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Abstract. The development of Yogyakarta has created large impacts on its urban periphery areas. Trickle-down effects for the surrounding development trigger the emergence of spatial transformation in Yogyakarta's urban peripheries. This study intends to identify spatial transformation in Yogyakarta's urban peripheral by using the spatial analysis method which obtained from the land-use satellite map. Transformation measurement utilizes land use, total population, and economic growth variables in the last ten years (2007-2017). Results show that a spatial transformation was reported from the land use aspect, accounted for 15.22%, due to the reduction in agricultural land due to conversion into the constructed land area, up to 22,82%. From the land use map, the pattern of land-use changes in urban peripheries occurs along with the transportation networks. Population growth and economic growth also showed increasing rates at 5,06% and 9%, respectively. From all variables used in the analysis, it is interesting to find that majority of the urban periphery areas in Yogyakarta experiences a low transformation level, mostly located in the Sleman regency. Furthermore, this study provides several insights from the spatial transformations in the urban periphery to conceive some urban policies regarding urban agglomeration.

1. Introduction

The number of cities inhabited by more than 100.000 population would possibly rise by 170% in 2030. It will transform their surrounding rural areas frequently into urban ones [1]. The transformation of the outskirts is triggered by rapid urbanization, which causes an increased demand for the urban-space. Urbanization defines a process of becoming urban, which usually refers to demographic or urban population transition as the basis of analysis. In Indonesia, the urbanization process has constituted a part of the spatial configuration called desakota (urban-rural or rural-urban) [2].

Housing becomes a basic primary human needs. Cities' attractiveness as a place for the residence reflects through amenities and conveniences offered by the city, including housing [3, 4]. A greater level of urbanization will result in a higher need for urban land space, especially for the housing sector. However, the demand for housing in the urban center area has triggered the rising of housing prices. Due to the limited urban land resources, there is a widening urban expansion on the outskirts of the city that takes up areas in the suburbs. It can indicate the spatial enlargement of built-up areas. Besides, this urban expansion engenders land-use changes, particularly in the fringe area [5].

People in the suburbs are interested live in the city because of its attractiveness, especially economic welfare. This condition triggers rapid development, which results in several urban problems, such as

high population density, buildings, and traffic. Moreover, urbanization continues in the cities of developing countries without adequate planning of infrastructure expansion. As a result, this rapid urbanization leads to unplanned expansion, which also can lead to spatial transformation within the suburban area [5].

Spatial transformation in peri-urban areas correlates with increasing patterns of residential land area that are carried out by developers in large quantities. The increasing land area even happened in large urban areas, especially in East Asia, where large-scale housing development also dominates the peri-urban areas. Likewise, what happens in the Greater Jakarta, especially in Tangerang Regency, is an invitation of large-scale housing development with a total of ± 60 developers. On the other hand, in urban and peri-urban areas of Bandung, such as the sub-districts of Parongpong, Lembang, Cimenyan, Cilengkrang, Cileunyi, Bojongsoang, Dayeuhkolot, Margahayu, and Margaasih, there is also an area for a large-scale housing development that covers 51 new formal housing development with an area of 2,382.13 Ha [6].

Yogyakarta is a city that has a big attraction, known as a city of education, culture, tourism, and others. The development of Yogyakarta has affected the peri-urban areas or its surrounding area. During several periods, the rural sector in the peri-urban area of Yogyakarta also begin to shift. The spreading of the outward development of the city triggers a spatial transformation in the peri-urban area of Yogyakarta, forming agglomeration that is now known as the Yogyakarta Urbanized Area (YUA). Based on the Regulation of the Special Region of Yogyakarta No. 2 of 2010 concerning Regional Spatial Planning (RTRW) of Yogyakarta, YUA covers all Yogyakarta area, parts of Bantul Regency, and parts of Sleman Regency.

A previous study tried to understand regional transformation stages by using the study case of Maguwoharjo, part of the urban fringe area in Yogyakarta [7]. Another study conducted in Mexico tried to elaborate on urban growth pattern changes, which generated by housing production transformation [8]. This study investigates spatial transformation in Yogyakarta's peri-urban area, measured through the changing of characteristics patterns in land use, population density, and economic growth.

2. Methodology

Spatial transformation is a change of rural to urban in a specific time-span [7] through a shift in land use from rural characteristics (agrarian) to urban ones (settlements). Spatial transformation in peri-urban areas will change the form of land use because spatial transformation also includes changes in land-use methods that are caused by changes in the number and density of the population. This phenomenon occurs in Yogyakarta who experiences the distribution of urban physical appearance towards suburban areas.

Spatial transformation in this study is examined in three (3) aspects, namely physical, social, and economy. The physical aspect is measured by the changing patterns of land-use, which is shown through the transformation of activity patterns and built-up areas. The social aspect is measured by the population growth that continues to spread towards the outskirts of the city. Lastly, economic growth is used to indicate the transformation of the economic aspect. For this measure, the districts' average income per year is employed to gauge economic growth. Lastly, all the measurements for three different aspects are calculated and combined to define the spatial transformation level.

In this study, we used YUA that covers Yogyakarta, parts of the Bantul Regency (Subdistricts of Kasihan, Sewon, and Banguntapan), and Sleman Regency (Sub-districts of Depok, Ngemplak, Ngaglik, Mlati, Godean, and Gamping). The map and distribution area of this study are shown in Figure 1 and Table 1 sequentially.
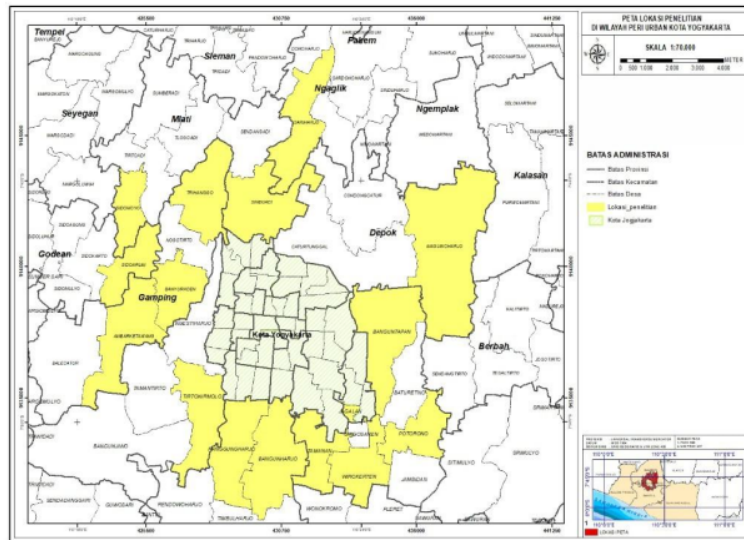
Figure 1. Location map of Yogyakarta Urbanized Area (Source: Analysis Result, 2019).

Table 1. Coverage of the Peri Urban Region of Yogyakarta

No	District	Sub-district	Village	Area (Ha)
1.	Sleman	Gamping	Banyuraden	400
			Ambarketawang	628
			Trihango	562
			Nogotirto	349
		Godean	Sidoarum	373
			Sidomoyo	302
		Mlati	Sinduadi	737
			Sendangadi	536
		Ngagglik	Minomartani	153
			Sinduharjo	609
			Sariharjo	689
		Depok	Catur Tunggal	1.104
			Condong Catur	1.501
			Maguwoharjo	950
		Ngempalk	Wedomartani	1.244
2.	Bantul	Banguntapan	Jagalan	27
			Banguntapan	833
			Singoseran	67
			Baturetno	394
			Wirokerten	386
			Tamanan	375
			Potorono	390
		Sewon	Panggungharjo	561
			Bangunharjo	679
		Kasihan	Ngestiharjo	510
			Tamantirto	672
			Tirtonirmolo	513
		Total		15.544

3. Results

Spatial Transformation Analysis in the Peri-Urban Area of Yogyakarta
Regional transformation is a representation of regional development that is described as a process of changes and shifting characteristics of the regional components in a certain period of time as a result of the inter-relationships between the components of the region. Hence, the transformation of the region includes multi-dimensional variables.

The transformation examined in this study is changes in the characteristics of the regional components, which include changes in population density, percentage changes in built-up area, percentage of non-built-up areas, and percentage of economic growth occurring in the peri-urban area of Yogyakarta. These variables are used to analyze the dynamics of urban level in villages included in the peri urban areas of Yogyakarta..

Urban level assessment in this study aims to explore further about the transformation of the area that occurred in the study area. By knowing the urban level in the study area, the current condition of the region can be explained more comprehensively, especially the urban condition of the region. From this urban level, a change or transformation of the region could be examined because there are areas with high urban levels with low transformation level or vice versa, due to certain factors

3.1. Land use Transformaton.
Transformation can be seen through the development of built-up area. The increase of built-up area can be seen based on the amount of constructed land, both from the ratio of the area and the distance from the city center. Meanwhile, land use changes can be seen from changes in paddy fields and raw land that have been converted into settlement, education, industry, as well as trade and services. This criteria is distinguished by the location of human activities, where the built-up area is closely related to living activities and the vacant area has no direct relationship with settlement. However, in this study, the classification of built-up area is an interpretation of image maps with the supervised image classification method. In the peri-urban areas of Yogyakarta, the settlement tends to be scattered and clustered around the main and secondary road networks. Some of the constructed land tends to be linearly patterned following the road network.

3.1.1. Non Built-up Area (Agricultural Land). Over the past 10 years, the area of paddy fields in villages has experienced shrinkage. This is inseparable from the development of the built-up area that occurred in the peri-urban areas of Yogyakarta and the addition of the population in the region. Table 2 shows changes in the area of non-built up area (paddy fields) in each village between 2007 and 2017

From the data obtained, it is known that the village with the largest percentage of change in agricultural land area is Sidoarum Village, Godean sub-district. During 10 years, there had been a 165-hectares decline of agricultural land areas or 44% from the total area, which left 84 hectares of paddy fields in 2017 (22.52% of the total area). Meanwhile, the village with the smallest percentage of agricultural land change is Sidomoyo Village, Godean District, which endures -7.95% or 24 hectares loss, leaving them with 129 hectares of non-built-up area in the village (42,72%).

Table 2. Changes of agricultural land area in the peri urban area of Yogyakarta (Source: Analysis Result, 2020)

Village	Total area of agricultural land		Number of change (Land area)	Percentage agricultural land area	
	2007	2017		2007	2017
Banyuraden	143	82	-61	35,75	20,5
Ambarketawang	264	257	-7	42,04	40,92
Trihango	150	113	-37	26,69	20,11

Village	Total area of agricultural land		Number of change (Land area)	Percentage agricultural land area	
	2007	2017		2007	2017
Nogotirto	100	52	-48	28,65	14,9
Sidoarum	249	84	-165	66,76	22,52
Sidomoyo	129	105	-24	42,72	34,77
Sinduadi	85	78	-7	11,53	10,58
Sendangadi	194	168	-26	36,19	31,34
Minomartani	58	20	-38	37,91	13,07
Sinduharjo	259	132	-127	42,53	21,67
Sariharjo	156	137	-19	22,64	19,88
Catur Tunggal	100	69	-31	9,06	6,25
Condong Catur	132	97	-35	13,89	10,21
Maguwoharjo	487	419	-68	32,45	27,91
Wedomartani	746	565	-181	59,97	45,42
Jagalan	2	1	-1	7,41	3,7
Banguntapan	132	118	-14	15,85	14,17
Singoseran	26	16	-10	38,81	23,88
Baturetno	86	78	-8	21,83	19,8
Wirokerten	155	143	-12	40,16	37,05
Tamanan	153	95	-58	40,8	25,33
Potorono	129	127	-2	33,08	32,56
Ranggungharjo	135	78	-57	24,06	13,9
Bangunharjo	173	146	-27	25,48	21,5
Ngestiharjo	97	60	-37	19,02	11,76
Tamantirto	288	183	-105	42,86	27,23
Tirtonirmolo	187	101	-86	36,45	19,69
Total	4815	3524	-1291	854,59	590,62

3.1.2. Built-up Area. All constructed lands in the researched villages have increased in size. The differences in the constructed land area (Ha) and percentage of constructed land (%) are inferred from the magnitude of the increase in the constructed land area within a span of 10 years. This is influenced by the size of the change in the percentage of constructed land that occurred in each village from 2007 to 2017.

**Table 3.** Change of Built-up Area in the peri urban area of Yogyakarta (Source: Analysis Result, 2020)

Village	Built-up Area		Number of change (Land area)	Percentage of Built-up Area	
	2007	2017		2007	2017
Banyuraden	263	324	61	65,75	81
Ambarketawang	423	430	7	67,36	68,47

Village	Built-up Area		Number of change (Land area)	Percentage of Built-up Area	
	2007	2017		2007	2017
Trihango	421	457	36	74,91	81,32
Nogotirto	234	281	47	67,05	80,52
Sidoarum	265	286	21	71,05	76,68
Sidomoyo	105	164	59	34,77	54,3
Sinduadi	625	680	55	84,8	92,27
Sendangadi	372	399	27	69,4	74,44
Minomartani	97	135	38	63,4	88,24
Sinduharjo	332	458	126	54,52	75,21
Sariharjo	456	474	18	66,18	68,8
Catur Tunggal	997	1089	92	90,31	98,64
Condong Catur	748	783	35	78,74	82,42
Maguwoharjo	1114	1185	71	74,22	78,95
Wedomartani	551	732	181	44,29	58,84
Jagalan	28	29	1	103,7	107,41
Banguntapan	647	662	15	77,67	79,47
Singoseran	46	57	11	68,66	85,07
Baturetno	300	308	8	76,14	78,17
Wirokerten	278	290	12	72,02	75,13
Tamanan	230	288	58	61,33	76,8
Potorono	261	263	2	66,92	67,44
Ranggungharjo	429	486	57	76,47	86,63
Bangunharjo	536	563	27	78,94	82,92
Ngestiharjo	378	415	37	74,12	81,37
Tamantirto	357	461	104	53,13	68,6
Tirtonirmolo	375	461	86	73,1	89,86
Jumlah	10868	12160	1292	1889	2139

From the data above, it can be seen that Minomartani Village, Ngaglik Sub-district, experienced the largest increase in constructed land area (38 hectares or 24.84%). On account of that, the village's area of constructed land in 2017 reached 135 hectares or 88.24% of Minomartani's total area, indicating that constructed land covers most of the village's area. In general, the peri-urban area of Yogyakarta increases by 15.22% or 1,292.16 hectares during 2007-2017, while the area of agricultural land was reduced by 22.82% or 1,031.32 hectares

On Figure 2, we can also see that the pattern of changes in constructed land on peri urban areas occurs in a spread way following the transportation route. This shows that the change in the constructed land and non constructed land mostly occurs in villages or sub-districts that are no longer bordering with Yogyakarta like in 2007, but the changes occurred in villages that experienced changes in the urban level in zoning of peri urban areas.
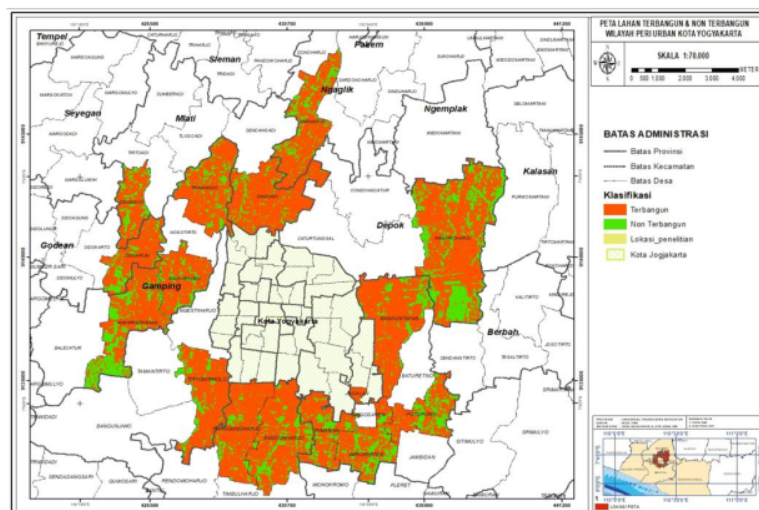
Figure 2. Built Up Area in Peri-Urban Area of Yogyakarta (Source: Analysis Result, 2020).

3.2. Population Density

Over the past 10 years, the average population growth in the urban peri-urban areas of Yogyakarta has increased by 5.06%. This situation increases the need for residential land as a place to live, both downtown and suburbs. The increasing population is positively correlated with land-use, making changes in land use acceptable. The reduction in agricultural land-to-constructed land conversion becomes strong evidence that the transformation process is clearer.

Based on the percentage of population growth of each village in the subdistrict region included in the peri urban area, it can be concluded that from 2007 to 2017, the villages experienced population growth almost every year with a growth percentage of 4% -6%.

Population growth that occurs due to birth rates and incoming migration continues to increase so that the population of the region also increases. The high increase in population directly or indirectly will reduce the area of vacant land or non constructed land in the peri urban area of Yogyakarta. The open land is used to meet the demand for housing and other buildings as infrastructure for the activities of its residents.

Table 4. Population growth and density in peri-urban areas (Sources: Analysis Result, 2020).

Village	Number of Population		Growth	Density	
	2007	2017	(%)	2007	2017
Banyuraden	12.692	20.349	6,03%	3.173	5.087
Ambarketawang	18.781	24.389	2,99%	2.991	3.884
Trihango	12.734	20.514	6,11%	2.266	3.650
Nogotirto	14.650	20.334	3,88%	4.198	5.826
Sidoarum	12.724	19.456	5,29%	3.411	5.216
Sidomoyo	7.536	8.178	0,85%	2.495	2.708
Sinduadi	31.792	34.435	0,83%	4.314	4.672
Sendangadi	12.075	17.624	4,60%	2.253	3.288

Village	Number of Population		Growth	Density	
	2007	2017	(%)	2007	2017
Minomartani	13.615	17.515	2,86%	8.899	11.448
Sinduharjo	13.808	21.899	5,86%	2.267	3.596
Sariharjo	15.144	28.834	9,04%	2.198	4.185
Catur Tunggal	60.045	81.473	3,57%	5.439	7.380
Condong Catur	34.574	67.044	9,39%	2.303	4.467
Maguwoharjo	26.686	42.433	5,90%	2.809	4.467
Wedomartani	20.796	30.666	4,75%	1.672	2.465
Jagalan	3.449	3.790	0,99%	12.774	14.037
Banguntapan	32.771	56.270	7,17%	3.934	6.755
Singoseran	3.189	5.040	5,80%	4.760	7.522
Baturetno	11.969	19.220	6,06%	3.038	4.878
Wirokerten	10.917	15.320	4,03%	2.828	3.969
Tamanan	8.590	15.030	7,50%	2.291	4.008
Potorono	10.092	14.280	4,15%	2.588	3.662
Ranggungharjo	25.505	35.660	3,98%	4.546	6.357
Bangunharjo	18.723	31.140	6,63%	2.757	4.586
Ngestiharjo	26.265	40.720	5,50%	5.150	7.984
Tamantirto	15.421	28.950	8,77%	2.295	4.308
Tirtonirmolo	19.107	26.850	4,05%	3.725	5.234

Based on Table 4, the village with the highest density is Jagalan Village, Banguntapan District. It is due to Jagalan Village's adjacency to the city of Yogyakarta and its fairly small area compared to other villages that are also directly adjacent to the City of Yogyakarta.

The population density in the peri-urban area is centralized in the Kasihan sub-district with 57 people/Ha, Depok sub-district with 54 people/Ha, and Banguntapan sub-district with 52 people/Ha. On the other hand, the lowest population density occurs in the Ngemplak sub-district with 25 people/Ha. This condition might happen due to the distance between Ngemplak and Yogyakarta and its total area, which is larger compared to other villages.
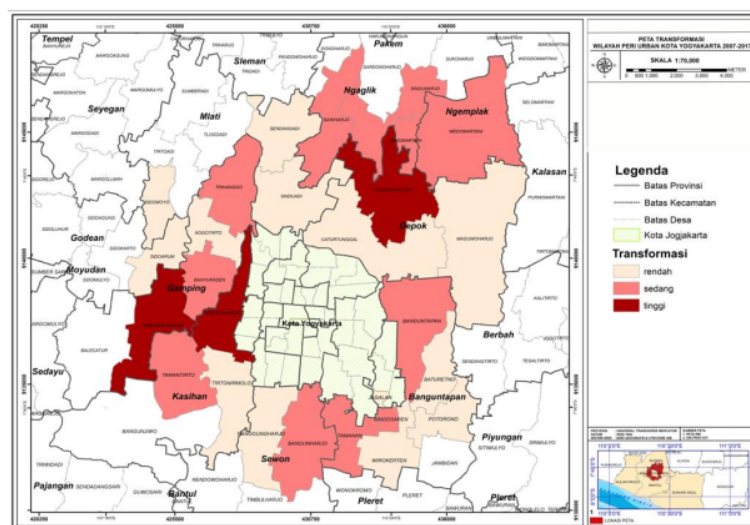
3.3. Analysis of Economic Growth

An important measure to determine the success of economic development in a region is the rate of economic growth. Economic growth illustrates the real impact of development policies that have been implemented, especially in the economic field. One of the important factors that can determine the economic conditions of a region in a certain period is the income data, which in this study is referred by the trade sector, agricultural sector, and income of government employees on each village in the peri-urban area of Yogyakarta.

Table 5. Economic Growth Peri-Urban Area of Yogyakarta. (Sources: Analysis Result, 2020)

Village	Growth (%)										Average of Growth
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Tamanan	7	5	-12	17	10	7	9	14	3	14	7%
Jagalan	-4	-7	-11	-7	-3	5	4	7	0	5	-1%

Village	Growth (%)										Average of Growth
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Singoseran	0	0	-5	-6	-8	0	2	2	1	-1	-2%
Wirokerten	35	13	-24	55	-6	0	3	0	0	1	8%
Baturetno	25	0	-14	6	5	-1	1	1	-1	3	3%
Potorono	37	35	-27	24	62	48	41	9	9	6	24%
Banguntapan	16	29	-34	36	10	1	3	0	-1	2	6%
Condong catur	5	3	-9	-10	-5	27	-2	1	-13	69	7%
Catur tunggal	1	1	0	-3	0	20	-2	-4	0	83	10%
Maguwoharjo	-33	75	25	-3	-64	62	9	32	31	27	16%
Ambarketawang	115	32	53	12	19	9	5	1	3	5	25%
Banyuraden	31	128	6	7	19	37	-19	6	4	8	23%
Nogotirto	19	141	84	-52	53	-5	-24	50	-77	25	22%
Trihanggo	84	70	21	-4	6	-36	12	-7	-35	30	14%
Sidoarum	37	-25	6	-9	5	3	13	-6	15	13	5%
Sidomoyo	24	9	-37	3	24	1	29	-18	1	21	6%
Ngestiharjo	0	0	115	5	-52	-7	17	17	-3	3	10%
Tamantirto	22	37	63	13	-43	17	25	19	31	12	20%
Tirtonirmolo	-5	28	77	-13	-46	3	1	2	-1	2	5%
Sendangadi	0	26	-11	0	22	-5	56	8	-11	18	10%
Sinduadi	-11	14	-2	-4	20	20	67	36	-37	28	13%
Minomartani	1	-22	29	-20	9	-1	-2	-5	-17	79	5%
Sinduharjo	-82	-2	-3	19	94	24	-33	-21	36	29	6%
Sariharjo	-82	1	-1	14	92	8	4	-50	18	68	7%
Bangunharjo	-6	-5	-31	-42	-79	41	1	-27	2	13	-13%
Panggungharjo	-8	-5	-45	-65	-35	92	1	-10	1	3	-7%
Wedomartani	8	-7	-38	-15	48	-17	26	11	4	13	3%

Based on the data in Table 5, from 2007 to 2017, economic growth has experienced significant annual changes. Some villages experienced an increase in their annual income, while others suffered from decline. Ambarketawang Village enjoys the biggest income with a total income of Rp. 97,716,031,556 (2017) from Rp. 13,440,125,000 (2007), while the lowest income occurred in Jagalan Village with an income of Rp. 1,824,000,000 (2017) from Rp 2,096,000,000 (2007). The imbalance of economic growth that occurred in the villages in the peri-urban areas was influenced by differences in the amount of income from traders, government employees, and farmers.

Figure 3. Spatial Transformation in the Peri-Urban Area of Yogyakarta (Source: Analysis Result, 2020).

Figure 3 shows the distribution of spatial transformation from 2007 - 2017 in the peri-urban of Yogyakarta. The variables of economic growth, land use, and population density become the basis for the classification of spatial transformation. They result in three levels: high, medium, and low. The high level has happened in Ambarketawang, Ngestiharjo, and Condongcatur. These occur due to adjacency to the center of Yogyakarta, areas' economic and population development, and changes in land conditions. Baturetno, Potorono, Jagalan, Tirtonirmolo, Wirokerten, Nogotirto, Sendangadi, Sidoarum, Sidomoyo, Caturtunggal, Sinduadi, Maguwoharjo, and Panggungharjo experienced low transformations, with others underwent a moderate one.

4. Conclusions

Based on the study, there are several relevant findings. Firstly, from 2007 to 2017, there has been increasing land building in the peri-urban area of Yogyakarta by 15.22% or 1,292.16 Ha. On the other hand, the agricultural land area has decreased by 22.82% or 1,031.32 Ha.

The villages with the most significant percentage change in non-developed land areas are in Sidoarum Village, Godean District. In 10 years, the agricultural land area has decreased by 165 hectares or 44%, which makes the village's paddy fields, in 2017, only accounted for 22.52% of the total area of 84 hectares. Meanwhile, the smallest percentage change in the non-built land area was in Sidomoyo Village, Godean Sub-district with -7.95% or 24 hectares, so that there were still 129 hectares of non-developed land in this village (42.72%).

The decrease in the amount of land area that occurred in the peri-urban area marks the annual development of Yogyakarta, which is closely related to the population growth of the urban peri-urban area (5.06%). This population growth will affect the increasing need for residential land as a place to live, both in the downtown or suburbs. Based on the percentage of population growth of villages in the subdistrict region included in the peri-urban area, from 2007 to 2017, they experienced population growth almost every year with a growth percentage of 4% -6%.

Besides, the influence of the sector of economic growth greatly influences the transformation in the urban peri-urban area of Yogyakarta. From the results of the analysis conducted by researchers, in 2007-2017, economic growth experienced significant changes each year. Some villages enjoy an increase in economic growth (annual income), while in others, there is a decline. Ambarketawang Village obtains

the largest income with a total of Rp. 97,716,031,556 in 2017 from Rp. 13,440,125,000 in total income in 2007. On the other hand, the lowest income occurred in Jagalan Village with the amount of Rp. 1,824,000,000 from a total income of 2,096.000,000 in 2007. The imbalance of economic growth that occurred in peri-urban areas is affected by the income of traders, the proportion of government workers, and farmers.

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