

RESEARCH ARTICLE



The Impact of National Strategic Project Development Yogyakarta International Airport on Land Use and Land Cover Dynamic

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ABSTRACT

Land use has been demonstrated to exert a considerable influence on human life, ecological functions, and environmental sustainability. The objective of this paper is to map changes in land use and land cover (LULC) patterns and directions of built-up land development around Yogyakarta International Airport. The data source utilised is Pleiades, and image interpretation is conducted visually to generate a LULC map. Land use and Land Cover change data are obtained through the process of overlay. The average nearest neighbour is known to determine the distribution pattern, while the standard deviation ellipse is understood to determine the direction of built-up land development. The overlay results indicate substantial changes in LULC, with a decrease in mixed plantations of 528.2 ha and in agricultural land of 112.7 ha. Conversely, there was a substantial augmentation in residential areas, encompassing 29.4 ha, and service and trade areas, amounting to 11.2 ha. The findings indicate that the ratio of built-up land patterns in 2014 was 0.63, in 2018 it was 0.59, and in 2022 it was 0.33; with this value, the built-up land pattern is clustered. The research findings indicate a shift in the direction of built-up land, initially orienting eastward and subsequently shifting to the northeast, in a parallel configuration to the arterial road. These findings demonstrate the importance of monitoring LULC dynamics for controlling land use and developing equitable and sustainable land use policies.

Introduction

Land use and land cover (LULC) have been identified as pivotal factors in the maintenance of environmental equilibrium, carbon reserves, ecosystem sustainability, and socio-economic life of communities [1–4]. In addition, Padmini et al. and Ma et al. [5,6], there is a strong correlation between rapid changes in LULC and population growth, development, economic growth, and human activities. Uncontrolled land use changes have the potential to result in excessive urban expansion, trigger climate change, and various disasters [7–10], and if occurring in rural areas, can result in increased rural poverty and reduced food security [11,12]. The issue of land use in rural areas is a critical concern in the context of rural development [13], and this condition also applies to the study area. The development of Yogyakarta International Airport as one of the national strategic projects located in Kulon Progo District has had a profound impact on the transformation of rural areas into urban areas, thereby attracting industries, warehouses, trade, services, and residential areas [14,15]. These significant economic activities have resulted in increased land use changes, which have the potential to exert adverse effects on communities and the environment [16].

According to data from the Regional Disaster Management Agency [17], development of airport infrastructure has an impact on land-use change, causing flooding disasters in several villages. In addition, Sholikah et al. and Tikuye et al. [18,19] also shows that the reduction of agricultural land (rice fields and fields) has led to a decrease in agricultural production, which is feared to threaten the sustainability of the

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livelihoods of farmers/agricultural communities in the study area. In this case, a detailed analysis of the impact of airport development on land-use change is required. This data can be used as a basis for integrated spatial planning so that the development of the airport aerotropolis area can achieve environmental, socio-economic, and cultural sustainability [20,21].

Monitoring land cover change constitutes a mechanism for controlling land cover change [22–24], compiling LULC predictions, forming the basis for disaster mitigation, and formulating sustainable land use management policies [22–25]. A plethora of efforts have been made to monitor alterations in land use. Nevertheless, certain endeavours persist in relying on low-resolution satellite imagery [18,19]. Whilst these images have the advantage of covering a wider area, they also have lower accuracy [26–28] and less detailed classification results [2]. The absence of details in LULC change monitoring is a matter of concern, as it may result in high land use inconsistencies, spatial conflicts, and various environmental damages [29,30]. A review of the extant literature reveals that previous studies have limitations in terms of data accuracy and have not analysed patterns of land use change distribution [17,31]. Conversely, both the accuracy and the patterns of LULC change are pivotal in determining regional growth patterns and in the control of uncontrolled urban sprawl [32].

The lack of detailed analysis of the impact of infrastructure development on LULC change is feared to lead to increased land-use change and reduced agricultural yields, which may threaten food security and the sustainability of community livelihoods. The lack of detailed multi-temporal land use data is also feared to have implications for the imprecision of land use regulation and control policies. This research aims to fill the gap in previous research [18,19] to produce a land use map with a high level of accuracy and a more complete classification of uses, where the analysis of land use dynamics is adjusted per phase, namely before, during, and after airport construction. This research also complements the research of Zhang et al. [13]; Kamruzzaman et al. [31] in relation to the preparation of distribution patterns and changes in the direction of land use patterns as one of the bases for the formulation of spatial and land use policies [32]. The objectives of this study are threefold: to provide multi-temporal land use data with greater precision and accuracy, to analyze LULC change patterns, and to provide information on the impact of large-scale development carried out through national strategic projects on land use dynamics. It is anticipated that this data and information will underpin the formulation of comprehensive land use policies and planning, representing a pivotal component in achieving environmental sustainability and mitigating the adverse effects of natural degradation and climate change.

Materials and Methods

Study Area

This research was conducted in the Temon Sub-district, Kulon Progo Regency, Yogyakarta Special Region (Figure 1), which is affected by the development of Yogyakarta International Airport (YIA) and its supporting infrastructure.

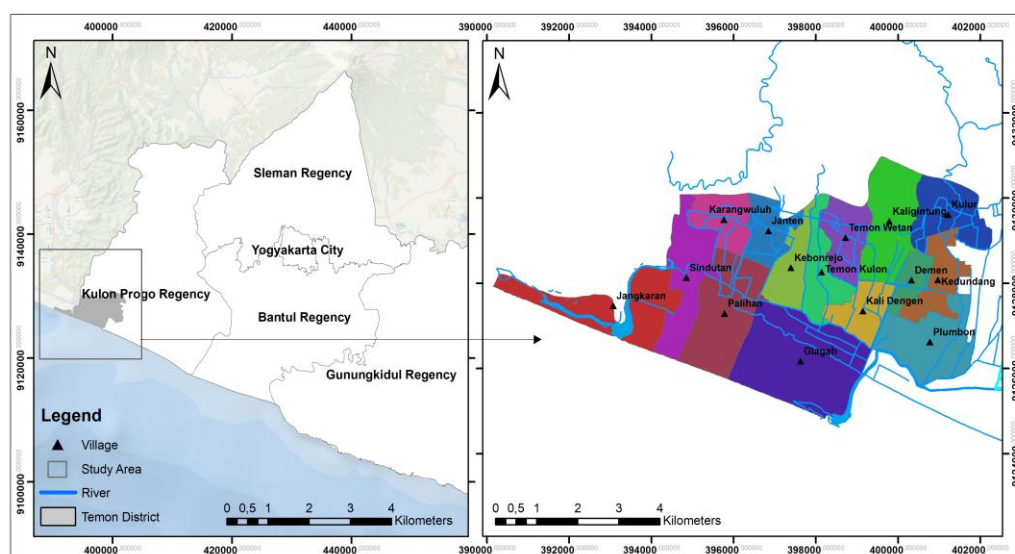


Figure 1. Study area, Temon Sub-district, Kulon Progo Regency, Special Region of Yogyakarta, Indonesia.

Site selection is crucial since YIA is one of the largest infrastructure developments or megaprojects of Indonesia's national strategy project, with a land acquisition area of 578 ha. The construction was carried out in a rural area dominated by agricultural land, with the community mostly working as farmers. The construction of the airport and its supporting infrastructure triggered the growth of various trade and service facilities and encouraged the emergence of new settlements. The limited detailed monitoring of land use changes is feared to cause urban sprawl and lead to irregularities in land use. A description of the study area is presented in Figure 1.

Materials and Data Analysis

The data presented in this study encompasses Pleiades imagery captured in 2014, before the commencement of airport construction, on 20 September 2014. Pleiades images are very high-resolution images that researchers widely use to produce detailed-scale maps [33,34]. The land use classification in this study includes 14 types; therefore, it is complete and more detailed. The visual interpretation method was chosen because it can produce more detailed and accurate land use classifications [35], even though it takes longer and requires the accuracy of the interpreter [36]. Accuracy testing was conducted to ascertain the veracity of the interpretation of land use in relation to actual conditions in the field. The samples in this study were obtained using the Slovin formula, which yielded 120 sample points. The sample was determined using stratified random sampling, thereby ensuring representation of the number and type of land use within the sample.

The interpretation of Pleiades imagery, which demonstrated its reliability, can produce land-use maps for 2014, 2018, and 2018. To address the primary research objective of mapping changes in land use from 2014 to 2018 and 2018 to 2022, an overlay of maps was performed. The overlay process yields two products: a land-use change map and a multitemporal land-use change matrix. The methodology employed in the generation of multitemporal land-use patterns involves the implementation of average nearest neighbor analysis, which can be delineated as follows:

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

$\bar{D}_O$ = The observed average distance of each feature and its nearest neighbour

$\bar{D}_E$ = The expected distance is the average distance between neighbours in a hypothetical random distribution.

To find out the values of $\bar{D}_O$ dan $\bar{D}_E$ the following formula can be used:

$$\bar{D}_O = \frac{\sum_{i=1}^n d_i}{n} \quad (2)$$

$$\bar{D}_E = \frac{0.5}{\sqrt{n/A}} \quad (3)$$

n = Total number of features

A = The area that encompasses all the features or values of a specified area

Furthermore, to ascertain the direction of the distribution pattern of built-up land change, a standard deviation ellipse analysis was utilized. Consequently, the direction of multitemporal built-up land growth was analyzed to determine the center point and direction of the built-up land growth pattern. A research flowchart, which delineates the data sources, analysis process, and research results/outputs, is presented in Figure 2.

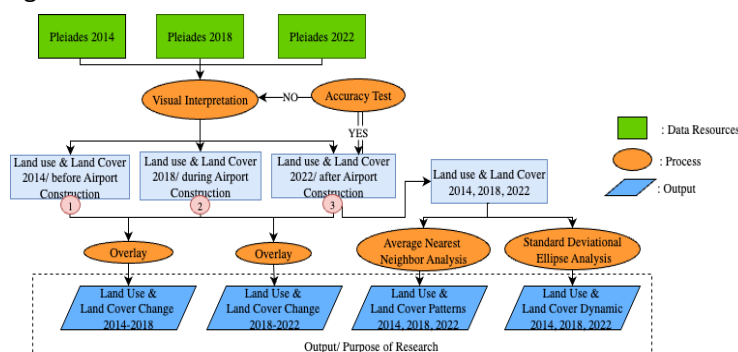


Figure 2. Research flow diagram.

Results

Land Use and Land Cover Accuracy

Accuracy testing was conducted to ascertain the validity of the land use interpretation results in relation to actual field conditions. The samples used in this study were obtained using the Slovin formula, resulting in 120 sample points. The sample points were determined using stratified random sampling, ensuring the representation of all samples according to their LULC types. Based on the accuracy test in the field, there were errors in 9 out of 120 sample points. Based on the analysis using the confusion matrix, the accuracy of the interpretation of the results was 92.5%. This value indicates that the results of the visual interpretation carried out using Pleiades images were classified as high (United States Geological Survey/USGS).

Multitemporal Land Use-Land Cover Changes

The results of land use and land cover interpretation in 2014 showed that the Temon Sub-district is a rural area where land use/land cover is dominated by agricultural land, mixed plantations, and low-density settlements, as shown in Figure 3a. The construction of the airport has changed the land use by at least 578 ha for the airport and 10 ha for resettlement for affected residents. The construction of airports as aerotropolis areas has triggered an increase in land conversion, including trade and services, hotels and inns, and new settlements. The results of the interpretation of land use and land cover before (2014), during (2018), and after the YIA construction (2022) are presented in Figure 3.

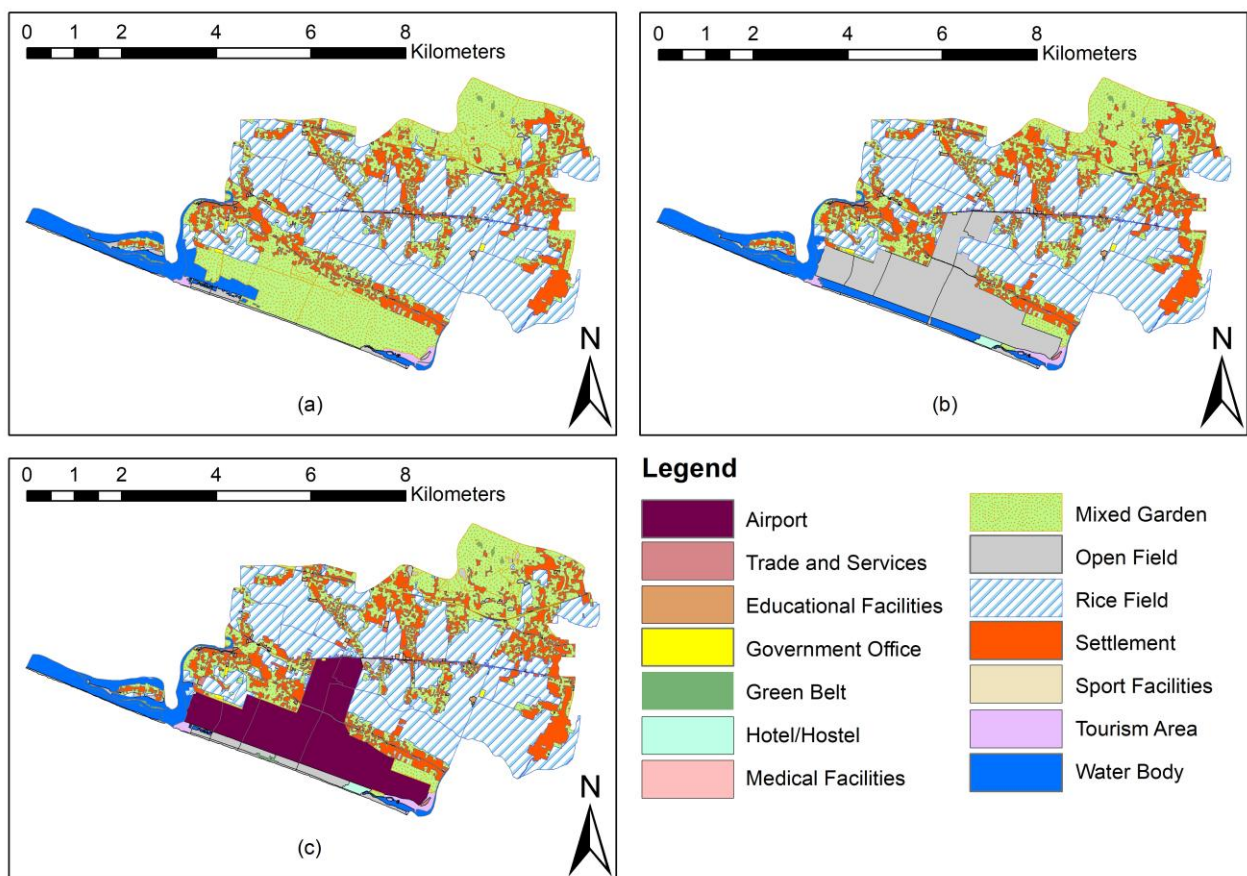


Figure 3. Land use and land cover map; (a) 2014 before construction YIA, (b) 2018 during construction YIA, (c) 2022 after construction.

The findings of this study show that the development of Yogyakarta International Airport has resulted in significant changes in the location of the airport and the surrounding area. The findings of the study show that before the construction of the airport in 2014, agricultural land was still very extensive, reaching up to 1,434 ha (39%), and mixed plantations were also very extensive, reaching 1,331 ha (36%). The results of the analysis show that in 2014, almost 75% of the study area was a source of livelihood for the community in the form of rice fields and mixed gardens/fields. However, with the establishment of the airport location in the

Temon Sub-district, followed by land clearing, some areas in the sub-district experienced massive land conversion. The process of land clearing and the start of YIA construction in 2018 caused a decrease in mixed plantations; in this period, only 800 ha (22%) remained, and agricultural land covered 1,375 ha (37%). After the construction and operation of the airport, land use change continued, especially on the north side of the airport entrance and along the national road. During this period, agricultural land continued to decrease by 1.5% (55 ha). The airport's existence catalyzes the growth of trade and service areas, which expanded by 11.2 ha between 2014 and 2022. Additionally, hotels and guesthouses that were previously absent have been developed, resulting in an area of 14.07 ha being built by 2022. Detailed data on land use in the study area for 2014, 2018, and 2022 are presented in Table 1.

Table 1. Land use and land cover area, percentage in 2014, 2018, and 2022.

Land-cover and land-use type	2014		2018		2022	
	ha	%	ha	%	ha	%
Airport (AP)	0	0	0	0	569.93	15.65
Trade and Services (TandS)	16.23	0.44	24.82	0.68	27.45	0.75
Educational Facilities (EF)	8.79	0.24	8.39	0.23	8.39	0.23
Government Office (GO)	8.18	0.22	8.27	0.23	8.28	0.23
Green Belt (GB)	2.03	0.055	2.029	0.055	24.24	0.67
Hotels/Hostels (HT)	0	0	9.39	0.25	14.07	0.39
Medical Facilities (MF)	0.74	0.02	1.13	0.031	2.20	0.06
Mixed Plantations (MP)	1,331.26	36.47	800.50	21.93	803.09	22.06
Open Field (OF)	73.08	2.001	629.60	17.25	87.89	2.41
Rice Fields (RF)	1,433.65	39.28	1,375.30	37.67	1,320.99	36.29
Settlements (ST)	528.33	14.47	555.84	15.23	557.75	15.32
Sport Facilities (SF)	2.95	0.08	2.94	0.08	2.95	0.08
Tourism Area (TA)	22.46	0.61	22.99	0.63	23.31	0.64
Water Bodies (WB)	222.15	6.086	209.25	5.73	189.27	5.20

Table 1 shows that airport construction not only resulted in the loss of rice fields but also resulted in a reduction in mixed gardens and fields. The results of this study show that airport development not only biophysically changes the land use in the study area. However, the reduction in arable land has implications for the livelihoods of people who are largely dependent on the agricultural sector. It is feared that this condition will lead to a reduction in income, which may increase poverty. The results of the overlay analysis of the land use and land cover maps in the period between 2014 and 2018, as shown in Figure 4a, show that the airport development in Temon Sub-district not only changes the land use in the area where the airport is built. The research results show that during the period 2018–2022, land use change also occurred massively in the areas along the national road and the southern causeway. The results of this study show that the pattern of land use change occurring in the study area, particularly around the road network, is characterized by a non-clustered pattern. The results of further analysis show that the random pattern of change occurs mostly in rice fields. The spatial pattern of land use and land cover change that occurs can certainly lead to land fragmentation, further threatening the existence of agricultural land.

Legend

- Changed
- Constantly



Figure 4. Map of land use and land cover change in Temon Sub-district: (a) 2014–2018 and (b) 2018–2022.

Figure 4 shows that the pattern of land use and land cover change between 2014–2018 and 2018–2022 is quite different. In the period 2014–2018, most of the areas that changed were in the form of land clearing for airport development in the lower part of the study area, while in the upper part, there were also some changes intended for the relocation of residents. In the period 2018–2022, the pattern of changes in the lower part was characterized by the development of the airport area, with some changes also occurring around the airport. To find out in detail which types of land use changed in each period, Table 2 and Table 3 present the results of overlaying multi-temporal land use maps. Table 2 is a matrix showing the types of land use that changed from 2014 to 2018, while Table 3 is a matrix explaining the types of LULC changes from 2018 to 2022.

Table 2. Matrix of land use and land cover changes period 2014–2018 in Temon Sub-district.

Land use and land cover type	Year 2018 (ha)												
	Trade and services	Education facilities	Government office	Green belt	Hotel/ hostel	Medical fac.	Mixed garden	Open field	Rice fields	Settlements	Sport fac.	Tourism area	Water bodies
Trade and services	16.23	0	0	0	0	0	0	0	0	0	0	0	0
Educational fac.	0	8.40	0	0	0	0	0	0	0	0	0	0	0
Government office	0	0	8.2	0	0	0	0	0	0	0	0	0	0
Green belt	0	0	0	2.03	0	0	0	0	0	0	0	0	0
Hotels/ hostels	0	0	0	0	0	0	0	0	0	0	0	0	0
Medical facilities	0	0	0	0	0	0.05	0	0	0	0	0	0	0
Mixed garden	1.29	0	0	0	8.15	0	800.5	434.9	0	41.62	0	0	15.41
Open field	1.44	0	0.10	0	0	0	0	51.88	0.19	3.33	0	0.41	0.67
Rice fields	0.24	0	0	0	0	0	0	79.85	1.34	0.42	0	0	0.13
Settlements	0.25	0	0	0	1.24	0	0	25.20	0	501.2	0	0	0
Sport facilities	0	0	0	0	0	0	0	0	0	0	0.15	0	0
Tourism area	0	0	0	0	0	0	0	0	0	0	0	0.90	1.48
Water bodies	0	0	0	0	0	0	0.2	42.11	10.48	0	0	0.08	173.9

Table 3. Matrix of land use and land cover changes period 2018–2022 in Temon Sub-district.

Land use and land cover type	Year 2022 (ha)													
	AP	T and S	EF	GO	GB	HT	MF	MP	OF	RF	ST	SF	TA	WB
Airport (AP)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trade and Services (TS)	0.00	25.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Education Fac. (EF)	0.00	0.00	8.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Government Ofc (GO)	0.00	0.00	0.00	8.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Green Belt (GB)	0.00	0.00	0.00	0.00	2.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hotels/Hostels (HT)	0.00	0.00	0.00	0.00	0.00	9.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Medical Facilities (MF)	0.00	0.00	0.00	0.00	0.00	0.00	1.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixed plantation (MP)	0.25	0.27	0.00	0.00	0.00	0.43	0.00	792	9.64	0.06	2.09	0.00	0.00	0.00
Open Field (OF)	546.86	1.92	0.00	0.00	2.76	1.97	0.90	1.85	74.23	0.00	0.92	0.00	0.00	0.46
Rice Field (RF)	21.2	0.51	0.00	0.00	0.00	0.11	0.17	0.09	3.12	1,352	1.30	0.00	0.00	0.45
Settlements (ST)	1.9	0.00	0.00	0.00	0.00	2.17	0.00	0.00	0.00	0.00	553.84	0.00	0.00	0.00
Sport Facilities (SF)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.95	0.00	0.00
Tourism Area (TA)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23	0.00
Water Bodies (WB)	0.00	0.00	0.00	0.00	19.5	0.00	0.00	0.36	0.76	0.00	0.00	0.00	0.32	188.36

Tables 2 and 3 present a comprehensive and detailed overview of the land use changes that occurred within the study area. The findings of this study demonstrate that trade and service LULC have undergone a significant increase in addition to airport development. In contrast, the previous land use type is predominantly rural, with some changes to infrastructure, trade, and service areas. The data presented in

the land use change matrix for the periods between 2014 and 2018 and 2018 and 2022 show a significant increase in built-up land growth, particularly in residential areas and trade and service areas. The construction of YIA airport impacts five villages: Jangkaran, Sindutan, Palihan, Kebonrejo, and Glagah. To gain a more detailed understanding of the land use change in each of these villages, a visual representation can be provided as Figure 5.

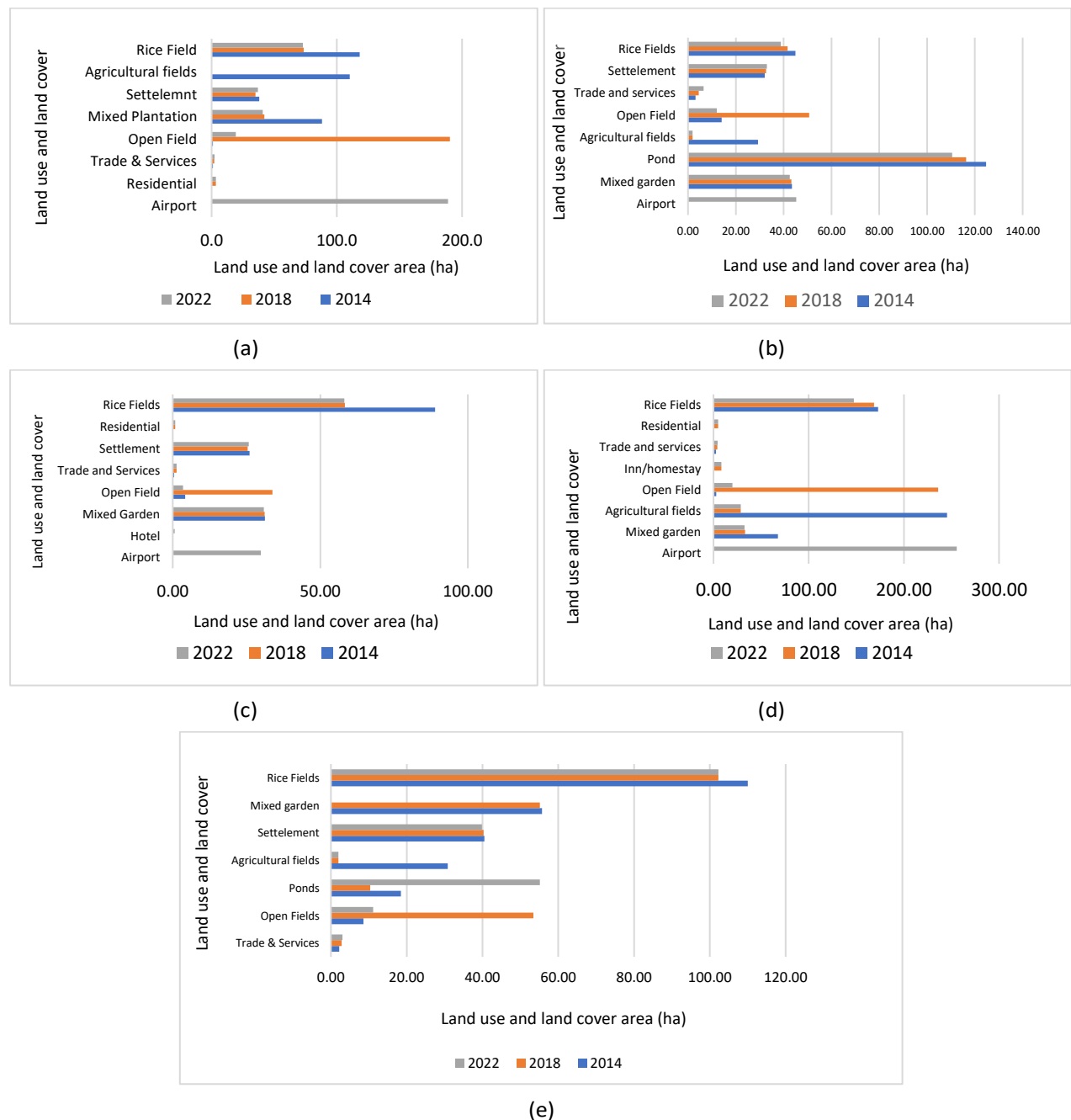


Figure 5. Land use and land cover change of villages affected by the construction of Yogyakarta International Airport: a) Palihan, b) Jangkaran, c) Kebonrejo, d) Glagah, e) Sindutan.

Based on Figure 6, the villages that experienced the highest decrease in agricultural land and rice fields were Glagah Village (agricultural land decreased by 216.8 ha and rice field land decreased by 25.5 ha), Palihan (agricultural land decreased by 110 ha, and rice field land decreased by 45 ha), and Sindutan (agricultural land decreased by 29 ha and rice field land decreased by 8 ha). The findings of this study indicate that the development of national strategic projects has changed most of the land use conditions of the 5 villages directly affected by YIA airport.

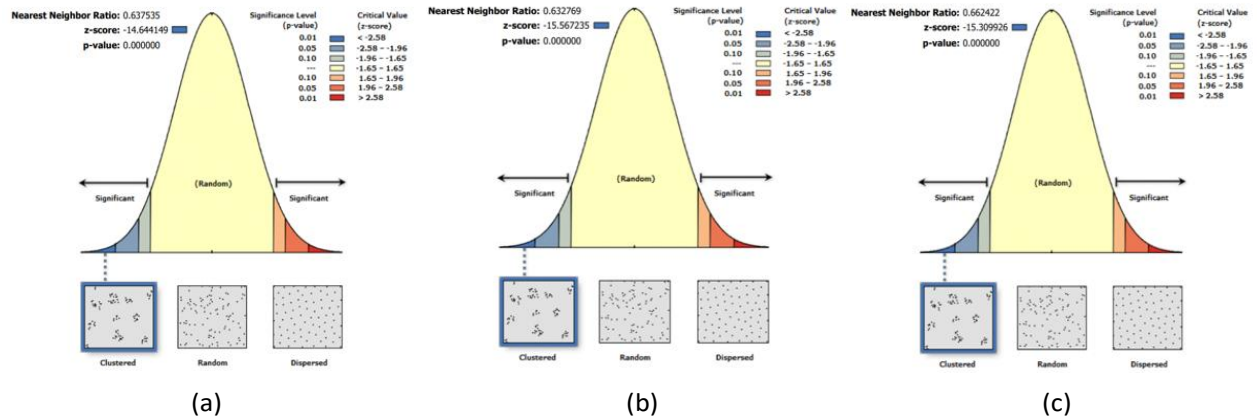


Figure 6. Distribution pattern of built-up land in Temon Sub-district with a clustered pattern in (a) 2014; (b) 2018; (c) 2022.

Changes in the Pattern and Direction of Built-Up Land Growth

The objective of the average nearest neighbour analysis is to ascertain the spatial aggregation characteristics of built-up land growth patterns that occur in rural areas both before and following the development of airport infrastructure. The results of the nearest neighbour analysis conducted in this study are presented in Figure 6, while the data on changes in significance values and the level of density/distance between built-up land are presented in Table 4.

Table 4. The nearest neighbor ratio of built-up land in 2014–2022.

Year	Coverage observation distance (m)	Expected average distance (m)	Nearest neighbor ratio	Z-value	p-value	Type
2014	90.72	142.92	0.63	−16.25	0	Clustered
2018	91.70	154.81	0.59	−18.17	0	Clustered
2022	43.67	128.51	0.33	−35.45	0	Clustered

The results of the analysis of the average nearest neighbor showed that the pattern of distribution of built land at the study site in 2014, 2018, and 2022 has a significant p-value of < 0.1 , so it was included in the clustered pattern. The results of this pattern analysis support the research of Salouw and Pramono [37] where clustered patterns are influenced by topography in the form of plains, fertile land, and the existence of agricultural land/rice fields around residential areas. The clustered pattern of built-up land growth in the study area is formed because it follows the geographical conditions of the area, where this area is a rural area with agricultural land that separates settlements from one another. Based on Figure 6 and Table 2, although the built-land pattern has the same shape, the significance value of the z value, the value of the nearest neighbor value, and the value of the coverage observation distance have decreased. The decrease in the three values shows that the distance between the central point of the built land is getting closer, and the level of built land density has increased.

In addition to examining the pattern of built-up land, this research also investigates the growth of built-up land. To ascertain the centre point data and spatial distribution patterns of the direction of built-up land use, a standard deviation ellipse analysis was conducted, with the results presented in Figure 7. The analysis of built-up land growth is a crucial element in understanding the patterns of growth that occur over time. The findings of this study can inform the formulation of land stewardship policies, the identification of key drivers that stimulate the expansion of built-up areas, and the establishment of a regulatory framework for the rate of built-up land growth.

The results of the analysis presented in Figure 7 demonstrate a shift in the centre of the standard deviational ellipse, which corresponds to the centre of gravity of the built land. In 2014, the centre of the standard deviation was located on the east side, while in 2022, the centre of the standard deviation ellipse shifted westward. The economic growth centre had a more significant influence on the change in the ellipse point in 2014 in Wates City. In contrast, by 2022, with the operation of YIA and the growth of economic activity, the central point shifted closer to the airport. This shift underscores the pivotal role played by the airport's regulatory influence on the expansion of built-up land from 2018 to 2022. Concurrently, the trajectory of

built land growth, as delineated by the ellipse line, underwent substantial alterations. In 2014, the direction of built-land growth exhibited a tilt towards the south and east. However, from 2018 to 2022, the direction of built-up land growth shifted towards the northeast, extending along the trajectory of the national road.

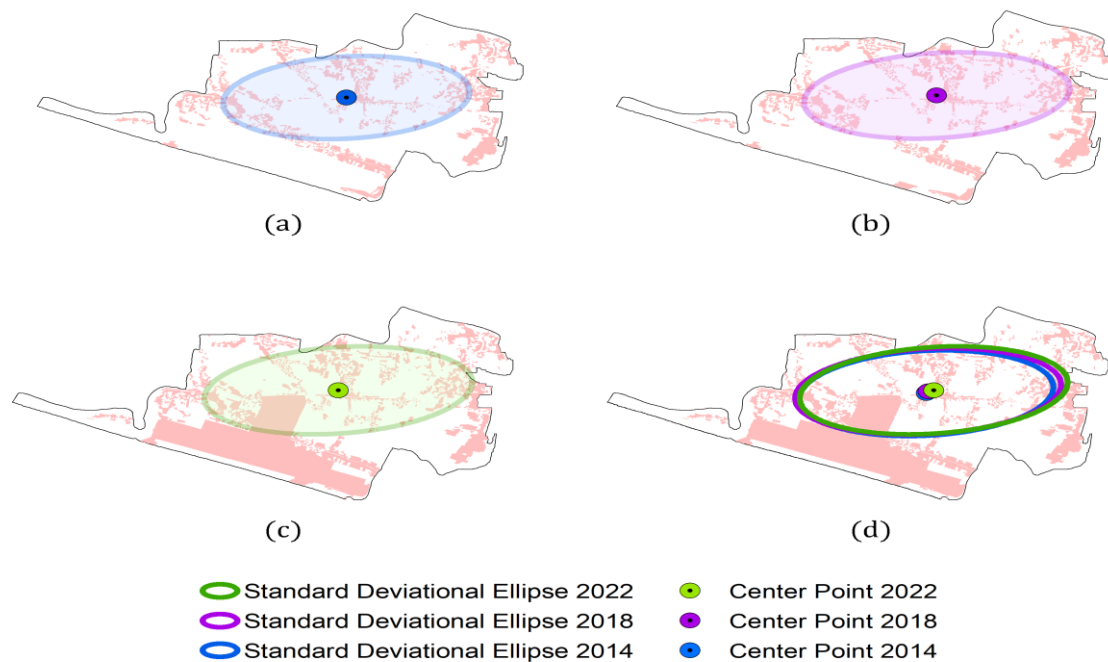


Figure 7. Standard deviational ellipse of the built-up land; (a) 2014, (b) 2018, (c) 2022, (d) changes in standard deviational ellipse in 2014, 2018, and 2022.

Discussion

The analysis of the impact of the development of the national strategic project of the YIA airport development produced several findings. Empirical findings demonstrate that there are significant spatial and temporal differences in the dynamics of land use between the 2014–2018 and 2018–2022 periods. The 2014–2022 period was characterised by a more significant alteration in land use and land cover, influenced by direct factors such as the development of the airport. In contrast, the 2018–2022 period witnessed a relative decline in changes to land use, with the influence of proximate causes, such as the pandemic, being minimal. Theoretically, the findings of this study corroborate those of Sisay et al. [38] in Africa, which state that policy/political factors on land use, including for development or agriculture, have a very dominant influence on the rate of land use dynamics. The present study's findings are consistent with the theory of land use dynamics proposed by Lambin and Geist [39], which asserts that proximate causes, such as agriculture and deforestation, play a pivotal role in shaping land use dynamics. The findings of this study align with the research conducted by Indrayati et al. [28], which demonstrates that land use dynamics are also influenced by factors related to road accessibility.

The present study provides further insights that build upon the findings of Kamruzzaman et al. [31] by demonstrating that land use patterns in airport areas are significantly influenced by spatial planning. However, the present study also indicates that these patterns are shaped not only by spatial planning but also by other factors, including spatial preferences, such as land needs, land suitability levels, and business opportunities. The intricate interplay between biophysical dimensions and political, socio-economic factors, characterized by a high degree of complexity, exerts a significant influence on the decisions made by the community, institutional entities, and governmental bodies concerning land use. This, in turn, gives rise to variations like land use across different geographical areas. Theoretically, the research findings demonstrate that the dynamics of land use, influenced by airport development, give rise to novel spatial functions that can exert an influence on shifts in the social, economic, and cultural conditions of the community. The results of this study serve to reinforce the research conducted by Suwanlee et al. [23], which demonstrates that changes in land use in rural areas do not solely result in alterations to the physical aspects/land cover. The decline in the function of mixed gardens, fields, and people's plantations as green open spaces results in a shift in land function from ecological space to commercial space.

The utilization of Pleiades imagery as one of the very high-resolution satellite images in this study facilitates the presentation of more detailed land use/land cover information, thereby complementing the findings of previous research conducted by Sholikah et al. [18]; Syafitri and Santosa [40], which was limited to the classification of land use in built-up land classes. The spatial resolution of this study provides a more detailed classification of built-up land, including settlements, trade and services, educational facilities, hotels, and so on. This detailed information is undoubtedly beneficial in planning the development of aerotropolis in more detail. Methodologically, this study contributes to the research of Almazroui et al. [41] by using Landsat imagery to map urban sprawl, though the latter study has a lower level of accuracy. The research findings demonstrate that the utilization of visually interpreted Pleiades imagery, in addition to its capacity to produce detailed types of land cover/use classifications, attains a high level of accuracy of 92%.

Empirical evidence from recent research indicates that the development of airports, expansion of trade and service areas, and the establishment of hotels and settlements have led to a decline in rice fields, fields, and mixed gardens, which serve as crucial sources of livelihoods for communities. The spatial pattern of built-up land growth, characterized by random occurrences on agricultural land, poses a growing threat to the existence of rice fields. The reduction in agricultural land within the study area has a discernible impact on the socio-economic aspects of rural areas, jeopardizing food security and the sustainability of livelihoods for agrarian communities. Moreover, the substantial decrease in vegetation cover, which the development of optimal green belts has not counterbalanced, has consequences for reducing water catchment areas, increasing urban heat, and increasing carbon emissions. The findings of this study corroborate several earlier studies conducted by Almeida et al. [42]; Humbatova et al. [43] that development oriented towards the economic sector has a negative impact on environmental damage. The study further contributes to the discourse on the formulation of national strategy projects in Indonesia, particularly in rural regions, where the assessment of land value is constrained to biophysical parameters. This limitation stems from an absence of a comprehensive framework that incorporates socio-economic, cultural, and environmental dimensions, consequently impeding the realization of sustainable community life and environmental stewardship.

The findings of this research provide a valuable contribution to the concept of aerotropolis area development, a topic that has been extensively researched by Kamruzzaman et al. [31]; Kasarda and Appold [21], the location of the aerotropolis area under study is predominantly in urban and suburban regions, resulting in the formation of a commercial or industrial area around the airport. In contrast, this research focuses on an airport situated in a rural area characterized by agricultural land and agrarian communities. The concept of planned aerotropolis development prioritizes the development of superior agricultural products. The research contributes to the feasibility of airports that not only produce regional economic benefits but also encourage local economic growth. The strategic and planned development of commercial areas, residential areas, agricultural land areas, local protected areas, and the establishment of corridors connecting different regions are identified as key factors in the success of aerotropolis area development.

Conceptually, this research serves to reinforce the findings of McNair [44] on the significance of environmental justice in the context of airport infrastructure development. The study emphasizes that the loss of vegetation cover due to the construction of YIA necessitates the implementation of policies to ensure an equitable environment. This can be achieved by increasing green open spaces and establishing local protected areas, particularly as a means of disaster mitigation (tsunamis, floods, abrasion). The challenges inherent in the development of this aerotropolis area are complex, particularly given the location of YIA in a rural area where most of the population is dependent on the agricultural sector. The geographical conditions on the south side of the site are susceptible to tsunamis, abrasion, and tidal waves, while the east and west sides are prone to flooding, and the hilly areas to landslides. The implementation of monitoring systems for land use dynamics, as outlined in this study, serves as a fundamental aspect for the formulation of spatial planning and sustainable regional development policies.

Conclusion

The construction of YIA and its supporting infrastructure has a domino effect on land use changes that occur around the airport and the national road. This research shows that the existence of airports significantly changes the land use distribution pattern, the magnetic central point of built-land growth, and the landscape of the area, which was originally a rural area, into an urban area characterized by the growth of various commercial, trade, and service areas and various airport facilities. The planning of airport development as an aerotropolis area is a complex problem, particularly in the development of YIA in agrarian and disaster-prone areas. In this context, efforts to protect agricultural land as a source of community livelihood are necessary

so that development impacts do not cause people to lose their jobs, which can lead to increased rural poverty. The land use monitoring data is expected to become a basis for formulating spatial planning policies so that the development of the YIA aerotropolis area can realize increased regional and local economic growth while still prioritizing environmental sustainability. Research on the impact of YIA's development on land use change requires further study, especially to determine the impact assessed from the environmental and economic sectors. This study aims to inform the alignment and complementarity of environmental and economic aspects in the development of the aerotropolis area.

Author Contributions

WU: Conceptualization, Methodology, Software, Investigation, Writing - Review & Editing; **CS:** Writing-Review & Supervision; **NR:** Writing – Review & Supervision.

Conflicts of Interest

There are no conflicts to declare.

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