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Original Article

Spatial Variability of Land Use Changes Due to JJLS (Southern Cross Road Network) Development in Kulon Progo Regency in 2016, 2020, and 2024

Ali Muwahhid[1]*, Dyah Rahmawati Hizbaron[1], Bachtiar Wahyu Mutaqin[1].

[1]Faculty of Geography, Universitas Gajah Mada, Yogyakarta City, Indonesia

*cooresponding e-mail: ali.muwahhid@mail.ugm.ac.id

ABSTRACT
The construction of the JJLS (Southern Cross Road Network) project in Kulon Progo Regency passes through Kapanewon Galur, Panjatan, Wates, and Temon to connect the Provinces of DIY and Central Java. The development of JJLS infrastructure can lead to the development of residential land and other functional buildings in the surrounding areas (Hendry, 2021). This study attempts to determine changes in land use variability due to the construction of JJLS in Kulon Progo Regency. Based on this information, changes in land use that occur intensively in certain areas can be monitored and detected early, so that appropriate policies can be formulated to prevent uncontrolled changes in land use. The research method used in this study is the interpretation of sentinel 2 imagery, which is then overlayed with a land use map to determine land changes that occurred in 2016, 2020 and 2024. Statistical analysis was carried out to determine the effect of JJLS development on land use changes in Kulon Progo Regency, especially in the sub-districts through which JJLS passes. The results of the study showed that there were significant changes in land use in the range of 2016, 2020 and 2024. Based on the results of the RCI calculation in 2016 to 2020, the lowest RCI value is 0,2917 and the highest value is 3,156. While the RCI value for 2020 to 2024 had the lowest value of 0.3862 and the highest was 2,1791. Based on the RCI value, it is divided into 3 classes, low, medium, and high, in order to represent the intensity of change in each village. Based on the results of statistical calculations, it can be concluded that there is a strong influence between the JJLS variable and the growth of built-up area in the research location.

KEYWORDS
Land use and land cover change, JJLS, RCI, Kulon Progo

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INTRODUCTION

Referring to the Village Development Index in 2021, the coastal area of Kulon Progo Regency is included in the underdeveloped areas that require special attention in the form of access to market facilities to support socio-cultural, economic, tourism, and environmental sustainability activities. Part of the effort to overcome the inequality that occurs is through infrastructure development in the form of a road network.

Kulon Progo Regency has a road segment passed by the Southern Cross Road Network (JJLS) which passes through Kapanewon Galur, Kapanewon Panjatan, Kapanewon Wates, and Kapanewon Temon to connect the Provinces of DIY and Central Java. The Decree of the Governor of DIY No. 118/KEP/2016 states that the JJLS as a national road aims to develop border and underdeveloped areas by developing a road network system that can connect urban and rural activity centers. The development of JJLS infrastructure can lead to the development of residential land and other functional buildings in the surrounding areas (Hendry, 2021). The development of the road network will also have an impact on the expansion of built-up area and affect the development of the city structure (Bintoro, 2008). The development of the area due to the construction of the JJLS is marked by a drastic increase in land use conversion, which was originally non-built-up area, into built-up area.

Research conducted by Ramadhan (2019) found a change of built-up area in Kulon Progo Regency in 2011 by 6,7% or 4.427 Ha and experienced a significant increase in 2018 to 8.401 Ha or 12,85% of the total area. Sufiyana (2018) explained that there was a change in the perspective of the community in Kulon Progo, which initially considered land productivity for rural areas, now shifting to urban areas that consider the strategic location of a land. This change is usually accompanied by a decrease in the area of agricultural land to built-up area (Wahyudi, 2019). Therefore, monitoring is needed to control the trend of land use changes. If these conditions are neglected, it will endanger the ecosystem's sustainability (Pratomoatmojo, 2014; Dinda, 2022; Sudjana, 2024). In addition, coastal area is susceptible to shoreline recession caused by abrasion (Tilova, 2024).

The study of land use change and its spatial variability has gained considerable attention, especially in areas experiencing rapid infrastructure development. Various research has highlighted that the construction of large-scale transportation network often leads to significant land use transformations specifically in urban land and its spatial distribution (Ahasan, R., & Güneralp, B, 2022).

The Southern Cross Road Network (JJLS), as part of Indonesia's strategic infrastructure plan, is expected to influence spatial patterns of land use due to increased accessibility, urban expansion, and shifting socio-economic dynamics. Remote sensing and GIS-based approaches have become the state-of-the-art methods in detecting and analyzing land use and land cover changes over time. The use of multi-temporal satellite imagery, such as Sentinel-2 with its high spatial and temporal resolution, has enabled researchers to map land use transitions with improved accuracy and consistency (Phiri et al., 2020). Furthermore, Sentinel-2 imagery plays a key role in supporting informed decision-making processes related to land use change (Arfa, A., & Minaci, M, 2024). In particular, supervised classification methods combined with accuracy assessment metrics such as Overall Accuracy and the Kappa Coefficient are widely applied to land cover interpretations (Rwanga, SS & Ndambuki, JM, 2017). Supervised classification offers the advantage of controlling class definitions by utilizing known sample inputs (Richards, J.A. 2022).

Recent studies in Indonesia have demonstrated that infrastructure development often causes spatially heterogeneous land use changes, including the conversion of agricultural land to settlements, commercial zones, or bare land, with variations across different zones depending on proximity to the infrastructure corridor (Handayani, et al, 2018; Surya, et al, 2020; Salim & Faoziyah, 2022, Pravitasari, et al, 2021). The expansion of built-up areas prior to agricultural or bare land is the defining feature of urban growth dynamics (Dehghani, 2025). However, studies focusing specifically on the spatial variability of land use changes caused by the JJLS development remain limited. This research addresses that gap by integrating multi-temporal remote sensing data and spatial analysis techniques to assess the dynamics of land use change in Kulon Progo Regency.

This study offers a novelty to the research on land use changes due to the development of the Southern Cross Road Network) (JJLS), specifically focusing on the spatial variability in Kulon Progo Regency. The analysis is conducted across three different time in 2016 (before construction), 2020 (during construction), and 2024 (after construction) providing a perspective that is often lacking in similar studies.

This research conducted in several key aspects. First, the temporal aspect allows for a comparative assessment of land use dynamics before, during, and after the JJLS development, enabling the identification of both immediate and evolving impacts on the environment. Second, the study employs high-resolution Sentinel-2 satellite imagery, which facilitates more precise and detailed land use classification across different time periods. Third, this research emphasizes the spatial variability and distribution of those changes, revealing the heterogeneous nature of development impacts across different zones, such as urban fringes, agricultural lands, and coastal areas.

This study attempts to examine the influence of JJLS development on spatial variability of land use changes in Kulon Progo Regency. Based on this information, changes in land use that occur intensively in certain areas can be monitored and detected early. The findings of this research can be applied for regional planning and environmental policies for sustainable land management due to the development of the Southern Cross Road Network (JJLS).

METHOD

Research Location

This research was conducted in several sub-districts (including Kepanewon Galur, Panjatan, Wates and Temon) in Kulon Progo that is passed through by the Southern Cross Road Network (JJLS), which has 25,60 km segment. The coordinates are located between 390000 - 417000 mT and 9117300 - 9117300 mU. The research area is 145,04 km^2. Determination of the research location is carried out based on the distinct feature of each sub-districts such as a new airport (NYIA) located in Kapanewon Temon, Kapanewon Wates whis is city center of Kulon Progo, Kapanewon Panjatan which has the largest agricultural area in Kulon Progo, and Kapanewon Galur is the corridor that connects Bantul and Kulon Progo Regency. The following is a map of the research location stated in Figure 1.

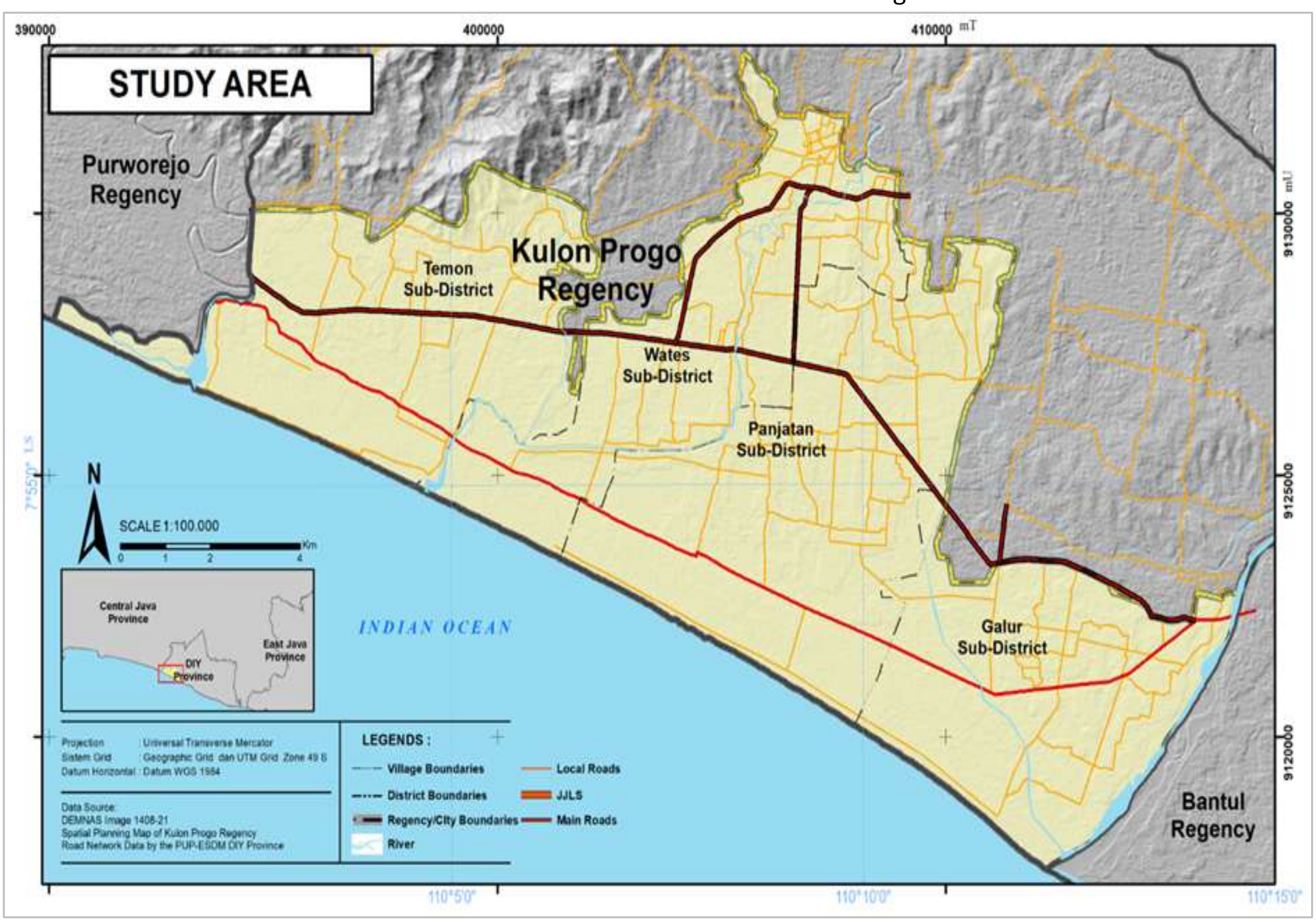

Figure 1. Research Location Ma

Research Approach

The research approach used in this study is a quantitative approach in the form of remote sensing analysis and statistical calculations.

Research Procedures

In general, this research was conducted in several stages, as shown in Figure 2.

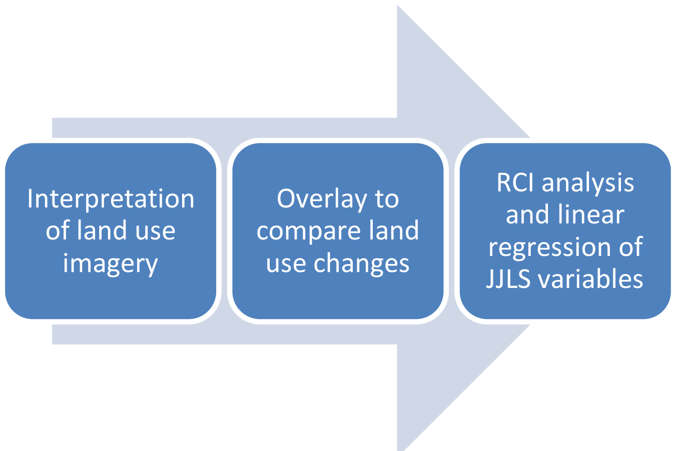

Figure 2. Research Procedure

Data Collection Instruments

Land cover information is obtained from Sentinel 2 imagery which has a resolution of 10 m. Land cover information obtained from Sentinel 2 imagery has a spatial resolution of 10 m. Spatial resolution affects the level of detail and accuracy of mapping information (Lillesand et al., 2015). Based on the LAPAN remote sensing data criteria (2015), the output from Sentinel imagery is included in the high spatial resolution criteria. According to PP No. 21 of 2021 concerning the Implementation of Spatial Planning, data with high spatial resolution can be used for the study of Regency Spatial Planning with a scale of 1: 50.000 or 1: 25.000 (BSNI, 2014).

The classification scheme used refers to the remote sensing-based land cover classification class compiled by LAPAN (2014). Table 1 is the land cover class classification system used in this study.

Table 1. Land Cover Map Classification Scheme

	Land Cover Classification
Non-built-up area	Body of water
	Fishpond/ pond
	Rice field farming
	Dry land farming
	Plantation
	Bare land
	Beach border
Built-up area	Urban Settlement
	Rural Settlement
	Industry, trade and tourism
	YIA Airport

Data analysis

1. Interpretation of Sentinel imagery

The composite combination method of visible channels (4,3,2), false color (8,11,4), NDVI (Normalized Difference Vegetation Index) index transformation results, and NDWI (Normalized Difference Water Index) index transformation results were used for visual interpretation in this study (ESA, 2015; Hakim, 2018; Sarun, 2018; Pamungkas, 2023).Research conducted by Putri (2020), compared the level of land use mapping accuracy of visual interpretation classification methods, supervised multispectral classification (maximum likelihood), and unsupervised multispectral classification (K-Means). Her research showed that the visual interpretation method had the highest level of accuracy with an accuracy level of 92,5%, while the accuracy of the maximum likelihood and K-Means methods were 62.5% and 40%, respectively. Therefore, this study uses visual image interpretation to obtain land cover information.

Furthermore, information related to the distribution of land use changes is obtained through overlay analysis using two land cover maps in different years. Based on the overlay results, the location of land use changes along with their area will be known. Analysis of land cover changes in the coastal area of Kulon Progo Regency was carried out on the 2016-2020 land cover map and the 2020-2024 land cover map. The analysis of land use changes will focus on the area and growth and conversion of land that was originally non-built-up area into built-up area that occurred in the study area.

2. Statistical Calculations

Statistical analysis is used to obtain the value of land use change from non-built up to built-up area. The statistical analysis used in this study is RCI analysis (Relative Covertion Index Analysis). RCI is a comparison between the proportion of land change in each village (RDk), with the proportion of land change in the entire study area (RTk). RDk is a comparison between the change of non-built-up area to built-up area (ADk) with the total area of non-built-up area in each village (AD). While RTk is a comparison between the area of change of non-built-up area to built-up area with the area of non-built-up area in the entire study area.

The RCI value can be used to indicate the intensity of the magnitude of changes in built-up area in each village. If the RCI value is 1, then the intensity of land changes in a village is the same as the changes in the entire study area. However, if it is more than 1, then the intensity of changes in built-up area in a village is higher than the intensity of changes in the study area. The formula for determining RCI in Susilo (2016) is as follows:

$$RCI = \frac{Rdk}{Rtk}; Rdk = \frac{Adk}{Ad}; Rtk = \frac{Atk}{At}$$

Meanwhile, to determine the relationship or influence between changes in land cover in this study using linear regression analysis with the help of SPSS software. Linear regression analysis is a statistical method that can be used to determine the relationship and influence of independent variables on dependent variables. Dependent variables are variables that experience the impact of the value of the independent variable, while independent variables are variables that have independent properties and their values are not affected by other variables because they generally will have an influence on the dependent variable.

The independent variable in this study is the distance of land cover change to JJLS. The value of the independent variable is obtained by using a road buffer (JJLS) with a buffer distance of 200m, 400m, 600m, and so on to find out how far JJLS affects the development of built-up area. The magnitude of the influence of the independent variable or JJLS on the dependent variable or the area of land use change can be known through the results of the significance value (Sig.), the correlation coefficient value (R) and the determination coefficient value (R squared).

The Sig. value indicates whether there is a correlation in the two variables used or not. If the Sig. value is less than 0,05 (<0,05) then there is an influence given by the independent variable to the dependent variable or the two variables are correlated. The R value has a range of values between 0 and 1, a value of 0 indicates that the relationship between JJLS and land cover change is very weak or even no relationship. However, if the coefficient value near 1 then the relationship between JJLS and land cover change is very close (Alipbeki, 2024). Meanwhile, the coefficient of determination (R squared) value explains how large a percentage is given by the independent variable to be able to explain or even predict the value of the dependent variable (Santoso, 2018).

RESULTS AND DISCUSSION

Land Cover Identification

Land cover identification was conducted using a remote sensing-based land cover classification system with various resolution levels, developed by the National Institute of Aeronautics and Space (LAPAN) in 2014. The interpretation of land cover utilized Sentinel-2 satellite imagery from the acquisition years 2016, 2020, and 2024, obtained from the Copernicus Data Space Ecosystem *https://browser.dataspace.copernicus.eu/*.

According to the remote sensing data criteria established by the Center for Remote Sensing Utilization (Pusfatja LAPAN) in 2015, Sentinel-2 imagery is classified as high spatial resolution imagery. This classification supports its suitability for accurate visual interpretation and reliable land cover classification. The use of Sentinel imagery provides high visual interpretation accuracy and enables precise land cover classification. In general, land cover classification is divided into vegetation areas, bare land, built-up land, and water bodies. (Saputra, 2023; Indriana, 2024). This makes the resulting information highly suitable for supporting spatial planning and regional development efforts.

The interpreted land cover map for the year 2024 is used as the reference for evaluating the accuracy of interpretation. Accuracy assessment could not be conducted for the 2016 and 2020 land cover maps due to limitations in field information and the unavailability of relevant informants to verify historical land cover conditions. Therefore, the 2024 land cover map serves as the basis for determining the interpretation accuracy level, as the field data collection was carried out in the same year as the imagery acquisition.

The accuracy assessment of land cover interpretation in the coastal area of Kulon Progo Regency in 2024 is presented in Table 3. Referring to the table, the land cover interpretation using Sentinel-2 imagery achieved an overall accuracy of 92.7% and a Kappa coefficient of 0.907.

Table 2. Results of Land Cover Accuracy Test in the Research Area in 2024

Confusion Matrix	**Field Observation**												**Row Totals (*Xi*)**	***User Accuracy (%)***	***Comission Error (%)***	***Xi*Xi+***
	Class	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**				
Interpretation	**1**	1											1	100	0	1
	2		18			2							20	90.0	10.0	480
	3		2	6									8	75.0	25.0	80
	4			3	73			1					77	94.8	5.2	5698
	5		3			59							62	95.2	4.8	3782
	6						4						4	100	0.0	16
	7			1				9	2				12	75.0	25.0	132
	8							1	35				36	97.2	2.8	1332
	9									4			4	100	0	16
	10		1					1			3		5	60.0	40.0	15
	11											4	4	100	0	16
Column Totals (*Xi+*)		1	24	10	74	61	4	11	37	4	3	4	216 (*Xii*)	233 (*N*)	11568 (Total *Xi*Xi+*)	
Producer Accuracy (%)		100	75.0	60.0	98.6	96.7	100.0	81.8	94.6	100	100	100				
Omission error (%)		0.0%	25.0%	40.0%	1.4%	3.3%	0.0%	18.2%	5.4%	0.0%	0.0%	0.0%				

Overall Accuracy: 92.7%

Koefisien Kappa: 0.907

1: YIA Airport; 2: Industry and Tourism; 3: Bare land; 4: Plantations; 5: Rural Settlement; 6: Urban Settlement; 7: Dryland Farming; 8: Rice Field; 9: Coastal Area; 10: Fishpond; 11: Water Bodies / River

Source: Analysis Results, 2024

The accuracy assessment of land cover interpretation in the coastal area of Kulon Progo Regency in 2024 is presented in Table 3. Referring to the table, the land cover interpretation using Sentinel-2 imagery achieved an overall accuracy of 92.7% and a Kappa coefficient of 0.907. The Kappa value, which approaches 1, indicates a high level of confidence in the classification results. This accuracy level is considered high, suggesting that the interpretation is reliable (>85%) and can serve as a credible reference for further research. The high accuracy demonstrates that the interpreted land cover closely represents the actual land cover conditions on the ground. Any discrepancies between the interpreted results and field observations were updated to ensure the data accurately reflect real conditions

Distribution of Land Cover Change

The most significant factor in urban development is the availability of infrastructure which support people movement, such as network transportation (Aburas, 2017; Zhou, 2020). Especially the area with accessibility near the Southern Cross Road Network (JJLS) (Pratiwi and Rahardjo, 2018). Wang, et al, (2010) and Muhammad (2022), stated that newly developed transportation infrastructure is the driving forces that could trigger spatial structure changes. Furthermore, transport infrastructure is a crucial aspect that engages the increase economic development and improve citizen well-being (Ghent, 2018). It is proved by Cao (2020) and Chadchan (2012) that main road is a significant aspect that affect urban development. In addition, the existence of main road construction can affect on reducing agricultural land due to the increase of land conversion if the area is located near roads and residential developments (Tang et al, 2023; Girsang, 2025; Buğday, 2019).Paramita (2011) stated that the increase in development of a region is generally along road corridors and regional centers. The phenomenon of regional development can occur by following transportation routes (Yunus, 2000). This theory can be proven by looking at changes in the appearance of land use that occurred in the period 2016 to 2024. Changes in land use in the period 2016, 2020 and 2024 are listed in table 3.

Table 3. Changes in land use over the years 2016, 2020, and 2024

Land Cover Classifications		Area (ha)					
		2016	**2020**	**Δ 2016-2020**	**2020**	**2024**	**Δ 2020-2024**
A	**Built-Up Area**	**1.312**	**2.424,3**	**1.112,3**	**2.424,3**	**3.038**	**613,7**
	YIA Airport	-	580,96	580,96	580,96	580,96	0
	Industry, trade and tourism	98,69	137,02	38,33	137,02	197,12	60.1
	Rural Settlement	1.108,92	1.544,25	435,33	1.544,25	2.067,06	522.81
	Urban Settlement	104,39	162,07	57,68	162,07	192,86	30.79
B	**Non-Built-Up Area**	**13.083,19**	**11.970,89**	**-1.112,3**	**11.970,89**	**11.357,19**	**-613,7**
	Bare land	13,17	13,99	0,82	13,99	17,62	3.63
	Plantation	5.284,13	4.693,89	-590,24	4.693,89	4.148,18	-545.71
	Dry land farming	2.116,24	1.740,87	-375,37	1.740,87	1.706,64	-34.23
	Rice field farming	4.921,85	4.805,07	-116,78	4.805,07	4.770,39	-34.68
	Beach border	206,24	259,83	53,59	259,83	263,75	3.92
	Fishpond/ pond	300,75	216,43	-84,32	216,43	209,8	-6.63
	Body of water	240,81	240,81	0	240,81	240,81	0
Total Area		**14.395,19**		**0**	**14.395,19**		**0**

Based on the table above, the land use conditions in 2016 to 2024 have experienced quite significant changes. This is due to the construction of Yogyakarta International Airport (YIA) and the South Cross Road (JJLS) as one of the national strategic projects. YIA Airport has an area of 580,96 ha which contributes to changes in built-up area and non-built-up area.

The table shows that land use in 2016 was dominated by non-built-up area in the form of plantations, rice fields, and dry land farming with an area of 12.322 ha or 85,6% of the total area of the study area. Meanwhile, the total area of built-up area cover in the form of rural settlements, urban settlements, industry, trade, and tourism was only 1.312 ha or 9,1% of the total area of the study area.

Meanwhile, the total change in non-built-up area cover to built-up area in 2020 to 2024 was 613,7 ha. Based on this value, there was an increase in built-up area of 82,36 ha or 16% when compared to the growth in the period from 2016 to 2020. The significant change in built-up land in the period from 2020 to 2024 was caused by several driving factors of change that gave rise to characteristics of urban activities in the community environment, such as the development of JJLS and the construction of YIA Airport (Pamungkas, 2023).

Analysis of Built-up Area Development 2016-2024

Based on the results of the RCI calculation in 2016 to 2020, the lowest RCI value was 0.2917 and the highest value was 3.156. Meanwhile, the RCI value for 2020 to 2024 had the lowest value of 0,3862 and the highest was 2,1791. Based on the RCI value, it is divided into 3 classes, low, medium, and high in order to represent the intensity of change in each village.

Table 4. RCI Values and Classification of Change Intensity in Each Village in 2016-2020

Subdistrict	No Village	Village	RCI Parameters				RCI	Intensity of Change
			ADK	AD	RDK	RTK	($\frac{RDK}{RTK}$)	
Galur	1	Karangsewu	30,56	794,91	0,0384	$\frac{544,67}{11970,89}$ = 0,0455	0,7943	Low
	2	Banaran	21,00	598,91	0,0351		0,7245	Low
	3	Tirtorahayu	20,21	471,84	0,0428		0,8850	Low
	4	Nomporejo	8,49	151,20	0,0562		1,1602	Moderate
	5	Pandowan	7,85	109,01	0,0720		1,4879	Moderate
	6	Kranggan	11,00	179,12	0,0614		1,2689	Moderate
	7	Brosot	17,07	216,54	0,0788		1,6288	Moderate
Panjatan	8	Bugel	15,71	598,71	0,0262		0,5422	Low
	9	Gorongan	12,89	561,67	0,0229		0,4742	Low
	10	Krembangan	12,70	451,05	0,0282		0,5818	Low
	11	Cerme	13,56	385,91	0,0351		0,7260	Low
	12	Gotakan	11,92	293,81	0,0406		0,8383	Low
	13	Panjatan	5,37	105,25	0,0510		1,0542	Low
	14	Kanoman	3,43	242,93	0,0141		0,2917	Low
	15	Depok	8,26	199,95	0,0413		0,8535	Low
	16	Bojong	8,23	342,56	0,0240		0,4964	Low
	17	Pleret	15,86	523,29	0,0303		0,6262	Low
	18	Tayuban	8,62	194,21	0,0444		0,9171	Low
Temon	19	Jangkaran	12,08	110,52	0,1093		2,2584	Hight
	20	Sindutan	13,61	174,93	0,0778		1,6075	Moderate
	21	Glagah	31,22	237,11	0,1317		2,7205	Hight
	22	Karangwuluh	6,72	138,86	0,0484		0,9999	Low
	23	Janten	8,40	123,07	0,0683		1,4102	Moderate
	24	Palihan	19,42	127,14	0,1527		3,1560	Hight
	25	Kebonrejo	9,05	102,71	0,0881		1,8205	Moderate
	26	Temonkulon	10,17	142,17	0,0715		1,4780	Moderate
	27	Plumbon	9,77	271,62	0,0360		0,7432	Low
	28	Demen	6,03	69,64	0,0866		1,7891	Moderate
	29	Kedundang	9,83	131,65	0,0747		1,5428	Moderate
	30	Kulur	5,40	204,47	0,0264		0,5457	Low
	31	Temonwetan	7,10	154,53	0,0459		0,9493	Low
	32	Kalidengen	6,72	132,00	0,0509		1,0519	Low
	33	Kaligintung	5,12	291,99	0,0175		0,3623	Low
Wates	34	Karangwuni	13,52	547,63	0,0247		0,5101	Low
	35	Sogan	10,16	216,08	0,0470		0,9715	Low
	36	Wates	25,76	237,32	0,1085		2,2427	Hight
	37	Giripeni	35,05	406,50	0,0862		1,7815	Moderate
	38	Kuwaru	12,24	218,51	0,0560		1,1574	Low
	39	Triharjo	25,86	343,15	0,0754		1,5571	Moderate
	40	Ngestiharjo	8,91	212,64	0,0419		0,8658	Low
	41	Bendungan	19,80	238,71	0,0829		1,7138	Moderate

Source: Analysis Results, 2024

Table 5. RCI Values and Classification of Change Intensity in Each Village in 2020-2024

Subdistrict	No Village	Village	RCI Parameters				RCI ($\frac{RDK}{RTK}$)	Intensity (2020-2024)
			ADK	AD	RDK	RTK		
Galur	1	Karangsewu	**36,22**	**758,69**	**0,0477**	$\frac{609,74}{10642,83}$ = **0,0573**	0,8333	Moderate
	2	Banaran	**18,30**	**580,61**	**0,0315**		0,5501	Low
	3	Tirtorahayu	**17,03**	**454,81**	**0,0374**		0,6536	Low
	4	Nomporejo	**6,95**	**144,25**	**0,0482**		0,8410	Moderate
	5	Pandowan	**6,47**	**102,54**	**0,0631**		1,1013	Moderate
	6	Kranggan	**9,45**	**169,67**	**0,0557**		0,9722	Moderate
	7	Brosot	**23,97**	**192,57**	**0,1245**		2,1727	Hight
Panjatan	8	Bugel	**21,31**	**577,40**	**0,0369**		0,6442	Low
	9	Gorongan	**18,60**	**543,07**	**0,0342**		0,5978	Low
	10	Krembangan	**26,16**	**424,89**	**0,0616**		1,0747	Moderate
	11	Cerme	**32,48**	**353,43**	**0,0919**		1,6041	Moderate
	12	Gotakan	**21,18**	**272,63**	**0,0777**		1,3560	Moderate
	13	Panjatan	**7,48**	**97,77**	**0,0765**		1,3354	Moderate
	14	Kanoman	**8,66**	**234,27**	**0,0370**		0,6452	Low
	15	Depok	**11,72**	**188,23**	**0,0623**		1,0868	Moderate
	16	Bojong	**14,21**	**328,35**	**0,0433**		0,7554	Low
	17	Pleret	**22,06**	**501,23**	**0,0440**		0,7682	Low
	18	Tayuban	**11,73**	**182,48**	**0,0643**		1,1220	Moderate
Temon	19	Jangkaran	**9,58**	**100,94**	**0,0949**		1,6566	Hight
	20	Sindutan	**8,33**	**166,60**	**0,0500**		0,8727	Moderate
	21	Glagah	**14,64**	**222,47**	**0,0658**		1,1486	Moderate
	22	Karangwuluh	**3,49**	**135,37**	**0,0258**		0,4500	Low
	23	Janten	**5,52**	**117,55**	**0,0470**		0,8197	Moderate
	24	Palihan	**13,70**	**113,44**	**0,1208**		2,1080	Hight
	25	Kebonrejo	**8,32**	**94,39**	**0,0881**		1,5385	Moderate
	26	Temon Kulon	**11,74**	**130,43**	**0,0900**		1,5711	Moderate
	27	Plumbon	**7,51**	**264,11**	**0,0284**		0,4963	Low
	28	Demen	**3,18**	**66,46**	**0,0478**		0,8352	Moderate
	29	Kedundang	**8,40**	**123,25**	**0,0682**		1,1896	Moderate
	30	Kulur	**6,44**	**198,03**	**0,0325**		0,5676	Low
	31	Temon Wetan	**6,45**	**148,08**	**0,0436**		0,7603	Low
	32	Kalidengen	**7,58**	**124,42**	**0,0609**		1,0634	Moderate
	33	Kaligintung	**6,32**	**285,67**	**0,0221**		0,3862	Low
Wates	34	Karangwuni	**20,06**	**526,32**	**0,0381**		0,6653	Low
	35	Sogan	**9,07**	**207,01**	**0,0438**		0,7648	Low
	36	Wates	**26,34**	**210,98**	**0,1248**		2,1791	Hight
	37	Giripeni	**41,74**	**364,76**	**0,1144**		1,9974	Hight
	38	Kuwaru	**12,19**	**206,32**	**0,0591**		1,0313	Moderate
	39	Triharjo	**30,74**	**312,41**	**0,0984**		1,7175	Hight
	40	Ngestiharjo	**10,36**	**202,28**	**0,0512**		0,8940	Moderate
	41	Bendungan	**24,06**	**214,65**	**0,1121**		1,9565	Hight

Based on the RCI value classification in each village, the intensity of change in the 2016-2020 period, there are four villages that have a high intensity change classification, specifically Wates Village, Palihan Village, Glagah Village, and Jangkaran Village. Meanwhile, there are thirteen villages with a moderate intensity change classification, and twenty-four villages are included in the villages with a low intensity change classification. Furthermore, all villages in Panjatan District have a low intensity of land cover change classification.

The intensity of land cover change in the 2020-2024 is distributed fairly. There is a significant decrease in the number of villages with a low change intensity classification from the previous period of twenty-four to fourteen villages. Meanwhile, there is an increase in the number of villages with a medium change intensity classification from the previous thirteen to twenty and for the high change intensity classification it has increased from four to seven villages. This shows an increase in the quality and equity of development in the development of built-up area in the 2020 to 2024 period. The high intensity of land cover change indicated by the RDK which is the ratio between area a new-built land (ADK) with remaining area of agricultural land (AD).

The RTK value in 2016-2020 was 0,0455, while the RTK value in 2020-2024 was 0,0573, which shows that the ratio or intensity of land changes in the study area, namely part of the coastal area of Kulon Progo Regency, has experienced a significant increase.

Analysis to determine the development of built-up area is presented spatially using a land change intensity map, the unit of analysis used is village administration. Based on the built-up area change intensity map for 2016-2020 and 2020-2024 (Figure 3 and Figure 4), it can be seen that villages with low change intensity values tend to be in the southern part or are closely associated with the southern coast which is dominated by rice field agricultural land cover and dry land agriculture such as in Banaran Village, Tirtorahayu Village, Bugel Village, Gorongan Village, Bojong Village, Sogan Village, Plumbon Village, and Karangwuni Village. Meanwhile, Karangwuluh Village, Kaligintung Village, Kulur Village, and Temon Wetan Village have low change intensity because they are located in areas with steep topography with undulating relief characteristics because they are included in the Menoreh Hills area, thus inhibiting the growth rate of built-up area.

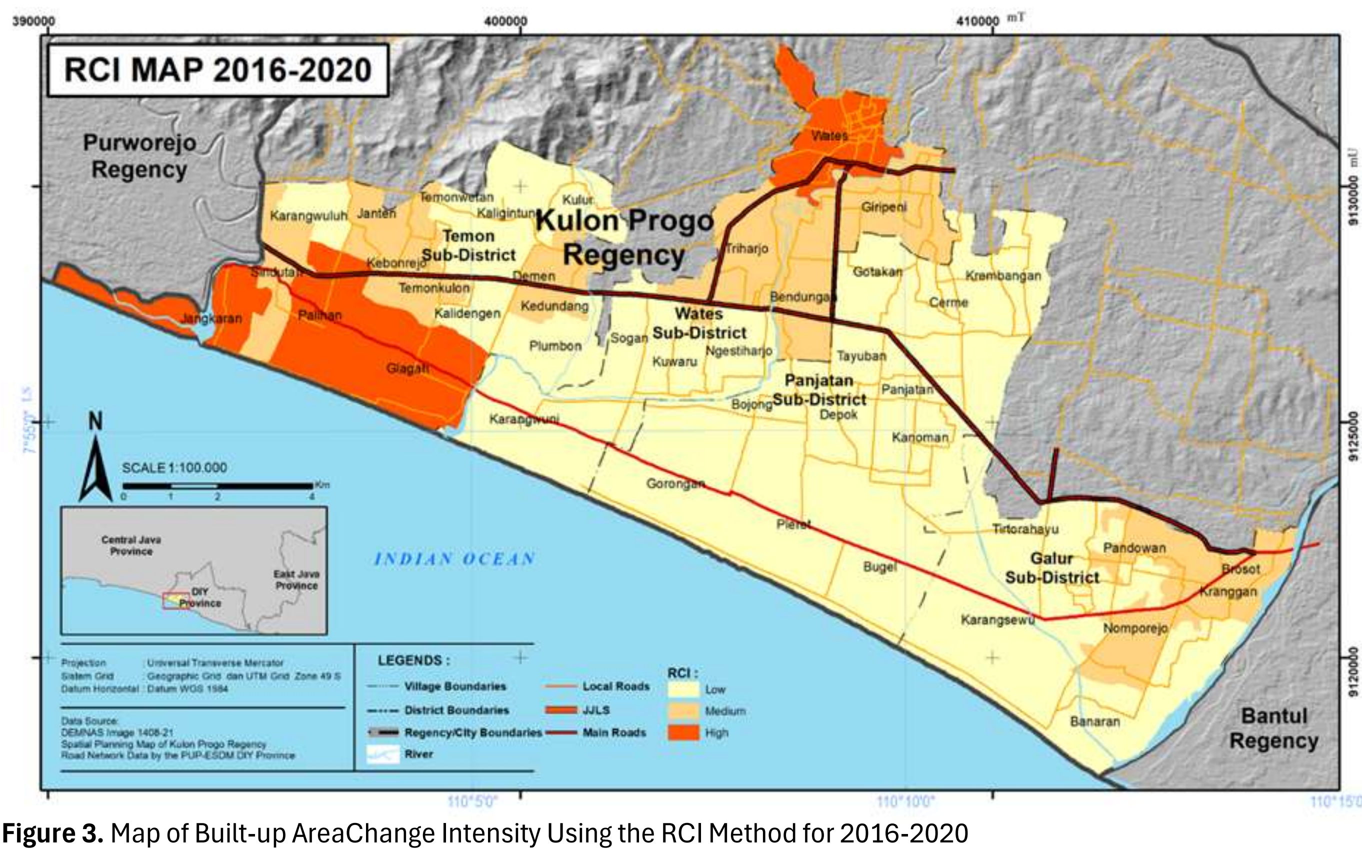

Figure 3. Map of Built-up AreaChange Intensity Using the RCI Method for 2016-2020

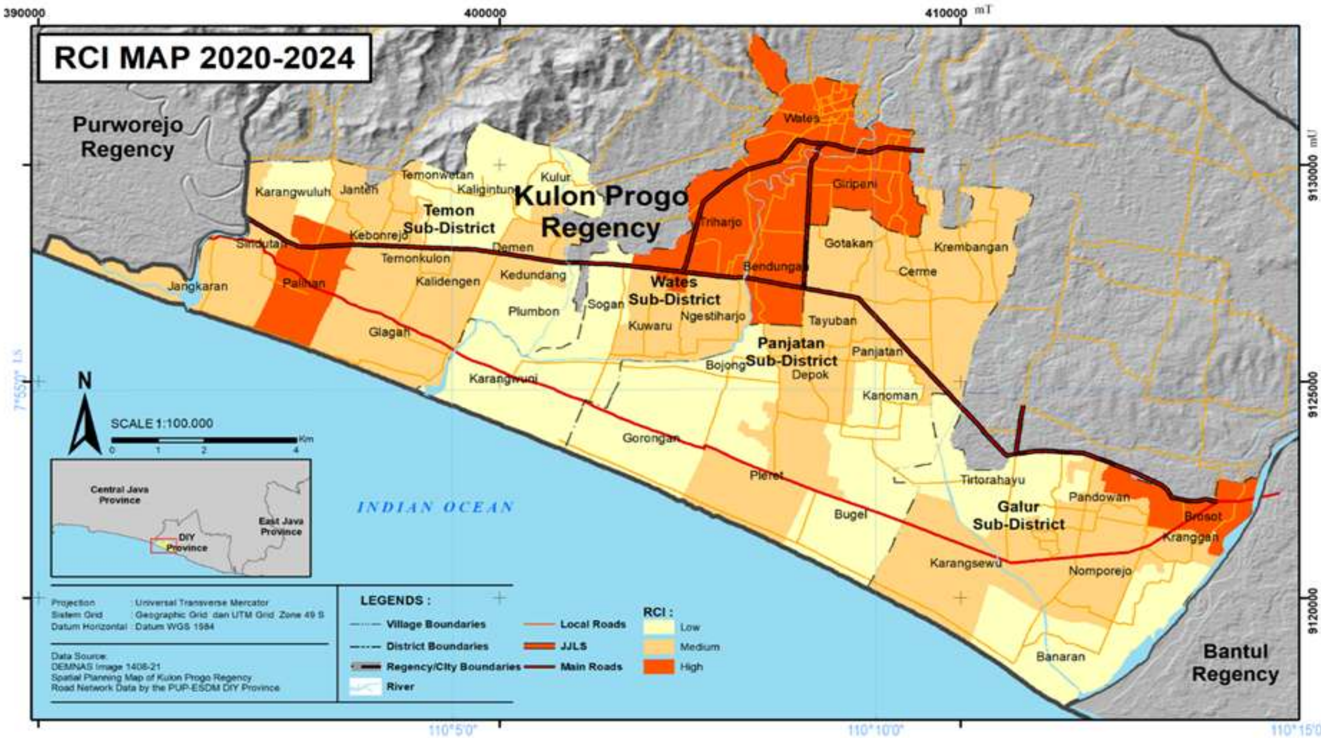

Figure 4. Built-up Area Change Intensity Map Using the RCI Method for 2020-2024

Impact of JJLS on Built-up Area Development

To find out how much influence JJLS has on the development of built-up area in the surrounding area using statistical analysis of linear regression test whose results can be interpreted through the significance value (Sig.), correlation coefficient (R), and determination coefficient (R squared). Linear regression analysis uses buffer technique to find out how much growth of built-up area is located on the right and left of JJLS which will then be used as a variable. The buffer technique is carried out in both time periods, namely the period of built-up area development from 2016 to 2020 and the period of built-up area development from 2020 to 2024. The magnitude of the influence of JJLS on the growth of built-up area in some coastal areas of Kulon Progo Regency is stated in table 6 and the graphs in figures 5 and 6 which show the correlation between the distance of the land buffer to JJLS and the magnitude of the area of built-up area growth that occurs.

Table 6. Statistical calculation of the influence of JJLS on built-up area growth

A. Linear Regression 2016-2020

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	Sig
	.773[a]	.597	.588	6.84807	.597	65.207	<,001

a. Predictors: (Constant), Distance

B. Linear Regression 2020-2024

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	Sig
	.838[a]	.703	.696	5.07259	.703	106.334	<,001

a. Predictors: (Constant), Distance

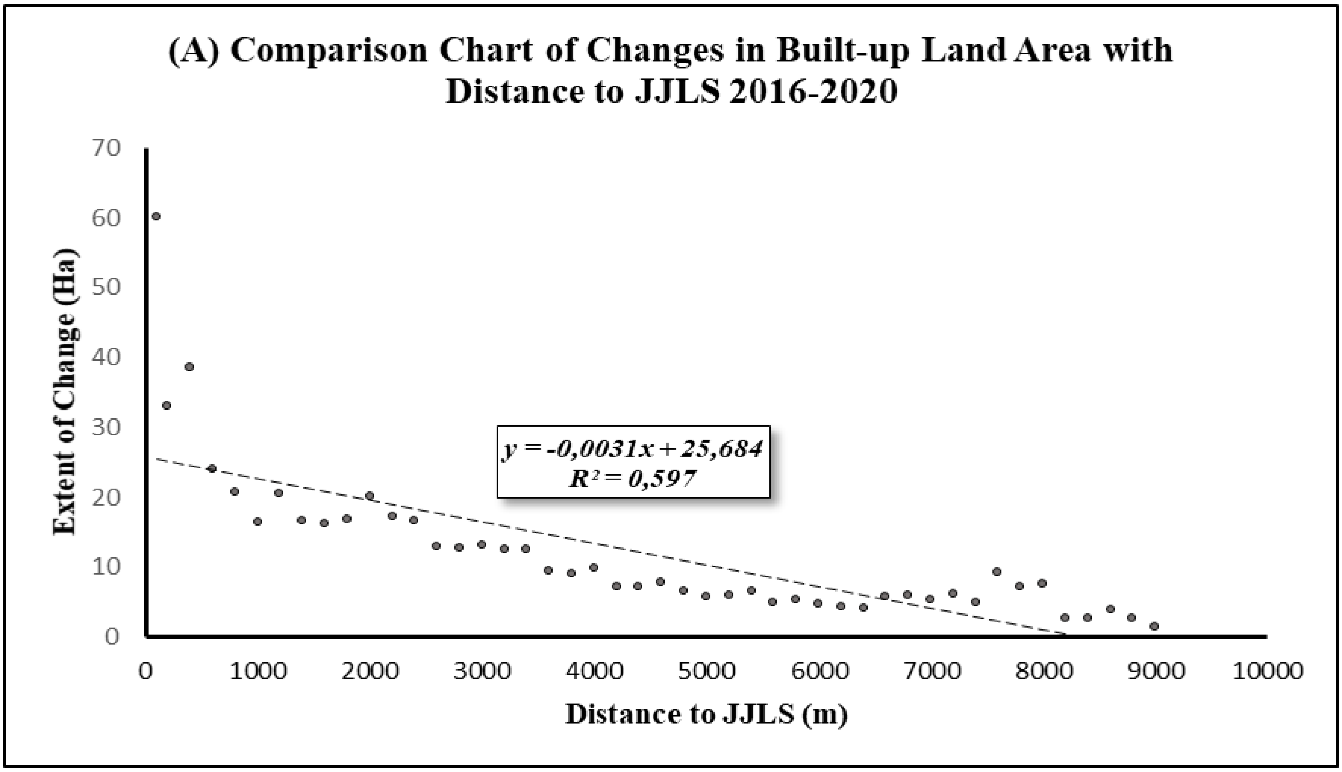

Figure 6. Comparison graph of built-up area with JJLS Buffer 2016-2020

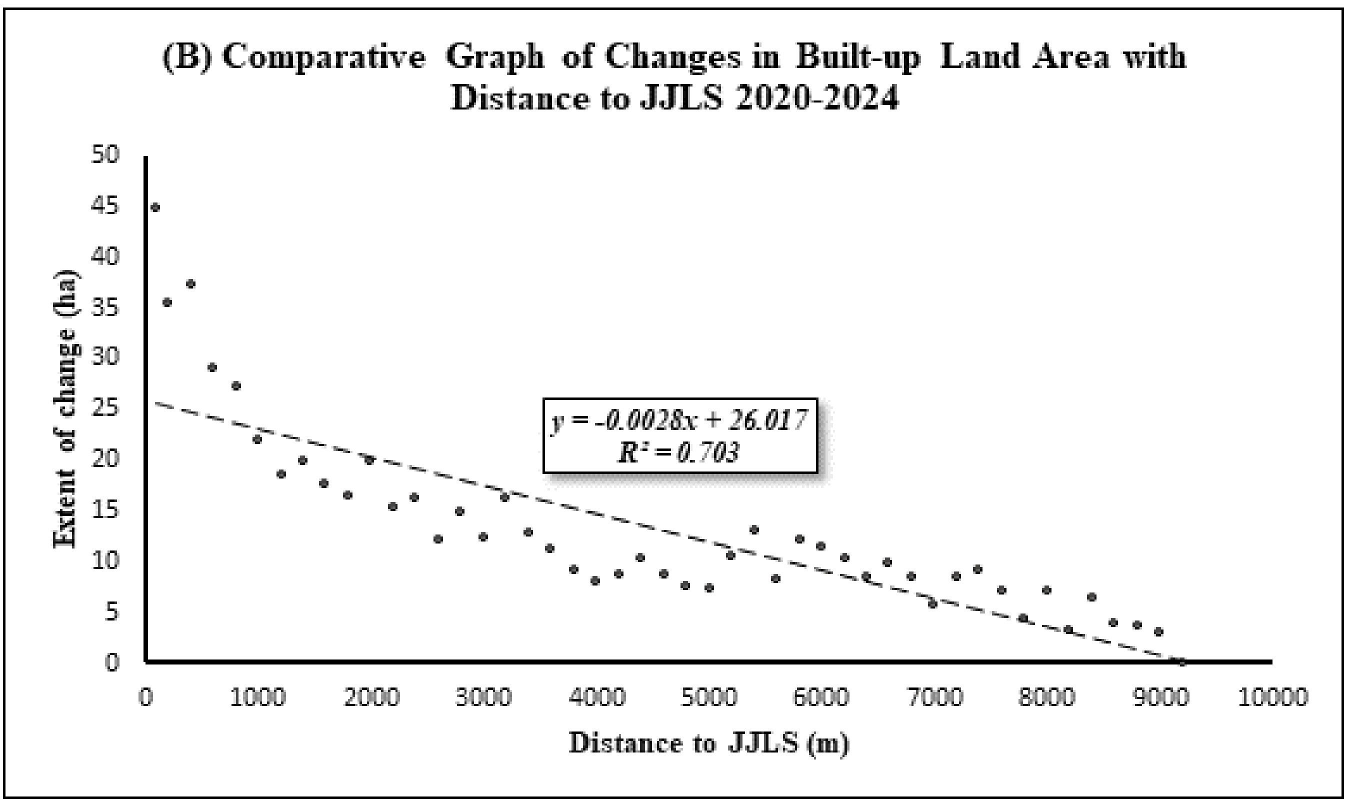

Figure 7. Comparison graph of built-up area with JJLS Buffer 2016-2020

Based on the results of the linear regression test, the significance value (Sig.) was obtained in two year periods which showed a value of <0,001 or less than 0,05 so that it can be concluded that the regression model is statistically significant. This means that the distance variable significantly affects changes in land cover area. Then the value (R) or correlation coefficient in the results of the regression test for 2016-2020 and the period 2020-2024 showed values of 0,773 and 0,838, respectively. This states that there is a strong influence between the JJLS variable and the growth of built-up area in the study area. Furthermore, the coefficient of determination (R Square) value is 0,597 in the period 2016-2020 and 0,703 in the period 2020-2024. If the coefficient value is closer to 1, the relationship between JJLS and land cover changes is very close (Alipbeki, 2024). Meanwhile, the coefficient of determination (R squared) value explains how large a percentage the independent variable contributes to explaining or even predicting the value of the dependent variable (Santoso, 2018). Based on the determination coefficient value obtained, JJLS as an independent variable has an influence on changes in built-up area area of 59% in the 2016-2020 period and its influence increases to 70% in the 2020 to 2024 period.

CONCLUSION

The development of functional infrastructure in the form of JJLS in Kulon Progo Regency has a positive impact on increasing the economy of the community and region. Although it has a good impact on the economy, the dynamics of rapid changes in built-up area can have a negative impact on the environment due to the high conversion of land functions. Land use from 2016 to 2024 has changed quite significantly. Land use in 2016 was dominated by non-built-up area in the form of plantations, rice fields, and dry land agriculture which had an area of 12.322 ha or 85.6% of the total area of the study area. Meanwhile, the total area of built-up area cover in the form of village settlements, urban settlements, industry, trade, and tourism was only 1.312 ha or 9,1% of the total area of the study area. For 2024, there was a significant increase in the use of built-up area in the form of industrial trade and residential areas, and there was a significant decrease in the use of non-built-up area in the form of plantations, urban land agriculture, rice fields and ponds.

Based on the RCI value, it is divided into 3 classes, low, medium, and high, to represent the intensity of change in each village. Based on the results of the RCI calculation in 2016 to 2020, the lowest RCI value was 0,2917 and the highest value was 3,156. While the RCI value for 2020 to 2024 has the lowest value of 0.3862 and the highest is 2,1791. Based on the RCI value, it is divided into 3 classes, low, medium, and high, to represent the intensity of change in each village. The conclusion from the results of the statistical analysis shows that there is a significant influence between the JJLS variable on the growth of built-up area in this study area.

This study has several limitations. First, the analysis of land use changes resulting from the development of the Southern Cross Road Network (JJLS) in Kulon Progo was limited to a general classification of land use, specifically distinguishing between built-up and non-built-up areas. This approach does not capture more detailed land categories, such as residential areas, public facilities, agricultural land, or protected zones. Second, limited availability of field validation data and spatial accuracy may affect the reliability of the land use classification results. Future studies are encouraged to apply a more detailed and specific land use classification to better capture the diverse impacts of JJLS development on various land types. Additionally, integrating socio-economic data and adopting participatory approaches involving local communities can provide deeper insights into the dynamics of land use change in affected areas.

Conflict of Interest The author declares that he has no conflict of interest relevant to this research.

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