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Urban Expansion and Land Cover Changes in the Special Region of Yogyakarta: The Impact of Transportation and Tourist Attractions

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ABSTRACT

This study examines the relationship between urban expansion and land cover changes in the Special Region of Yogyakarta (DIY), with a focus on the impacts of transportation infrastructure and tourist attractions. Over recent decades, rapid urbanization driven by economic growth, improved transportation networks, and expanding tourism has significantly transformed land use patterns across the province. The development of the Yogyakarta International Airport (YIA) and the improvement of road networks have been key drivers of urban sprawl, particularly in Sleman and Bantul. These areas have experienced the conversion of agricultural land into residential and commercial zones. The expansion of tourist destinations, such as Gunung Merapi and Prambanan, has further accelerated land use changes, intensifying urban growth and putting pressure on local ecosystems. This study utilizes satellite imagery and spatial regression models to examine land cover changes and their drivers, revealing that infrastructure development and the tourism sector play pivotal roles in shaping the region's landscape. The findings underscore the need for sustainable spatial planning policies to mitigate the environmental impacts of urban sprawl and ensure the long-term resilience of DIY's natural resources and cultural heritage.

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1. INTRODUCTION

The Special Region of Yogyakarta or Daerah Istimewa Yogyakarta, hereinafter referred to as DIY, is known as a province in Indonesia that has a long history of spatial planning besides Jakarta or Batavia and other areas such as Surakarta (Solo), Mataram (Lombok), Bali (Denpasar and Gianyar), Aceh (Banda Aceh), and Makassar (Ujung Pandang). Dating back to the 16th century, it features a unique spatial planning system that implements a spatial framework based on Javanese cosmological philosophy and royal culture, which remains recognized to this day. This system prioritizes the balance between nature and social life. The center of DIY's spatial planning is located in the Yogyakarta Palace, which serves as a symbol of the city's arrangement, with an imaginary axis connecting Mount Merapi and the Palace (Basundoro & Putra, 2019; Suryanto et al., 2015; Wijayaningsih et al., 2022).

Formally, the DIY spatial planning regulations were established through the granting of special rights to the Yogyakarta Palace and the Ngayogyakarta Hadiningrat Sultanate in managing spatial planning, culture, and governance within its territory, as recognized in the 1949 RIS Constitution and Law No. 3 of 1950. This allowed the region to integrate both cultural traditions and modern governance. The DIY, as outlined in Law No. 13 of 2012, further strengthened its commitment to preserving cultural heritage while promoting economic growth. As of now, the region's spatial planning is still guided by core values like *hamemayu hayuning bawana* (preserving harmony with nature) and *manunggaling kawula lan Gusti* (the unity of the people and the divine), which continue to shape its urban development. Referring to DIY Regional Regulation No. 5 of 2019, DIY regional spatial planning for 2019 until 2039 aims to realize DIY as a world-class center for education, culture, and a leading tourist destination by prioritizing integrated development between sectors based on disaster mitigation, the uniqueness of DIY spatial planning, and the environment through quality and sustainable spatial planning.

As a designated center for education, culture, and tourism in its spatial planning, DIY is facing rapid population growth and urbanization, similar to another central region in Indonesia. The increasing population in this region has led to significant changes in land cover patterns and population movements, which tend to spread to the surrounding areas. As one of the leading educational centers, with over 30 universities, DIY attracts numerous students from all over Indonesia. In addition, the rapidly growing tourism sector, driven by its cultural and natural attractions, has also contributed to increased population and economic activity in this province. Statistical projections show that the urbanization rate in DIY is expected to reach 81.3% by 2030, making DIY one of the provinces with the highest urbanization rates in Indonesia. This increasing population growth has contributed to the rapid urbanization process, triggering the development of settlements and infrastructure that extend beyond the city limits to the surrounding suburbs and rural areas (Anggit & Putri, 2022; Ariwibowo & Fibiona, 2025; Gunawan et al., 2023a; Widodo et al., 2015).

Along with rapid urbanization, DIY also faces the problem of urban sprawl or uncontrolled urban sprawl. Urban sprawl often manifests itself in the form of low-density area expansion, irregularly distributed development, and high dependence on private vehicles. This phenomenon frequently results in the conversion of agricultural land into built-up areas (Nandi & Dewiyanti, 2019), which not only reduces the land available for agriculture but also has the potential to harm natural habitats and exacerbate environmental damage in urban

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areas. Sprawl in DIY primarily occurs in the city's border areas, where residential areas are expanding, land use is shifting towards trade and commercial centers, and transportation infrastructure is increasing to support this growth pattern (Anggit & Putri, 2022). Research indicates that improved infrastructure, particularly in transportation, is a primary driver of this sprawl, as it facilitates access to previously more remote or underdeveloped areas. This unplanned urban sprawl leads to problems such as traffic congestion, increased air pollution, and unequal access to public services in suburban areas (Behnisch, 2022; Fang, 2022; Lima et al., 2021). Several areas, such as Sleman and Bantul, have undergone a significant change in land use, with previously dominant agricultural areas now transitioning into built-up land and settlements. A deeper examination of the causes and effects of this phenomenon is crucial for developing more sustainable development policies.

Land cover change in the DIY, particularly in areas experiencing urban sprawl, is evident in the conversion of agricultural land to built-up areas. Rapid economic growth, primarily driven by the education and tourism sectors, is the leading cause of this conversion. Very fertile farming land in areas such as Kulon Progo and Bantul has been converted to meet the demand for housing, infrastructure, and commercial development. This land conversion has a significant impact on environmental sustainability in the DIY. For example, areas that were once agricultural or forested are now more frequently converted into residential areas or commercial centers, resulting in reduced water absorption, increased soil erosion, and environmental pollution. These changes also impact biodiversity and reduce the natural carrying capacity, which is crucial for human life (Concepción et al., 2016; Mohammadi et al., 2020; Turrent et al., 2025). Previous research on land cover change and urban expansion in Yogyakarta has often focused on specific aspects, such as urban sprawl or environmental impacts, without integrating the role of transportation infrastructure and tourism. Studies like those by Anggit & Putri (2022) have not fully explored how transportation networks and tourist destinations influence land conversion. This study addresses this gap by using spatial regression to analyze land cover changes in DIY, investigating how factors such as transportation infrastructure, access to tourist areas, and residential development drive urban sprawl and forest infiltration.

This study aims to analyze land cover changes in DIY with a spFbigatial-based approach, using spatial regression to identify areas experiencing urban expansion and forest infiltration. The primary focus of this study is to investigate how factors such as transportation infrastructure, accessibility to tourist areas, and residential development influence land cover changes in DIY. Using satellite imagery data and spatial regression models, this study aims to investigate the relationship between transportation infrastructure (roads, toll roads, and public transportation networks) and urban expansion in peri-urban areas, as well as how tourism factors (such as the Borobudur Temple and Mount Merapi) influence sprawl patterns. By analyzing urban sprawl and forest infiltration trends in DIY, this study aims to provide deeper insight into how regional development can be carried out sustainably, mitigating environmental impacts. Overall, this study aims to present a clearer model of the relationship between urbanization, infrastructure, and natural resources in DIY, providing policy recommendations that can be implemented to create sustainable urban development and mitigate the negative impacts of urban sprawl. This spatial and regression analysis is expected to provide a more comprehensive picture of land cover change in DIY and the

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factors that influence it, as well as contribute to more informed and sustainable regional planning.

2. METHODS

Located on the island of Java, the DIY province comprises the city of Yogyakarta and four districts: Sleman, Bantul, Kulon Progo, and Gunungkidul. City and districts are represented by YK, SM, BT, KP, and GK respectively, as shown in Figure 1. The uniqueness of DIY lies not only in its status as a special region in Indonesia but also in its rich culture, tourism, and educational centers, which make it one of the leading destinations for migration and urbanization. Geographically, DIY also boasts a significant diversity of natural resources, making it unique compared to other regions in Indonesia. Its landscape consists of volcanic hills, agricultural land, and coastal areas. This area also features international tourist destinations, including the Borobudur Temple, Prambanan Temple, and Mount Merapi, which attract tourists from both within Indonesia and abroad. DIY is located in the south of Java Island, bordering Central Java to the north, the Indian Ocean to the south, Banten to the west, and East Java to the east. This province has a diverse topography, ranging from volcanic hills in the north, including Mount Merapi, to beaches in the south. DIY is also famous for its education, tourism, and trade sectors, which make it one of the regions with the fastest urbanization rate in Indonesia.

DIY has a tropical climate with two distinct seasons: the rainy season, which lasts from October to March, and the dry season, from April to September, with an average annual rainfall of 2,000-4,000 mm. The average temperature in this area ranges from 24°C to 32°C, depending on elevation. This climate, which supports soil fertility, also encourages agricultural activities in areas such as Kulon Progo and Bantul. However, urbanization pressures have led to the conversion of agricultural land into built-up areas. DIY's demographics are dominated by a population concentrated in the city of Yogyakarta, with large migrations occurring because DIY is a leading center of education and tourism in Indonesia (Amrullah & Sari, 2024; BPS, 2023).

DIY is experiencing rapid urbanization, which has an impact on the conversion of agricultural land and green open spaces into housing and infrastructure areas. This study utilizes data from the Indonesian Topographic Map (RBI) in the form of the National Digital Elevation Model (DEMNAS) by Badan Informasi Geospasial Indonesia (BIG), as well as topographic data and main highways, to analyze land cover changes in this area. This data supports spatial analysis to identify areas affected by urban sprawl and to examine how transportation factors and tourist attractions influence regional development. This analysis is crucial for understanding the dynamics of land use change in DIY and provides valuable insights for more sustainable urban planning.

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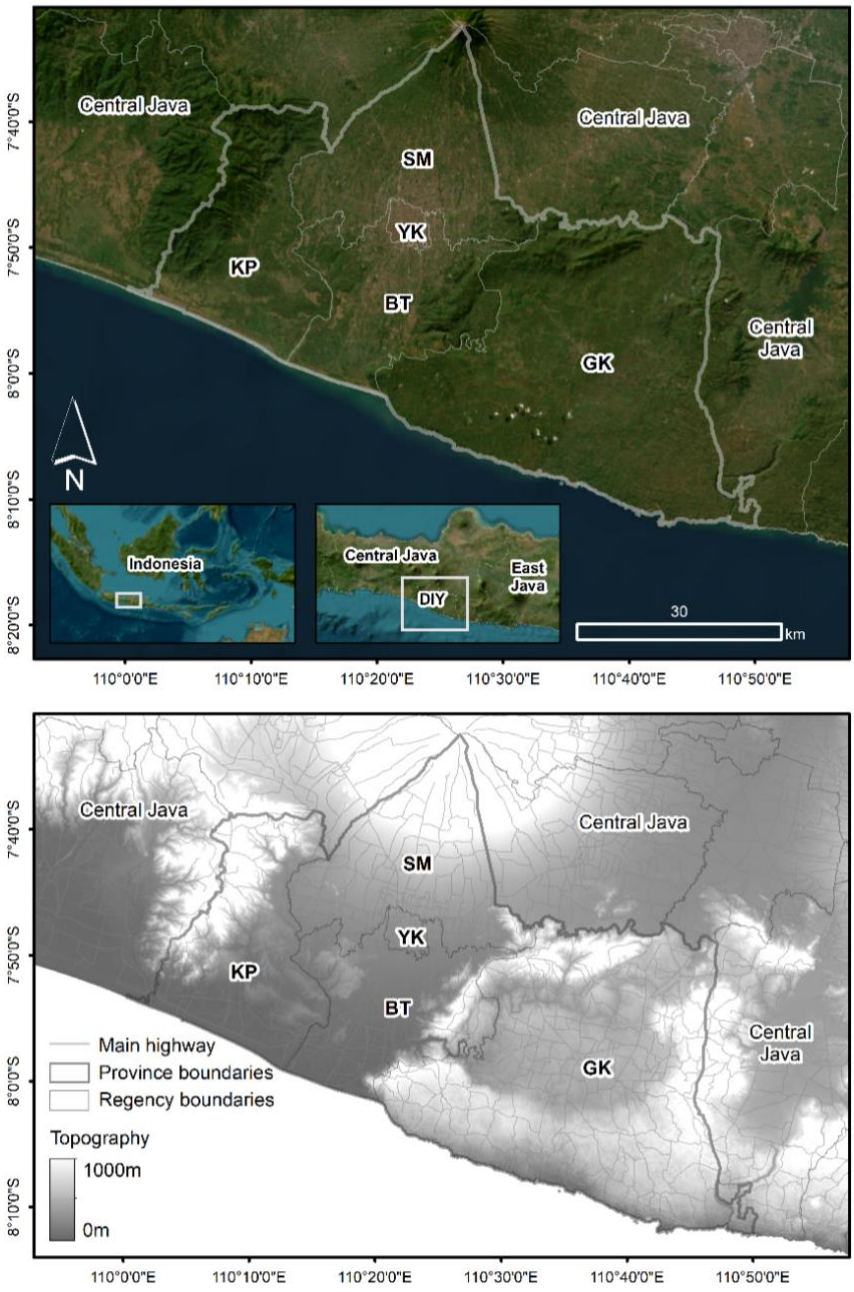

Figure 1. Special Region of Yogyakarta and its topography

Land cover changes in DIY were analyzed using the global land cover dataset available from Karra et al., (2021) accessed through Land Cover Explorer by Living Atlas ArcGIS. This dataset includes annual data from 2017 to 2023, which is used for temporal and spatial analysis. This data was collected from Sentinel-2 satellite imagery with a resolution of 10 meters, which provides information on land changes on a global scale using machine learning algorithms. Land cover was then categorized into five main types: Built-up Land, Empty Land, Vegetation, Agricultural Land, and Swamp Land, as illustrated in Figure 2. This technique was carried out to simplify the classification that is more relevant to the characteristics of regions in Indonesia, as also done by Abdurrahman et al. (2025).

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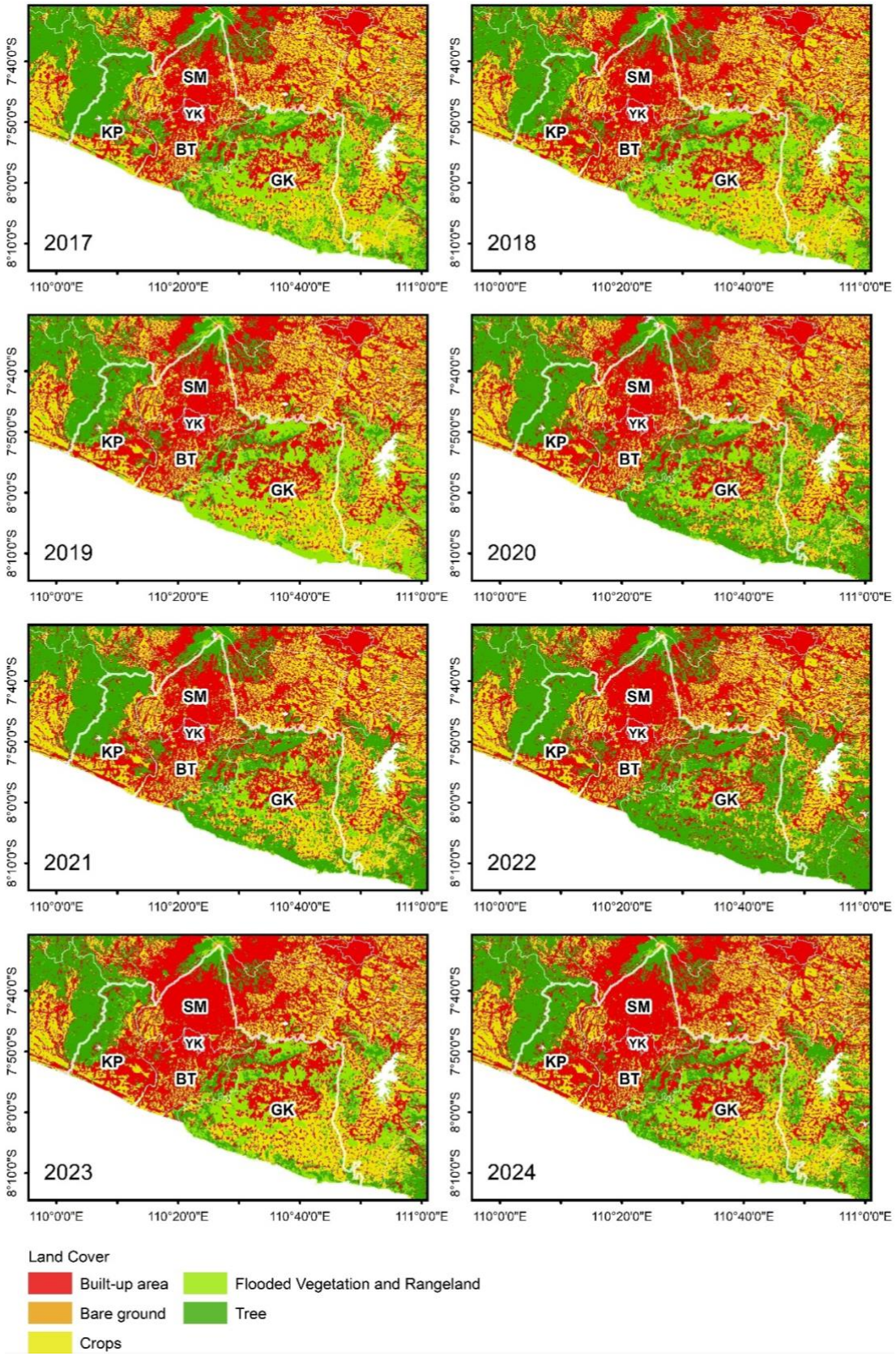

Figure 2. Land cover of DIY in 2017 – 2024

Land cover change can be assessed using various methods (Abdurrahman et al., 2025; MohanRajan et al., 2020). In this study, a simple linear regression approach was employed, where the slope represents the rate of change in land cover. The analysis was conducted

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using the raster calculator tool, applied to all land cover data within the study period. The years (x) were reclassified into numerical values, with 2017 designated as Class 1 and consecutively numbered up to 2024 as Class 8, to facilitate temporal analysis. The land cover categories (y) were also reclassified: Built-up Area is classified into the smallest class value, Class 1; Bare Ground as Class 2; Crops as Class 3; Flooded Vegetation and Rangeland as Class 5; and Trees as Class 6, the highest class. This analysis encompassed a total of 8 time steps (n = 8) covering the period from 2017 to 2024.

$$m = \frac{n \cdot \Sigma(x \cdot y) - \Sigma x \cdot \Sigma y}{n \cdot \Sigma x^2 - (\Sigma x)^2}$$

A negative slope signifies a decline, such as the transformation of vegetation into built-up areas, commonly referred to as urban expansion. Conversely, a positive slope indicates an increase, such as the conversion of built-up regions into vegetated areas, referred to as urban decline or forest infiltration. A slope approaching zero suggests stability, with no significant changes. This method helps capture the dynamics of land cover change, revealing trends in urban expansion and land use stability across the study area. In this study, Simple Linear Regression (SLR) was chosen to analyze land cover changes over time, with time as the independent variable and land cover class as the dependent variable. The primary aim is to examine how land cover evolves temporally, without considering spatially dependent factors that could complicate the analysis. SLR is well-suited for identifying broad, overall patterns in land cover change over time, offering a straightforward and efficient approach. We do not hypothesize spatially varying relationships, and as such, more complex spatial regression models like Geographically Weighted Regression (GWR) or Spatial Autoregressive Models (SAR), which are designed to capture spatial heterogeneity, would not provide additional insights. Since our study focuses on capturing temporal trends, the added complexity of spatial models would not enhance the understanding of land cover changes but could complicate interpretation. Therefore, SLR is the most appropriate method for this study, allowing for a clear and interpretable analysis of land cover changes over time without unnecessary complexity.

Transportation factors that influence the development of the DIY region are analyzed using main road network data obtained from the Geospatial Information Agency, as well as transportation facilities, including airports, Helipads, Railway Stations, and Bus Terminals, sourced from Google Maps. This data provides insight into how accessibility from main roads affects city expansion and population movement. Tourist attraction data is taken through Google Maps scraping, which includes the name, category, rating, number of reviews, and spatial position of tourist attractions around DIY, especially those related to cultural tourism, such as Borobudur Temple, Prambanan Temple, and Mount Merapi. This data is used to map the concentration of tourist attractions in DIY, as well as identify how the presence of these tourist attractions is related to changes in land use and city expansion. The data used in this study have been summarized and can be accessed on the following page: https://www.google.com/maps/d/u/0/edit?mid=1jTTWUi5nDDNeSy-lOyejgWpLZEMrlII&usp=sharing.

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Using data from Google Maps and spatial analysis, this study aims to describe the impact of tourism objects and transportation on land cover changes, as well as the dynamics of urban expansion related to these factors (Eusébio, 2023; Mathayomchan & Sripanidkulchai, 2019; Suadaa, 2023). The results of this spatial analysis provide an overview of the impact of transportation infrastructure and tourism object concentration on urbanization and urban sprawl patterns in DIY.

3. RESULTS AND DISCUSSION

Land cover changes between 2017 and 2018 occurred in every city and district, showing a pattern of sprawl land conversion, particularly in peri-urban areas adjacent to the city center, as shown in Figure 3. Hotspots of urban sprawl were identified in the northern and southwestern parts of Yogyakarta City (YK), including Sleman Regency, a part of Kulon Progo Regency (KP), and a part of Bantul Regency (BT). Land cover changes tend to align with the presence of transportation infrastructure in the DIY. This indicates a significant relationship between land conversion and the accessibility and development of transportation infrastructure in the DIY province. Transportation accessibility and the development of Yogyakarta International Airport (YIA), located on the west coast of Kulon Progo, appear to be the main drivers of this transformation, which is closely related to the growth of the tourism and housing sectors. The spatial analysis conducted reveals that this land conversion not only alters the land's function but also has an impact on the social, economic, and environmental dynamics in this province.

Kulon Progo has experienced significant land cover changes driven by the development of key infrastructure, particularly the construction of the Yogyakarta International Airport (YIA) and the Solo-Yogyakarta-YIA toll road. The construction of YIA, which began in 2017 and became operational in 2020, has catalyzed the transformation of agricultural land into urban areas. These developments have had a profound impact on the region, notably resulting in a decline in agricultural land and an increase in built-up areas. According to a study by Jauhari et al., (2024), between 2013 and 2021, agricultural land in Kulon Progo decreased by approximately 14%, while built-up areas and bare land expanded significantly. This shift is part of a broader trend of increasing urbanization, with the construction of infrastructure facilitating the conversion of agricultural land for non- agricultural uses, such as residential and commercial developments.

The concept of an aerotropolis—a city structured around the airport—has further accelerated this transformation. As a result, dryland agriculture has been particularly impacted by these changes. The rate of built-up area growth in Kulon Progo has more than doubled, increasing from 55.35 hectares per year between 2010 and 2015 to 69.83 hectares per year between 2015 and 2020 (Litasari et al., 2022). The spatial distribution of this growth shows a clear trend of urban expansion moving from the northwest to the southwest, closely following the airport's location. This shift in land use underscores the importance of careful spatial planning to prevent further environmental degradation and to balance the demand for urban growth with the preservation of agricultural land and natural resources in the region. Effective management of this land conversion is crucial to ensure the region's sustainability and food security as urbanization continues to accelerate.

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Bantul has undergone significant changes in land cover, particularly in areas bordering Kulon Progo to the west, where urban sprawl has led to the conversion of agricultural lands into residential and commercial zones. However, the eastern part of Bantul, which borders Gunungkidul, has remained largely unaffected by urban expansion due to the high slopes of the mountains, which restrict development. Urban growth in the northern areas of Bantul, near Yogyakarta City, has been minimal, as most of the land in this region is already classified as built-up area. Consequently, urban expansion has spread predominantly towards the west, reflecting the typical pattern of urban sprawl in the province. This expansion is closely linked to improvements in transportation infrastructure, which have facilitated access to previously more rural areas, increasing land conversion rates.

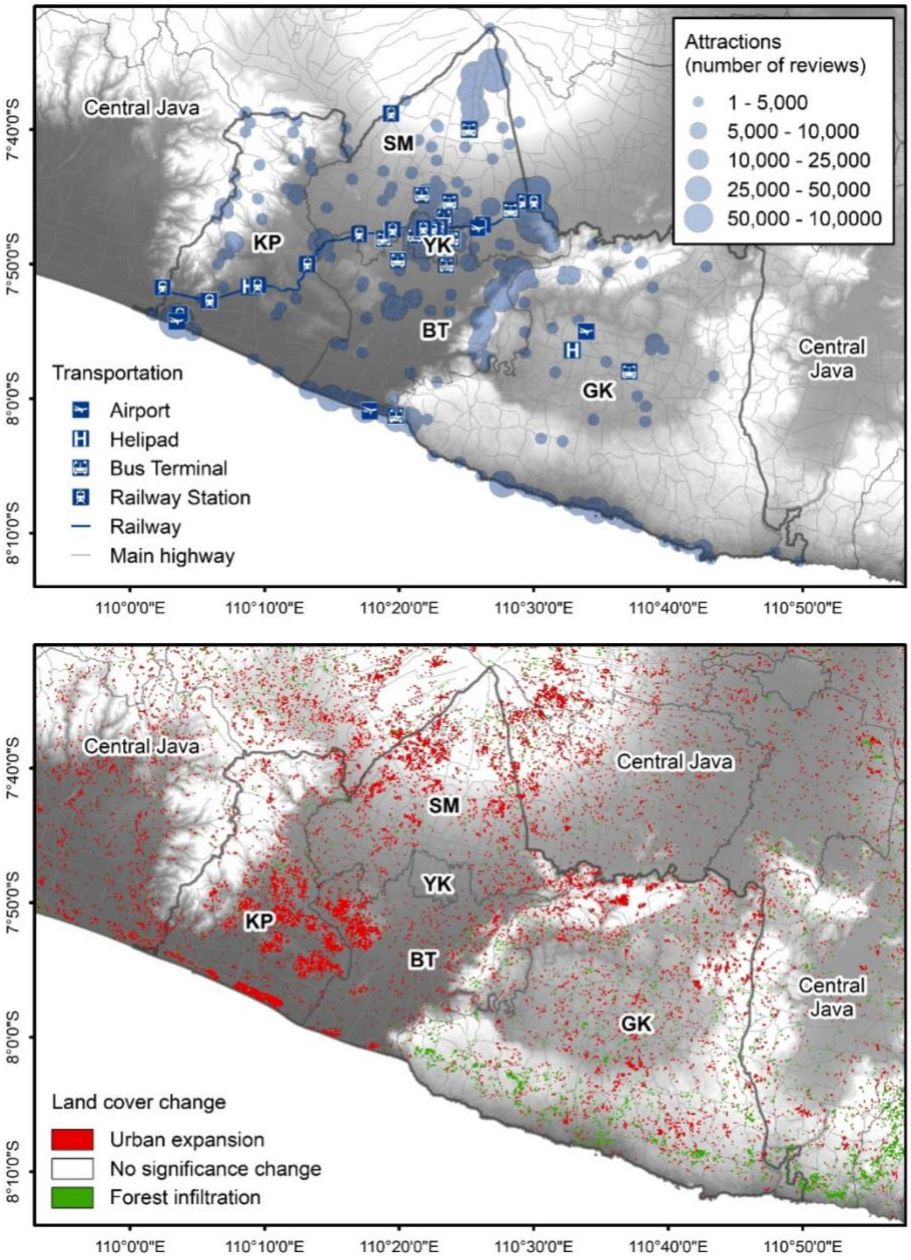

Figure 3. Distribution of transportation and attractions in DIY land cover change

The southern coast of Bantul has experienced particularly dramatic land cover changes, primarily driven by the expansion of shrimp farming. Mangrove areas and sandy soils have

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been converted into shrimp ponds, significantly altering the coastal landscape. Between 2007 and 2015, this conversion rate notably increased, highlighting the shift from natural coastal ecosystems to industrial aquaculture. A suitability analysis for land use in Bantul shows that a substantial area, around 634.82 hectares, is suitable for shrimp farming. However, this shift has come at the cost of reducing areas suitable for mangrove associations and agriculture, which has significant implications for biodiversity and local agriculture (Afsholnissa et al., 2019).

Additionally, the urbanization in Sewon and Kasihan districts has led to the conversion of agricultural land for non-agricultural uses, reducing the protected agricultural land from 14,407.50 hectares to 12,831 hectares (Budiyono et al., 2024). This reduction in agricultural land highlights the challenges of balancing urban growth with sustainable agricultural practices. Moreover, the carrying capacity of agricultural land is a growing concern, as unchecked development could lead to further environmental degradation (Prasetya et al., 2023).

Sleman, as a buffer district of Yogyakarta City, exhibits significant changes in its eastern and western parts, which are influenced mainly by shifts in residential land use. The Ngablak, Rejodadi, and Ngembesan areas, located near Kapanewon Gamping, close to the city center, have experienced the fragmentation of agricultural land into residential areas, accompanied by rapid urbanization in the urban fringe of Yogyakarta City. Since 2018, many cases of agricultural land and yards being converted into residential areas have been reported (Wahyuti et al., 2023).

The area in the north of Sleman, around East Kaliurang, has also experienced significant changes in land cover. A combination of tourism pressure, local economic growth, and infrastructure development influences changes in land cover. Some of the new tourist attractions built since 2017 include The Lost World Castle, Agrowisata Bhumi Merapi, Suraloka Interactive Zoo, Heha Forest, and the Plunyon Kalikuning Bridge.

Based on the land cover change map, Yogyakarta City has not experienced significant urban expansion or forest infiltration in recent years. The land cover in the city has remained primarily as built-up areas, which have been consistently developed even before 2017, leaving little room for significant changes in land use. This is visually represented in Figure 2, where no red (indicating urban expansion) or green (indicating forest infiltration) areas are observed within the city. The already established infrastructure and attractions, concentrated in the city center, have contributed to stable land cover, as there has been little need for further land conversion within the city limits.

Furthermore, studies indicate that Kota Yogyakarta has a high percentage of built-up areas, with approximately 85% to 93.3% of the land being developed, resulting in limited space for green areas (Arif & Nayan, 2022; Widiyastuti et al., 2020). This high level of urbanization has been primarily driven by the expansion of transportation infrastructure, such as the New Yogyakarta International Airport (NYIA), which has stimulated further urban development in surrounding areas, including Sleman and Bantul (Sidiq et al., 2024; Sukri et al., 2022). Additionally, the presence of numerous universities in the city has significantly influenced land conversion patterns, particularly in the peri-urban areas, as the demand for housing, services, and commercial spaces has grown to accommodate the expanding student population (Gunawan et al., 2023b). Despite the continued growth of the surrounding areas,

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the central core of Yogyakarta remains highly developed, with limited potential for further significant changes in land cover within the city itself.

Gunungkidul has not experienced many significant urban expansions, as the development in this area is more diffuse compared to other regions in DIY. While urban sprawl is visible, particularly along the border of Yogyakarta and in the northern areas bordering Central Java, these changes remain scattered and do not form concentrated urban growth areas. The coastal region, however, has shown signs of forest infiltration, with land cover shifting towards vegetation. This is particularly evident in the karst landscape of Gunungkidul, which naturally limits the development of urban environments due to its hilly and mountainous terrain, making it less suitable for large-scale residential or commercial development. These geographic constraints have limited the expansion of built-up areas.

Gunungkidul's coastal areas are now recognized as emerging tourism destinations, with significant potential for eco-tourism due to their scenic beauty. Despite the growth of tourism-related infrastructure, easy access from Yogyakarta has not significantly altered the land cover towards urban development, mainly due to the topographic limitations of the region. However, the government's reforestation programs, particularly in Bleberan Village, have led to notable changes in land cover. The implementation of community forestry programs has contributed to an increase in forest cover and enhanced carbon storage, with positive socio-economic outcomes for the local community. Between 1999 and 2018, the community forestry permit had a significant influence on land cover dynamics, supporting both environmental sustainability and economic development in the region (Sadono et al., 2020).

The karst topography of Gunungkidul also poses challenges due to its susceptibility to droughts, which are further exacerbated by climate and hydrogeological factors. To address these issues, adaptation strategies such as planting drought-resistant crops, adopting conservation agriculture, and promoting organic farming are being encouraged. These practices not only help conserve water but also improve soil health, creating a more resilient agricultural system in the face of climate change (Putri et al., 2024). Additionally, the development of agroforestry systems that integrate trees with crops and livestock is recommended to enhance biodiversity and provide additional income sources for local farmers, helping to further stabilize the region's land cover amidst environmental pressures

Overall, in DIY, significant land cover changes have occurred due to economic growth and improved transportation infrastructure, particularly in Sleman and Bantul. Urban sprawl has led to the conversion of agricultural land into residential and commercial areas, accelerated by the construction of key infrastructure, such as the New Yogyakarta International Airport (YIA). The expansion of tourism infrastructure and the growing population have also contributed to changes in land use, increasing pressure on the environment, and leading to land fragmentation. These shifts in land cover highlight the importance of meticulous spatial planning in managing urban growth and protecting the environment, particularly in areas with sensitive geographic features, such as volcanic slopes and coastal zones.

The impact of urbanization, coupled with tourism development and volcanic activity, has significantly altered Yogyakarta's landscape. Agricultural land has been replaced by urban and tourism developments, resulting in the loss of vegetation and a decline in agricultural space, with consequences for both biodiversity and ecosystem services. These ongoing land

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use changes underscore the urgency of implementing targeted planning policies that can guide sustainable development, balancing the need for growth with environmental conservation in the face of rapid urbanization and environmental challenges.

The findings of this study highlight the significant role of economic growth, infrastructure development, and tourism in driving urban sprawl in Daerah Istimewa Yogyakarta (DIY). The construction of Bandara Internasional Yogyakarta (YIA) and the improvement of road networks have facilitated easier access to areas previously considered more remote, particularly in Kulon Progo and Sleman, contributing to the conversion of agricultural land into residential and commercial spaces. This trend is consistent with the classic dynamics of urban sprawl, where enhanced transportation infrastructure leads to increased development in peri-urban areas (Rozano & Yan, 2018). In addition, the expansion of tourist attractions, such as developments in Kaliurang and Sleman, has accelerated the transformation of rural land into urban spaces, further intensifying urban sprawl. The proximity to tourism infrastructure and urban centers has made regions like Bantul more attractive for residential development. Areas such as Kecamatan Pajangan have witnessed significant land use changes due to their accessibility via key transport routes, including the Ring Road and Jalan Wates (Brody et al., 2006).

The impact of tourism on land use changes is particularly profound in regions such as Kulon Progo and Gunungkidul, where tourism and agriculture are closely intertwined. The development of coastal resorts and the "Segitiga Emas Pesisir" program in Kulon Progo has led to a shift in land use from agriculture to tourism-related infrastructure, resulting in the conversion of coastal and agricultural lands into commercial zones and resorts (Abdurrahman et al., 2025). Similarly, tourism development in Gunungkidul has led to the establishment of tourist resorts, some of which have encroached on environmentally sensitive areas, such as Pantai Baron. These findings underscore the need for careful spatial planning and regulation to manage tourism-driven development and prevent further environmental degradation. Given these dynamics, the study highlights the importance of implementing policies to reduce sprawl. Strategies such as smart growth, urban growth boundaries, and targeted infrastructure investments can help manage the rapid urban expansion, ensuring that development is directed toward more sustainable and ecologically sensitive areas (Knaap & Talen, 2005). Additionally, education and outreach programs are essential for raising awareness about the negative impacts of sprawl and promoting more sustainable development practices throughout DIY.

4. CONCLUSIONS

This study reveals that urban expansion and land cover changes in Daerah Istimewa Yogyakarta (DIY) province have been significantly driven by economic growth, transportation infrastructure development, and the growth of tourist attractions. The New Yogyakarta International Airport (YIA) and improved road networks have facilitated the conversion of agricultural land into residential and commercial areas, especially in Sleman and Bantul. The increasing demand for housing and services, combined with the expansion of tourism infrastructure, has further accelerated land-use changes, contributing to urban sprawl and land fragmentation. Despite the challenges posed by urban growth, the study emphasizes the importance of spatial planning policies in managing this growth while ensuring environmental

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sustainability, particularly in sensitive areas such as volcanic slopes and coastal zones. The impact of tourism on land cover changes is evident, particularly in areas such as Kulon Progo and Gunungkidul, where the development of coastal resorts and tourism-related infrastructure has led to a shift in land use from agriculture to commercial and residential zones. These changes, along with rapid urbanization, underscore the need for a more sustainable approach to urban growth. By implementing sprawl reduction policies, such as smart growth and urban growth boundaries, and focusing on targeted infrastructure investments, it is possible to guide development in a way that preserves the region's cultural heritage and natural resources. This study offers crucial insights for policymakers to develop balanced urban development strategies, ensuring that the future growth of DIY is both socially and environmentally sustainable.

5. RECOMMENDATIONS

This study identifies urban expansion and land cover changes at a macro level, the analysis conducted tends to be general at the provincial level and only focus on physical condition on the area. Further studies on a more specific area involving aspatial aspects such as socio-population characteristics, regional economy, and political and institutional conditions can be conducted to see the phenomenon and driving factors of urban expansion in more detail.

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