaries of the area to be researched;
b. changing the distribution pattern of the observed unit in the topographic map to a point distribution pattern;
c. assign a serial number to each point to facilitate analysis;
d. measure the shortest distance for the distance on a straight line between one point and another point which is its closest neighbor;
e. according to Novio et al. (2020), with ArcGIS software, the ANN (*z-score*) is interpreted as in Table 1 below.

Table 1. Conversion distribution grouping

No	Pattern	z-score
1	Clustered	<-1.65
2	Random	-1.65≥ - <1.65
3	Uniform (dispersed)	≥165

f The distribution pattern of land use conversion is carried out using ANN analysis with the working principle of grouping one cell with neighboring cell based on their similarity .

2. Food security

Food security is calculated using data from Karanganyar Regency In Figures for 2020, specifically the population of each subdistrict and the average paddy (rice) productivity per hectare per year, while agricultural land (paddy field) is obtained with the assistance of LANDSAT Satellite Imagery to determine the use of agricultural land in 2019. The primary element affecting food security as a result of population consumption is the availability of land, population, and land productivity for lowland rice, as defined by Martanto and Handayani (2020):

$$P = \frac{\text{land production in one year (kg/person/year)}}{\text{average consumption of rice per resident in one year (kg/person/year)}}$$

Or

$$P = \frac{(L \times Pr \times Pl \times R)}{K} \ldots\ldots\ldots\ldots\ldots (2)$$

P = total population (people);
L = land area (ha);
pr = land productivity (kg/ha);
Pl = number of rice planting in a year;
R = rice yield (in 1/100);
K = average consumption of rice per person in a year (kg/person/year)

The level of food security for each sub-district, namely surplus areas and minus areas, is calculated using formula (2), where minus areas are sub-districts that are not directed toward sustainable agricultural land but must also consider population density, and surplus areas are divided into two (two), namely high and low surplus, using the formula:

$$I = \frac{t_{max} - t_{min}}{k} \ldots\ldots\ldots\ldots\ldots (3)$$

I = class interval;
t_{max} =maximum food security;
t_{min} =minimum food security;
k = number of classes = 2 (high and low)

At the sub-district level in Karanganyar Regency, the pattern of land-use conversion and food security will subsequently be classified into three (three) areas (land), namely: 1) sustainable food agricultural land; 2) buffer land; and 3). convertible land. To obtain three (3) areas through the overlapping (overlay) of two (2) maps, namely the Land Use Conversion Pattern Map and the Food Security Level Map with scoring technique (weighting), Table 2 illustrates the overlap in scoring and data source in further detail.

Table 2. Scoring and data sources

No.	Variable	Calculation assumption	Grouping of research result (attribute)	Score	Data source
1	Land use conversion pattern	From the result of calculation with the help of LANDSAT Satellite Imagery and ArcGIS software	group	1	LANSAT Satellite Image Overlay 2009 and 2019
			Random	5	
			Uniform	9	
2	Food security level	From the calculation according to formula (2) and the level of food security in formula (3)	Minus	1	LANDSAT Satellite Image in 2019 and Karanganyar Regency in Figure for 2020
			Low surplus	5	
			High surplus	9	

Note: Scoring with AHP from Saaty (1994)

Map of each variable can be made, namely 1) Land Use Conversion Pattern Map and 2) Food Security Level Map and each sub-district will get a total score, then the total score is the basis for determining the direction of sustainable agricultural land use. Direction for sustainable food land is determined based on the result of class interval calculation according to formula (3), in order to obtain a grouping of sustainable land use direction in Karanganyar Regency as shown in Table 3.

Table 3. Grouping of sustainable land use direction in Karanganyar Regency

No.	Sustainable food land direction	Total score grouping
1	Land for sustainable food security (must not be converted)	$\geq (t_{min}+2I)$
2	Buffer land (conditionally converted)	$\geq (t_{min}+I)$- $< (t_{min}+2I)$
3	Land may be converted (Land for regional development)	$< (t_{min}+I)$

The assumption built is that agricultural land that has a uniform conversion pattern and high surplus food security is an area or sub-district that is directed to sustainable food land so that agricultural land cannot be converted, while on the contrary on agricultural land that has a clustered conversion pattern and minus food security is an area or sub-district whose agricultural land can be converted. Meanwhile, some of them are buffer zones or areas/districts that may or may not be converted depending on regional need, so that policy maker play a very important role in determining whether or not the area is converted from agricultural land use to non-agricultural use.

III. RESEARCH RESULTS AND DISCUSSION

The results and discussion of research in the administrative area of each sub-district in Karanganyar Regency are as follows.

A. Distribution pattern of land use conversion

To obtain land use conversion data for each research unit, an overlay between the 2009 and 2019 Land Use Maps was performed, and the overlapping difference between the 2009 and 2019 Land Use Maps (from LANDSAT Satellite Imagery) was visualized in the form of a Map Land Use Conversion 2010-2019 (for ten years) for each sub-district in Karanganyar Regency from agriculture to non-agriculture, as shown in Figure 2.

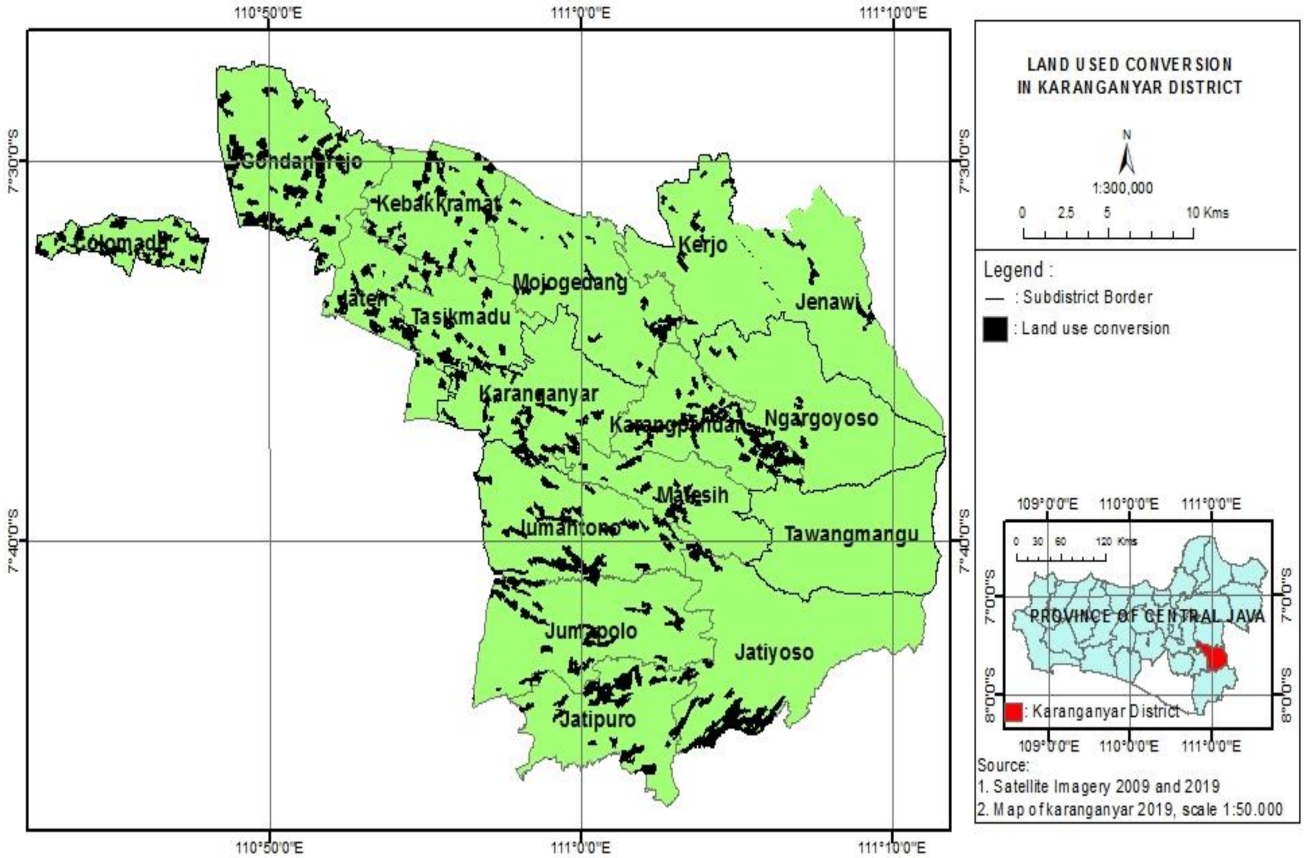
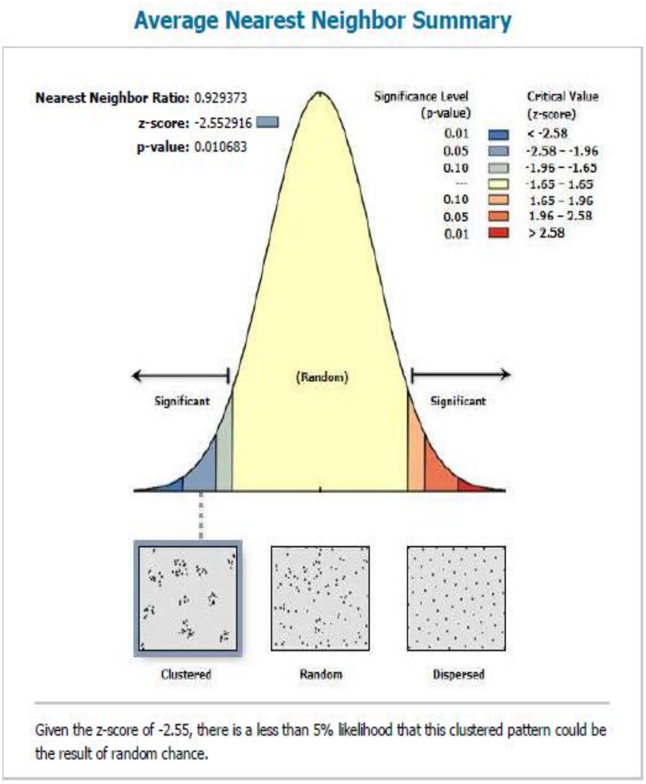


Figure 2. Map of Land Use Conversion for 2009-2019 in Karanganyar Regency

The pattern of land-use conversion can be determined using Figure 2, namely by ANN analysis. The outcome of the ANN and the trend of land-use transformation from agricultural to non-agriculture in Karanganyar Regency using ArcGIS Software are depicted in Figure 3.



Average Nearest Neighbor Summary

Observed Mean Distance:	697.532485
Expected Mean Distance:	750.541033
Nearest Neighbor Ratio:	0.929373
z-score:	-2.552916
p-value:	0.010683

Dataset Information

Input Feature Class:	Perubahan_kab
Distance Method:	EUCLIDEAN
Study Area:	804409311.119000

Figure 3. Conversion pattern and ANN for regency level in Karanganyar Regency

From Figure 3 it is known that the *ANN (z-score)* of Karanganyar Regency = -2.553 and in Table 1 it is located in line No. 1 which is <-165 and Figure 3 is Clustered so it can be said that the pattern of land use conversion in Karanganyar Regency is clustered pattern.

A sub-district study is required to ascertain the direction of food security in Karanganyar Regency. Karanganyar Regency is divided into 17 sub-districts (Figure 1); to ascertain the pattern of agricultural land use conversion and the z-score of agricultural land use conversion to non-agriculture at the sub-district level (Figure 3), and as a result, the pattern of agricultural land use conversion and the z-score of agricultural land use conversion to non-agriculture from 2009 to 2019 at the sub-district level, as well as the weighting (score) as in formula

Table 4. Conversion area and ANN of land use at sub-district level 2009 and 2019 in Karanganyar Regency

No.	SUB-DISTRICT	Conversion area		*ANN (z-score)*		
		Ha/10 th	%	z-score	Pattern	Score (Table 3)
1	Gondangrejo	67.84	13.34	2,731	dispersed	9
2	Kebakkramat	33.31	6.55	-1.093	Random	5
3	Kerjo	8.13	1.6	3.044	dispersed	9
4	Jenawi	8.63	1.7	1,643	dispersed	9
5	Jumantono	62.22	12.24	1,505	dispersed	9
6	Mojogedang	20.23	3.98	-1,892	clustered	1
7	Jaten	25.87	5.09	-2.507	clustered	1
8	Colomadu	29.93	5.88	2,191	dispersed	9
9	Jatiyoso	48.52	9.54	-1.156	Random	5
10	Jatipuro	42.14	8.29	2,197	dispersed	9
11	Tasikmadu	22.17	4.36	4,231	dispersed	9
12	Karanganyar	28.19	5.54	3,258	dispersed	9
13	Ngargoyoso	14.27	2.81	1.116	dispersed	9
14	Karangpandan	45.18	8.88	3,197	dispersed	9
15	Matesih	19.29	3.79	2,930	dispersed	9
16	Tawangmangu	1.01	0.2	-1,252	Random	5
17	Jumapolo	31.62	6.22	-1,710	clustered	1
	Amount	508.53	100			

In Table 4, it can be seen that land-use conversion at the Karanganar Regency level for 10 years, from 2010 to 2019 was 508.53 ha per year or 50.83 ha/year. In Table 4 above, it can also be seen that there are land-use conversion patterns *clustered* in 3 sub-districts, *random* in 3 sub-districts and 11 *dispersed*, while the Map of Land Use Conversion Pattern per sub-district in Karanganyar Regency can be seen in Appendix 1. According to Irawan (2005) the wariest of are the *clustered* patterns because land-use conversion tends to get bigger, while the safe for land use conversion is *dispersed*. To make a Direction Map for Sustainable Food Land Use in Karanganyar Regency in addition to the Land Use Conversion Pattern Map, it is also necessary to calculate the "level of food security" for each sub-district to make a Food Security Level Map.

B. Food security level

In determining food security per sub-district in the research area, data on the population in 2019 and the average productivity in 2010 (start of conversion) to 2019 are needed and this data is obtained from the BPS for Karang Anyar Regency, while the calculation uses formula (2) with the following condition:

1. Population of Karanganyar Regency in 2019 (BPS of Karanganyar Regency 2020)……………………... (P).
2. The average consumption of rice is 97.6 kg/capita/year (Arifin, Achsani, Martianto, Sari et al., 2018)..........(K).
3. Yield of dry milled grain in Indonesia: 64.02 % (BPS Indonesia, 2018)………………………………... (R).
4. Average productivity of paddy field in 2019 in Karanganyar Regency

Is 6000 kg/ha (BPS Karanganyar Regency, 2020) …. (Pr).

5. Rice cropping pattern in Karanganyar Regency 2 x a year ……………………………………………. (Pl).
   and after using formula (3) and Table 3 the results are as in Table 5.

Table 5. Food security at the sub-district level in Karanganyar Regency

No.	Sub-districts	Population year 2019 (soul)	Agriculture year 2019	Consumption ability (soul)	Food security Remainder (soul)	Food security Level	Food security Score	Conversion pattern scores (Table 4)	Total score	Land Use Direction
1	2	3	4	5	6	7	8	9	10	11
1	Jatipuro	29004	1424.42	112121	83117	SR	5	9	14	LB
2	Jatiyoso	37089	1096.28	86292	49203	SR	5	5	10	BV
3	Jumapolo	36351	2086.78	164257	127906	ST	9	9	18	LB
4	Jumantono	42939	2423.03	190724	147785	ST	9	9	18	LB
5	Matesih	40994	2576.88	202835	161841	ST	9	9	18	LB
6	Tawangmangu	45598	314.6	24763	-20835	Minus	1	1	2	BK
7	Ngargoyoso	33213	765.78	60277	27064	SR	5	1	6	BK
8	Karangpandan	40409	278.49	21921	-18488	Minus	1	9	10	BV
9	Karanganyar	81629	1898.87	149466	67837	SR	5	5	10	BV
10	Tasikmadu	61461	1764.93	138923	77462	SR	5	9	14	LB
11	Jaten	85583	1189	93590	8007	SR	5	9	14	LB
12	Colomadu	82199	626.94	49348	-32851	Minus	1	9	10	BV
13	Gondangrejo	81112	3569.12	280937	199825	ST	9	9	18	LB
14	Kebakkramat	64075	2265.32	178310	114235	ST	9	9	18	LB
15	Mojogedang	63217	2542.27	200110	136893	ST	9	9	18	LB
16	Kerjo	34963	1317.92	103737	68774	SR	5	5	10	BV
17	Jenawi	26683	1397.27	109984	83301	SR	5	1	6	BK
	Amount	886519		939795						

Sources:
1.BPS, Bantul District, 2019
2. Satellite Imagery LANDSAT 2019
Information:
ST : High surplus LV : Buffer land
SR : Low surplus BK : Land can be converted
LB : Land for sustainable food security

C. Land use direction

A map of the pattern of food security levels can be created from Table 5 (column 7) (Appendix 2), showing that areas with minus food security levels are located in three sub-districts, areas with a low surplus (SR) are located in six sub-districts, and areas with high surplus (ST) are located in eleven districts. It is projected that sub-districts with a big surplus will become a food barn (rice) for Karanganyar Regency. According to Table 5, the population's ability to consume rice in all sub-districts was 939795 people in 2019, while the total population was 886519 people (Table 5), implying that food security can be met in Karanganyar Regency by areas (sub-districts) with food surplus (rice) of (939795 people - 886519 people) = 53276 people. Subdistricts with clustered conversion patterns will become places prone to decreased food security; therefore, by overlaying the Land Use Conversion Pattern Map and the Food Security Level Map, a Land Use Direction Map will be generated to support sustainable food security in Karanganyar Regency. After overlaying two (two) maps, namely 1) Land Use Conversion Pattern Map (Appendix 1) and 2) Food Security Level Map from Table 5 (Appendix 2), the Land Use Direction Map as illustrated in Figure 4 will be created.

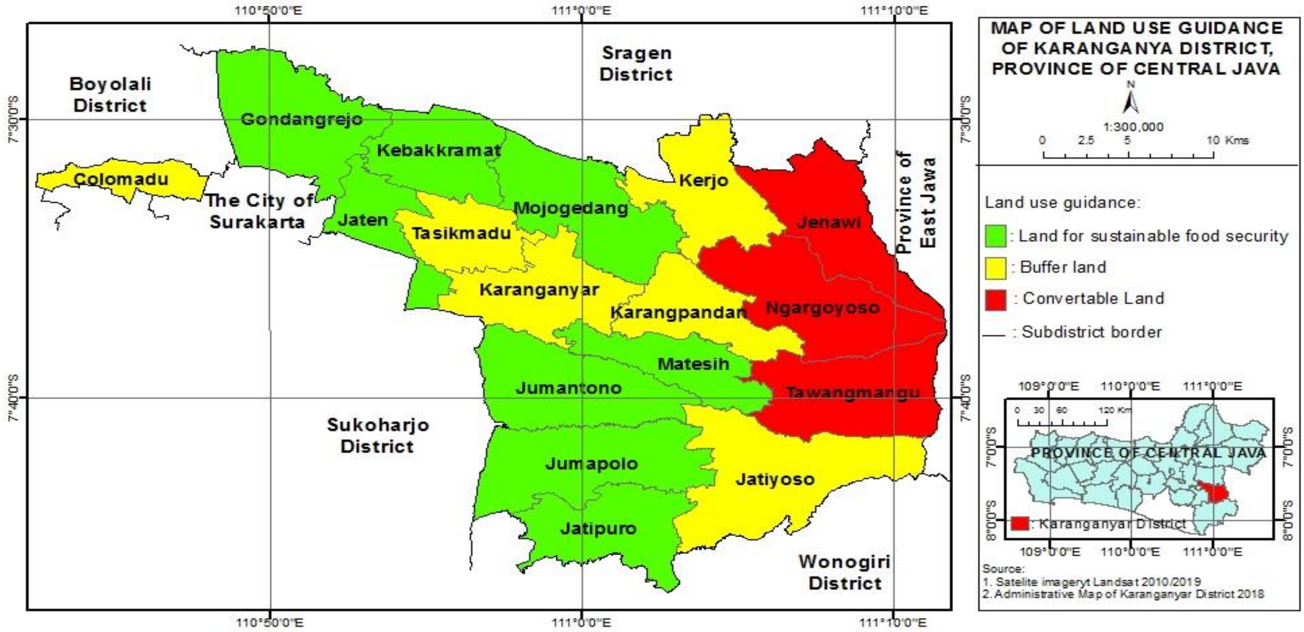


Figure 4. Map of Land Use Direction in Karanganyar Regency

The Land Use Direction Map for each sub-district in Karanganyar Regency is depicted in Figure 4 as follows: Eight sub-districts of land dedicated to sustainable food security, three sub-districts of convertible land, and up to six sub-districts of buffer lands; these buffer regions are critical to the viability of sustainable food security programs. Buffer land is a local government policy that provides a permit (policy) for the occurrence of land-use conversion, so the approach should be highly selective; for example, a conversion permit may be granted if the project is a national strategic project; however, a permit for the conversion of land use from agricultural to non-agricultural land is not granted.

V. CONCLUSION AND SUGGESTION

A. Conclusion

1. The land use conversion pattern in Karanganyar Regency is clustered at the sub-district level, with three clustered sub-districts, three random sub-districts, and eleven dispersed sub-districts, but the land-use conversion pattern at the regency level is distributed.
2. Food security in Karanganya Regency is controlled by 11 sub-districts with a surplus of food, six sub-districts with a food deficit, and three sub-districts with a food shortage. The regency as a whole is a food barn region.
3. Conversion of land use The pattern and level of food security at the sub-district level in Karanganyar Regency is one way to determine the direction of sustainable food land in the regency, with the following results: eight sub-districts of land for sustainable food security, three sub-districts of convertible land, and six sub-districts of buffer land.

B. Suggestions

1. Because land-use conversion creates a conflict of interest between social interests and food needs, the direction of sustainable food land is expected to be applied in the Karanganyar Regency to preserve the region's status as a food barn.
2. Strict regulations in the buffer zone (which may be converted conditionally) are required to ensure long-term food security in Karanganyar Regency.

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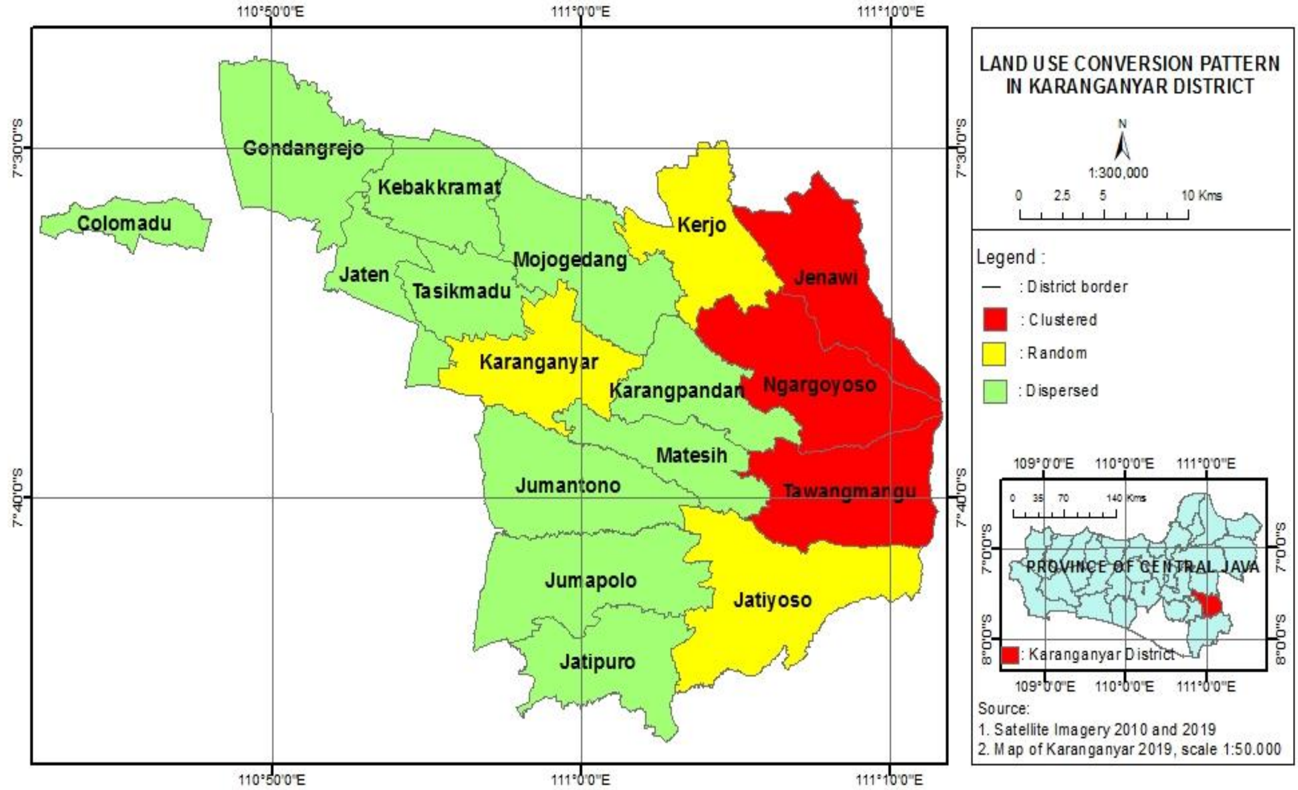
Appendix 1



Appendix 2