



Temporal Dynamics of Land Use Change in Peri-Urban Area of Sleman Regency for Sustainability Agriculture

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Abstract. Peri-urban areas are dynamic areas characterized by the transition between rural and urban areas. The city's development strongly influences intensive changes in peri-urban areas. Yogyakarta, as a city of education and culture, has significant growth that affects the development of surrounding areas. Depok and Mlati subdistricts are peri-urban areas administratively directly adjacent to Yogyakarta City. Spatial dynamics become apparent over time, so land conversion is inevitable. This study aims to determine the changes in land use area that occurred in 5 years (2015-2020) and analyze the temporal dynamics of agriculture. This analysis describes the condition of the peri-urban area of Sleman Regency in supporting sustainable agriculture. Land use data was obtained from SPOT image extracts that were delineated into 12 types of land use and then calculated through ArcGIS Pro 3.1.3 software. The results show that the Depok subdistrict experienced the most significant decrease in rice fields and an increase in residential land. Mlati subdistrict experienced the most significant decrease in mixed land and an increase in the type of yard. The dominance of land use change experienced by peri-urban areas is in the form of conversion from vegetated land to non-vegetated land. This phenomenon will affect sustainable agriculture in Sleman Regency.

Keywords: land use change, peri-urban, agriculture

1 Introduction

A mixture of urban and rural physical appearances characterizes peri-urban areas. The characteristics of peri-urban areas are dynamic and continue to experience development in various aspects, influenced by the city growth of the surrounding area. As a result, there is a shift from the rural appearance towards the urban appearance. One of the physical characteristics of urban areas is the increasing number of built-up land in peri-urban areas. Meanwhile, from a social perspective, the character of society is changing to become more individualistic, and culture is failing in society.

Urbanization causes rapid development of urban areas. Peri-urban areas are formed due to increasing population growth and rapid urbanization around city centers [2]. Urbanization has caused economic, social, and ecological changes,

including changes in land use [3]. Increasing population growth also results in increasing land requirements. Meanwhile, land availability remains the same, resulting in land conversion occurring [4]. Problems arise when land conversion occurs on productive agricultural land, resulting in a decrease in food production.

The southern part of Sleman Regency borders the city of Yogyakarta, which causes dynamic changes in both spatial and socio-economic use [5]. Kapanewon in the Sleman district, included in the peri-urban area are Kapanewon Mlati and Kapanewon Depok. These two Kapanewon directly border the city of Yogyakarta, where there is often a mix of activities, and they are most vulnerable to the impact of the expansion of urban activities. It is essential to control the dynamics of land conversion so that it is by the Sleman Regency Regional Spatial Planning (RTRW) because the RTRW is a reference in implementing the development of a region.

Land management is the process of planning and decision-making, organizing, directing, and controlling human, financial, physical, and information resources to achieve organizational goals efficiently and effectively in land management [6]. Changes in land use in peri-urban areas are increasing along with the growth and development of urban areas. Land use patterns in peri-urban areas reflect economic and population growth and community preferences as drivers of land use change. Peri-urban areas need policies to control changes in land use to realize family food independence and sustainable urban development.

Developing a peri-urban area (Mlati and Depok subdistrict, see **Figure 1**) in Sleman district will affect their land use in Yogyakarta. Therefore, the temporal dynamic of land use change in these areas is needed. The study aimed to determine the changes in land use area that occurred in 5 years (2015-2020) and to analyze the temporal dynamics of agriculture. This analysis describes the condition of the peri-urban area of Sleman Regency in supporting sustainable agriculture.

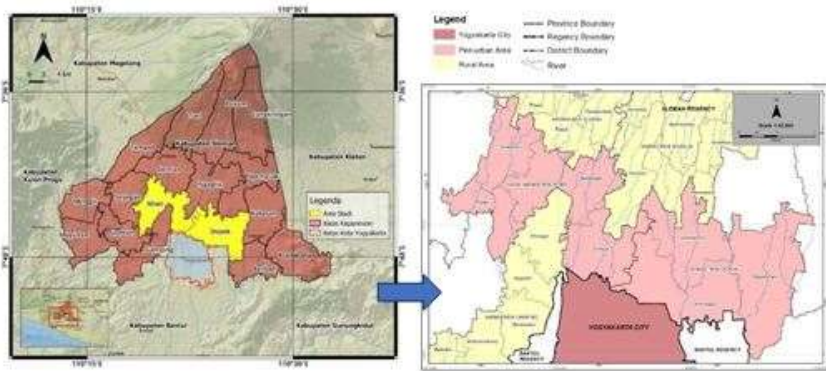


Figure 1. Study area

2 Materials and Method

This analysis was conducted in two stages. First, the preparation stage includes downloading SPOT images, merging image channels (layer stack), image cropping, geometry correction, visual classification, and field checking. The downloaded images were then merged and cropped according to the outer boundaries of the Sleman Regency administrative map to focus on the research location. Furthermore,

the image was geometry corrected using a base map reference (rivers and roads) to have the exact coordinates. After having the same coordinates as the base map, visual classification was based on interpretation according to the image's size, pattern, hue, texture, and color.

The land use classifications observed are forests, gardens, built-up land, rice fields, moorlands, and water bodies. The classification was carried out on all images of the observation year to obtain land use maps in 2015 and 2020. The second stage in this analysis is the analysis process stage. The method used in this stage is to overlay the land use maps of all years of observation to produce a transition matrix of land use change from year to year [7]. The stages and methods of data processing carried out in this research are presented in **Figure 2**. The data used in this research is land use data (2015 and 2020) obtained from SPOT image extracts that were delineated into 12 types of land use and then calculated through ArcGIS Pro 3.1.3 software.

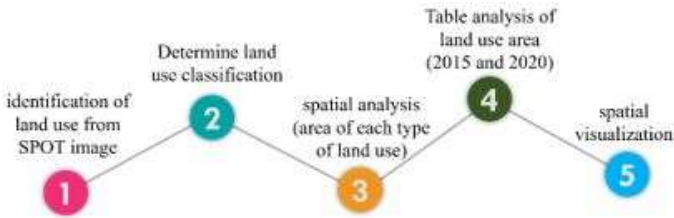


Figure 2. Stages of data processing

3 Results

Peri-urban areas are dynamic due to physical, economic, and social development. That development leads to land use conversion, which will finally affect the temporal dynamics of agriculture [8]. Peri-urban areas formed due to increased population growth and rapid urbanization around urban centers. Urbanization has caused economic, social, and ecological changes, including land use change. Increasing population growth also results in increased land requirements. Meanwhile, land availability remains the same, resulting in land conversion. Problems arise when land conversion occurs in productive agricultural land, resulting in a decrease in food production.

The temporal dynamics of land use change in the Melati and Depok Subdistrict are diverse; some land use types have increased, and others have decreased. The classification of land use types is divided into 12: residential buildings, non-residential buildings, yards, urban forests, mixed land, rice fields, waters, open land, moorland, paved surfaces, runways, and parks. The results showed that Depok and Melati sub-districts from 2015 to 2020 experienced very dynamic land use changes. The most significant land use change is built-up land in the Depok Sub-district, where the amount increased by 80.03 ha, while in the Melati Sub-district, the land use that experienced the most significant change was the yard, where the amount increased by 169 ha. The extent of land use change from 2015-2020 is presented in **Table 1** and **Table 2**.

Table 1. Change of landuse area in 2015-2020 at Depok Subdistrict

No	Land Use Type	Area in 2015 (ha)	Area in 2020 (ha)	Extensive changes in 2015-2020 (ha)
1	Residential Buildings	717,75	797,78	80,03
2	Non-Residential Buildings	160,90	176,13	15,23
3	Yard	1.107,62	1.136,21	28,59
4	City Forest	2,35	2,35	0
5	Mixed Land	222,75	193,16	-29,59
6	Ricefield	392,89	304,32	-88,57
7	Waters	90,27	95,03	4,76
8	Open field	195,96	190,41	-5,55
9	Field, moors, bushes, other plantations	74,37	52,72	-21,65
10	Hardened Surface	216,15	221,81	5,66
11	Runway	22,98	22,98	0
12	Park, greenways	9,67	13,04	3,37

Table 2. Change of landuse area in 2015-2020 at Mlati Subdistrict

No	Land Use Type	Area in 2015 (ha)	Area in 2020 (ha)	Extensive changes in 2015-2020 (ha)
1	Residential Buildings	410,97	449,37	38,4
2	Non-Residential Buildings	105,56	119,06	13,5
3	Yard	530,30	699,30	169
4	City Forest	1,35	1,35	0
5	Mixed Land	558,68	405,37	-153,31
6	Ricefield	900,39	853,64	-46,75
7	Waters	64,63	73,12	8,49
8	Open field	87,09	69,12	-17,97
9	Field, moors, bushes, other plantations	44,90	26,11	-18,79
10	Hardened Surface	134,24	134,95	0,71
11	Runway	-	-	-
12	Park, greenways	2,34	8,72	6,38

Table of changes in land area in 2015-2020 at Depok Subdistrict, we can see that within five years, there has been an extensive decline in the types of land use in the form of mixed land, ricefield, open field, field, moors, bushes, and other plantations. Some types of land use do not experience changes in area, such as city forests and runways. The land use type in residential buildings experienced the most significant increase. Table of changes in land use Area in 2015-2020 at Mlati Subdistrict, just like in Depok; in this area, we can see that within a period, there has been an extensive decline in the types of land use in the form of mixed land, ricefield, open field, field, moors, bushes, and other plantations. Other land use types experienced an increase in area, with the most significant increase in yard land. Urban forests do not experience changes in area.

As in the research conducted by [9], it is explained that land use change occurs due to natural and anthropogenic factors. In the case of the Kapanewon Depok and Melati areas, anthropogenic factors are more dominant in effecting land use change. Anthropogenic factors include the need for residential land, declining agricultural

land productivity, and weak land use regulations. Land use change has multidimensional effects on ecosystem balance, both present and future [10]. The analysis of land use change shows a considerable change in paddy fields, which decreased by 88.57 ha due to conversion to other land uses, mainly as settlements. The area of residential buildings increased by 80.3 ha during the 2015-2020 period, indicating a regional transition to urbanization in the Kapanewon Depok area. This transition is due to the relatively close distance to Yogyakarta City, so Kapanewon Depok is classified as a peri-urban area.

Some factors supporting land use change include increased human population and the need for natural resources, especially land for settlements [11]. This is by the trend of land use change in the Central Sleman Region. The spatial distribution of land use in 2015 and 2020 is presented through maps in **Figures 3** and **4**. The phenomenon of decreasing rice fields and increasing residential buildings can be observed in Kapanewon Depok. Residential development in Kapanewon has been relatively rapid in 5 years due to the number of developers who build housing or cluster houses. The area becomes a glance for investors to create housing because of the many educational facilities built in this subdistrict. Besides that, Kapanewon Depok is also located close to the Yogyakarta City area, so it becomes easy for investors to create cheap housing compared to the Yogyakarta City area.

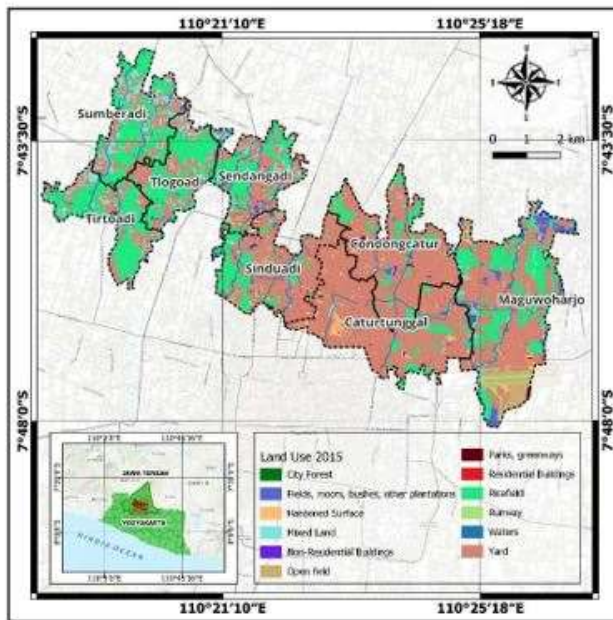


Figure 3. Land use map of peri-urban areas in 2015

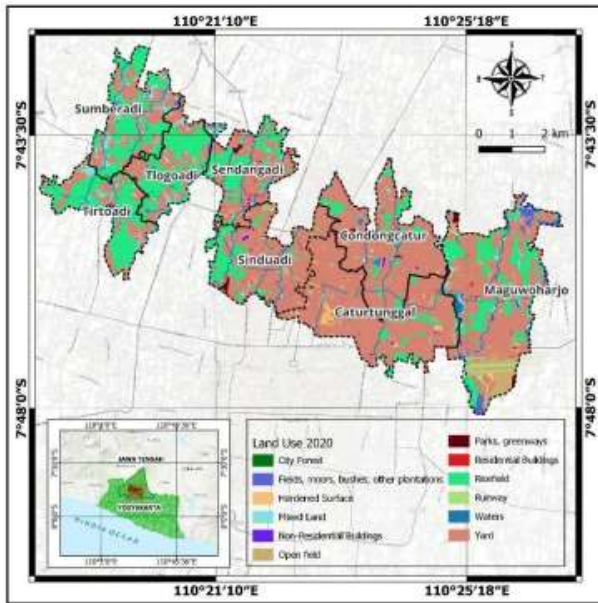


Figure 4. Land use map of peri-urban areas in 2020

Spatially, we can see a change in land use in rice fields in the Maguwaharjo sub- district, which has decreased in area and changed to other types of land use (see Figure 5). Land conversion analysis can be seen from spatial changes in area size, policy, and sustainable agriculture. Spatially, land conversion results in changes in the type of land use in several locations, thereby changing the use value/ecosystem services of the land. Land conversion causes changes in the area of a type of land use. Some types of land use have increased, and others have decreased. Information regarding land-use changes can be used as a guide in determining regional management policy strategies for stakeholders. Information regarding changes in agricultural land illustrates agricultural sustainability in the region so that local governments can make efforts to maintain and increase food security.

The impact of land use changes on agriculture: 1) The conversion of land from agricultural land to non-agricultural land, as in the peri-urban area of Sleman Regency, causes the agricultural area to decrease; 2) The decline in the agricultural area will impact the decline in agricultural crop productivity. Decreased productivity is also influenced by high land prices in peri-urban areas so that landowners sell their agricultural land; 3) As less and less land is used for agriculture, farmers are starting to be reluctant to work and choose other, more profitable jobs, such as selling, being a driver, or a laborer, 4) If this phenomenon continues to occur, regional food security will be low. This means that the region can no longer meet the needs of the people in the region and imports from other regions.



Figure 5. Potential changes in land use that occur in Maguwoharjo sub-district

Land use changes also impact the land's physical condition and ecosystem services [12]. Changes in land use impact the reduction of infiltration capacity. As a result, discharge extremes occur, such as flooding and drought, in downstream areas of the river. Adaptation and mitigation changes in land use are an effort to anticipate functional damage in watershed hydrology. Several regions in Indonesia and even several countries in the world are experiencing similar phenomena related to changes in land use, which impacts regional food security. Population and economic growth, regional expansion, and the need for housing cause humans to convert agricultural land into non-agricultural land, as happened in the peri-urban area of Sleman Regency.

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4 Conclusion

The Depok subdistrict experienced the most significant decrease in rice fields and an increase in residential land. The dominance of land use change experienced by peri-urban areas is in the form of conversion from vegetated land to non-vegetated land. This phenomenon will affect sustainable agriculture in Sleman Regency. This research can be further developed by adjusting the field conditions and predicting land use change.

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