Research article

Analysis of Land Conversion between 2013 and 2023 in Kalijambe District, Sragen, Central Java, Indonesia

Diantika Sebti Islamiyati[1,*], Agus Anggoro Sigit[1], Nirma Lila Anggani[1]

[1] Faculty of Geography, Universitas Muhammadiyah Surakarta, Sukoharjo 57162, Indonesia;

[*] Correspondence: e1002170296@student.ums.ac.id

Abstract

Land use changes in each region certainly have differences, such as in the Kalijambe District area. Based on the land changes that occurred, there are problems that occurred in the Kalijambe District , namely in the form of distribution and use of non-building land into buildings that occurred due to several factors. Kalijambe District is located in Sragen Regency with an area of 4,696.2 Ha consisting of non-rice field land (31.18%) and rice field land (40.73%) . This area has 14 villages and 137 hamlets, and 244 RTs. This study aims to 1) Analyze changes in land use in Kalijambe District in 2013 and 2023 2) Analyze factors that cause changes in land use in 2013 and 2023 in Kalijambe District. The research method uses a quantitative method, then overlay and digitization are carried out to determine the land use dispute, and finally conduct interviews with related parties to find out the actual conditions in the field. Land use has changed in the period 2013 to 2023, experiencing changes as wide as 1,180.1 ha (27.03%). Land without change or remains as wide as 3185.6 ha (72.97%). The highest change in land use type is settlements which increased by 204.1 ha (21.52%) . The main factor causing changes in use is the dominant licensing.

Keywords: land conversion, land use change, remote sensing; kalijambe district.

1. Introduction

Land use in Indonesia is largely shaped by the continuous interactions between humans and their environment. Human activities, particularly those involving land and habitat boundaries, play a crucial role in defining land use patterns. These interactions highlight the dynamic relationship between people and their surroundings, where land serves as a critical resource for economic, social, and environmental functions (Cai et al., 2022; Sianturi, 2022; Sumitro et al., 2023). This relationship is further influenced by demographic changes, technological advancements, and socio-economic developments, all of which contribute to the evolving nature of land use in the country (Asriana, 2022; Ridwan, 2016; Xu et al., 2022).

One of the key drivers of land use change is population growth. An increasing population leads to higher demands for land to meet housing, agriculture, and infrastructure needs (Al Rosyid et al., 2021; Christian et al., 2021; Oktavilia et al., 2022). This often results in land restructuring, where existing land uses are modified or converted to accommodate these demands. In Kalijambe District, Central Java, this phenomenon is evident, as the area experiences ongoing changes in its land use patterns. Such restructuring reflects the district's efforts to balance population growth with sustainable land management practices.

Kalijambe District encompasses 10 villages, covering a total area of approximately 4,669.2 hectares. The district is home to a population of 54,680 people as of 2023, with Banaran Village hosting the largest population of 5,589 residents. This concentration of people in Banaran highlights the varying population densities across the district, which can influence local land use strategies. Villages with higher population densities may face more pressure to optimize land use, potentially leading to intensified agricultural practices or increased urban development.

Between 2013 and 2023, Kalijambe District experienced an average annual population growth rate of 0.97%. While this growth rate may appear modest, its cumulative impact over a decade has significant implications for land use planning and management. Policymakers and stakeholders must consider strategies to address the growing demand for land while ensuring the preservation of natural resources and the well-being of local communities. By adopting sustainable land use practices, Kalijambe can continue to support its population without compromising the district's environmental and economic stability. The details of population growth in Kalijambe District, Sragen can be seen in Table 1.

Table 1. Comparison of Population by Village in Kalijambe District 2013 and 2023

No	Villages	Years	
		2013	**2023**
1.	Banaran	4,313	5,598
2.	Jetiskarangpung	3,901	4,784
3.	Wonorejo	3,760	4,772
4.	Karangjati	3,594	4,936
5.	Keden	3,354	3,854
6.	Donoyudan	3,351	4,295
7.	Saren	2,918	3,899
8.	Kalimacan	2,890	3,147
9.	Krikilan	2,784	4,564
10.	Samberembe	2,644	4,112
11.	Bukuran	2,173	2,816
12.	Ngebung	1,908	2,201
13.	Tegalombo	1,966	2,835
14.	Trobayan	2,005	2,867
	Total	**4,156**	**54,680**

Source: BPS Karanganyar Regency, 2024

Land use planning in Kalijambe District is centered on optimizing the functionality of various regional zones to ensure proper and sustainable use of resources. The district encompasses a total area of 4,695.93 hectares, comprising a significant portion dedicated to agriculture and other land uses. Rice fields cover an area of 1,959.21 hectares, accounting for 40.63% of the total land, while dry land makes up 2,790.93 hectares, representing 59.36% of the district's territory. These figures highlight the dominance of dry land use, which supports a range of activities, including settlements, plantations, and other economic ventures.

Efforts to balance these land use categories involve strategic planning that aligns with the district's developmental goals. Agricultural zones, particularly rice fields, play a vital role in supporting local food security and livelihoods (Brenya & Zhu, 2023; Tyczewska et al., 2023), while the extensive dry land provides opportunities for diverse land-based activities. Effective land management is essential to accommodate population growth, sustain agricultural productivity, and mitigate environmental challenges (Jumaedi, 2016; Xin & Tao, 2019). The distribution and utilization of land in Kalijambe District are detailed in the subsequent table, offering a clear overview of its current land use patterns. Land use planning with land use efforts in the region that includes parts of the region that function properly. Kalijambe District has an area of 4,695 ha with a rice field area of 1,905 Ha (41%) and dry land of 2,790 Ha (59%). The following is the land use in Kalijambe District can be seen in Table 2.

Table 2. Land Use in Kalijambe District by Area in 2013

No	Types of Land Use	Areas (Ha)	Percentage (%)
1.	I. Ricefield		
	a. Irrigation Simple	147	3
	b. ½ Technical Irrigation	274	6
	c. Cistern Rain	1,484	32
	Total I	**1,905**	**41**
2.	II. Dry Land		
	a. Tegal/garden	1,159	25
	b. Yard/building	1,469.88	31
	c. Etc	161.12	3
	Total II	**2,790**	**59**
	Total I + II	**4,695**	**100**

Source: BPS Karanganyar Regency, 2024

Based on Table 2, it can be observed that the land use types in the study area are divided into two main categories: rice fields and dry land. The rice fields cover a total of 1,905 hectares, which include three types of irrigation. Simple irrigation occupies 147 hectares or 3% of the total area, while ½ technical irrigation covers 274 hectares (6%), and cistern rain irrigation, the largest type, spans 1,484 hectares, contributing 32% of the total area. On the other hand, dry land occupies a larger area of 2,790 hectares, consisting of various land uses. Garden or farm land covers 1,159

hectares (25%), while yard or building land occupies 1,469.88 hectares (31%). The remaining 161.12 hectares (3%) are used for unspecified purposes. Overall, the total area of rice fields and dry land is 4,695 hectares, with rice fields accounting for 41% and dry land 59%.

Table 3. Land Use in Kalijambe District According to Land Area in 2023

No	Types of Land Use	Areas (Ha)	Percentage (%)
1.	I. Ricefield		
	a. Irrigation ½ Technical	1,484	32
	b. Cistern Rain	147	3
	c . Irrigation Simple	274	6
	Total I	**1,950**	**41**
2.	II. Dry Land		
	a. Yard/building	1,469.88	31
	b Tegal/garden	1,159	25
	c. Etc	161.12	3
	Total II	**2,790**	**59**
	Total I+II	**4,695**	**100**

Source: Kalijambe District in figures, 2023

Table 3 reveals that rice fields in Kalijambe District predominantly rely on a rainfed system, covering an area of 1,484 hectares, which accounts for 32% of the total. Farmers also utilize other irrigation systems, including ½ technical irrigation over 147 hectares (3%) and simple irrigation systems across 274 hectares (6%). The reliance on rainwater for managing rice fields underscores the critical role of natural water sources in supporting agriculture in the district. This dependency highlights potential vulnerabilities, especially during periods of irregular rainfall or prolonged droughts, which could impact agricultural productivity.

In addition to rice fields, dry land in Kalijambe District is allocated for various purposes, including yards/buildings, dry fields/gardens, and other uses. Dry fields and gardens make up the largest share, with an area of 1,469.88 hectares (31%), followed by yards/buildings at 1,159 hectares (25%), and other land uses at 161.12 hectares (3%). These proportions reflect the multifunctional use of dry land in the district, supporting both residential and agricultural activities. Such distribution emphasizes the need for efficient land use planning to balance the demands of population growth and agricultural sustainability.

Kalijambe District itself was established as a result of the expansion of Sumberlawang District in 2009. This expansion was driven by rapid population growth in the Sumberlawang area and increasing community aspirations for improved governance and services. The formation of the district was formalized under Sragen Regency Regional Regulation No. 18 of 2008. This administrative adjustment aimed to enhance public services and better address the needs of the growing population, reflecting the dynamic interplay between population trends and administrative restructuring.

Initially, Sumberlawang District comprised 10 villages. However, following the expansion, Kalijambe District now encompasses a total of 20 villages. This significant increase in the number of villages indicates the scale of reorganization required to meet the aspirations and demands of the local community. As a newly established district, Kalijambe faces challenges in managing its resources efficiently while fostering development that aligns with the expectations of its residents. Strategic planning and sustainable land management will be critical in achieving these goals.

2. Research Methods

This research uses remote sensing interpretation methods with the aim of producing data of actual land use types from digital values recorded in the data, and supported by field research to find out the real conditions in the field. Analysis using spatial aims to determine the distribution of land use by collecting data and then processing it using GIS (Alwedyan, 2023). Classification is obtained based on overlay, in addition, land use calculations can be carried out to mapping the location being studied. Spatial data in the form of land cover maps and images are secondary data and will be processed through GIS, the overlay analysis process is classified by GIS and the last is in the form of a map layout based on existing data.

Frequency table analysis as a method to find out the main factors of land use change . Interview data are grouped based on respondent results , then answer scoring. Conclusions are made based

on the scoring results, then the factors causing land use change will be obtained , while interview data are correlated with theory. The flowchart of this research can be seen below.
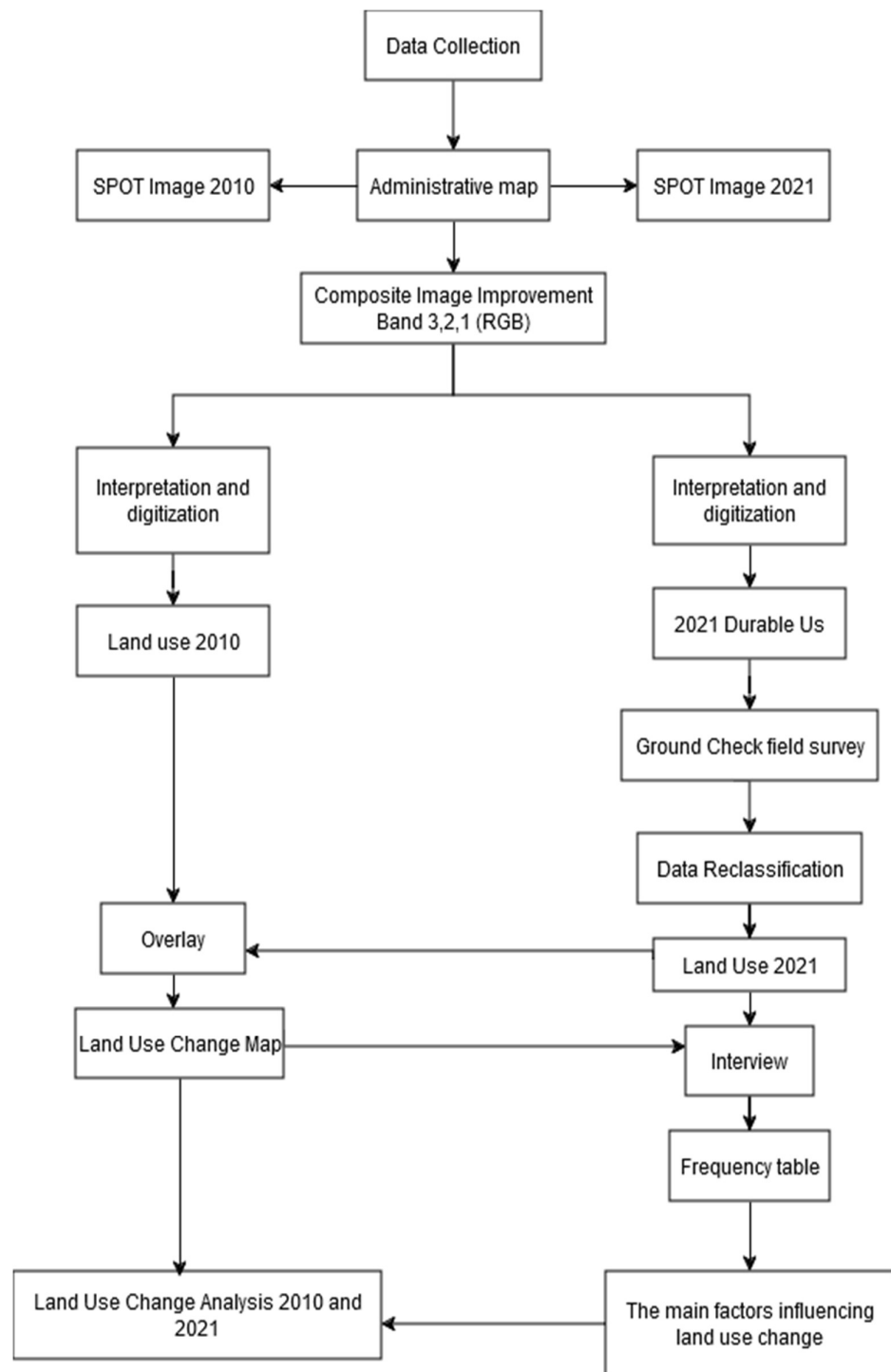

Figure 1. Research Diagram.

3. Results and Discussions

3.1. Land use changes in 2013 and 2023 in Kalijambe District

Various types of land use changes that occurred in Kalijambe District are forests, plantations, rice fields, fields, settlements, schools, and reservoirs. Meanwhile, dry fields became the sector with the highest land use change of 1709.6%Ha in 2013. The following is a table of land use changes in Kalijambe District in 2013.

Table 4. Land Use Based on Type in Kalijambe District in 2013

No	Land Use	Areas (Ha)	Percentage (%)
1.	Settlement	58.46	1.34
2.	Plantation	0.58	0.01
3.	School	1,709.83	39.18
4.	Moor	0.39	0.01
5.	Reservoir	388.55	8.9
6.	Forest	1,463.71	33.54
7.	Mixed Garden	1.94	0.04
8.	Land Empty	5.01	0.11
9.	Field	3.78	0.09
10.	Grave	732.15	16.78
	Total	**4,356.9**	**100**

Source : Compiled by Author, 2023

Based on Table 4, it can be observed that the distribution of land use in the area spans a total of 4,356.9 hectares and is divided into several categories. The largest proportion of land is allocated to schools, covering 1,709.83 hectares (39.18%), reflecting a significant focus on educational infrastructure. Forests occupy the second-largest area at 1,463.71 hectares (33.54%), indicating substantial natural vegetation and possible environmental conservation efforts. Graveyards account for 732.15 hectares (16.78%), highlighting cultural or religious practices influencing land allocation. Reservoirs, essential for water management, cover 388.55 hectares (8.9%). Settlements make up 58.46 hectares (1.34%), suggesting limited urbanization or population density, while plantations, moorlands, mixed gardens, fields, and empty land collectively account for only minor portions, each contributing less than 0.5% individually. This land use distribution underscores the region's emphasis on education, conservation, and cultural values, with relatively low agricultural activity and urban development.

Table 5. Land Use by Type in Kalijambe District in 2023

No	Land Use	Areas (Ha)	Percentage (%)
1.	Government	936.25	21.45
2.	Settlement	43.64	1
3.	Plantation	0.74	0.02
4.	School	8.97	0.21
5.	Mine	1,737.89	39.81
6.	Moor	6.92	0.16
7.	Reservoir	381.45	8.74
8.	Forest	1,231.82	28.22
9.	Mixed garden	6.88	0.16
10.	Land Empty	4.63	0.11
11.	Field	4.04	0.09
12.	Grave	2.99	0.07
	Total	**4,356.3**	**100**

Source : Compiled by Author, 2023

Based on Table 5, it can be observed that the total land area of 4,356.3 hectares is divided into various land use categories. The largest portion is allocated to mining activities, covering 1,737.89 hectares (39.81%), highlighting the region's strong reliance on mining as a primary economic activity. Forests occupy the second-largest area at 1,231.82 hectares (28.22%), emphasizing the significance of natural vegetation and environmental conservation. Government-owned land accounts for 936.25 hectares (21.45%), reflecting its importance in the region's administrative or institutional infrastructure. Reservoirs cover 381.45 hectares (8.74%), underscoring the importance of water resources.

Other land uses, such as settlements (43.64 hectares, 1%), schools (8.97 hectares, 0.21%), and moorland (6.92 hectares, 0.16%), make up smaller proportions, indicating limited urbanization and low emphasis on educational infrastructure. Mixed gardens, empty land, fields, and graveyards collectively represent less than 1% of the total area, with plantations covering only 0.74 hectares (0.02%), reflecting minimal agricultural activity.

The land use distribution indicates a region dominated by mining and forest conservation, with significant government presence, while other sectors, such as education, settlement, and agriculture, play a more minor role. This pattern highlights the region's economic dependency on natural resources and its potential need for diversification in land use to support broader development. In detail, the land conversion in the study area can be seen in Table 6, and spatially, it can be observed in Figure 2.
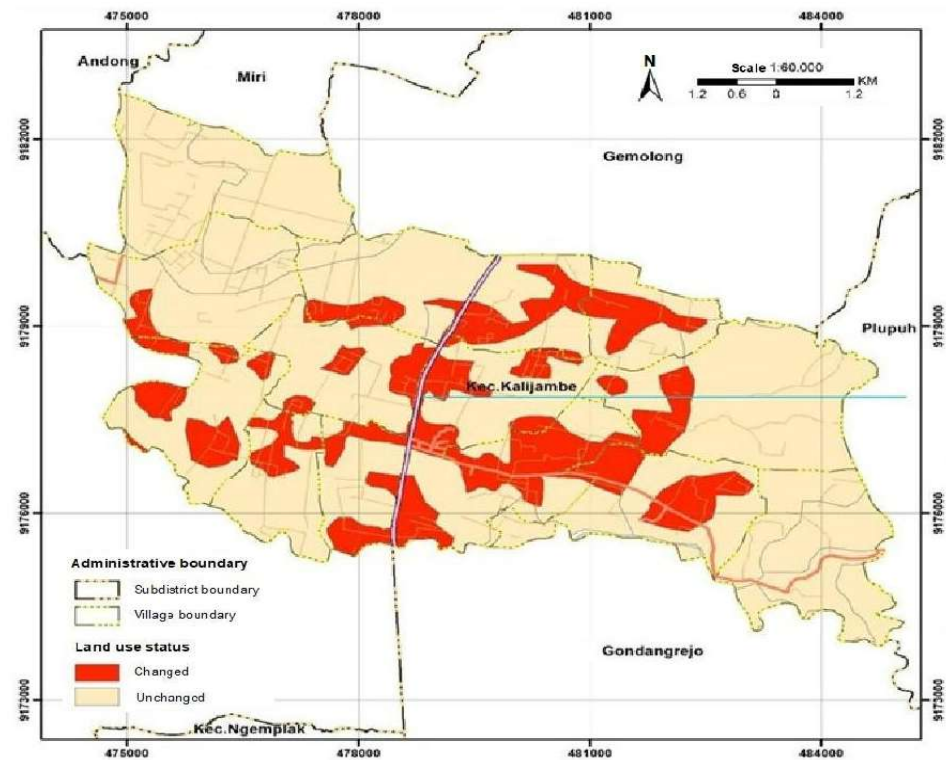

Figure 2. Research Result Map

Table 6. Land Use Change in Kalijambe District in 2013 & 2023

No	Village	Land Use Area (Ha)	
		Year 2013	**Years 2023**
1.	Ngebung	80	27
2.	Banaran	164.52	164
3.	Samberembe	61.99	128
4.	Donoyudan	115.3	105
5.	Wonorejo	185.21	115
6.	Saren	72.12	46
7.	Karangjati	20.12	70
8.	Keden	150	150
9.	Trobayan	199.05	169
10.	Kalimacan	390	215
11.	Jetiskarangpung	135.15	116
12.	Krikilan	253.65	253
13.	Bukuran	40.46	35
	Total	**1,620**	**1,432**

Source: Central Bureau of Statistics, 2023

Based on Table 6, it can be observed that the total land area decreased from 1,620 hectares in 2013 to 1,432 hectares in 2023, reflecting a reduction of 188 hectares. Significant reductions occurred in villages such as Kalimacan (from 390 to 215 hectares), Wonorejo (from 185.21 to 115 hectares), and Ngebung (from 80 to 27 hectares). These declines suggest potential land conversion for other uses, such as mining, which, as highlighted in Table 5, has become a dominant activity in the region. The consistent land use areas in Keden (150 hectares) and Krikilan (253.65 hectares) indicate stability in these locations, likely due to reduced pressure from economic or infrastructure development.

Some villages, however, experienced notable increases in land use, such as Samberembe, which grew from 61.99 hectares in 2013 to 128 hectares in 2023, and Karangjati, which expanded from 20.12 to 70 hectares. These increases may reflect land reallocation for residential, commercial, or infrastructure purposes, aligning with regional development priorities. The uneven patterns of land use changes across villages indicate that certain areas have been prioritized for growth, while others have seen reductions, potentially influenced by industrial activities or urban expansion.

The comparison with Table 5 suggests a strong correlation between the expansion of mining and government land use and the observed reductions in rural and forested areas. This trend highlights a prioritization of economic and administrative development, often at the expense of natural and rural land use. While these changes may support regional economic growth, they raise concerns about environmental sustainability and the impact on local communities. Balanced planning is essential to ensure that future land use changes address both economic goals and ecological and social considerations.

Based on Table 6, it can be observed that the total land area in the region decreased by 188 hectares between 2013 and 2023, with significant reductions in Kalimacan, Wonorejo, and Ngebung. These changes are strongly correlated with the expansion of mining and government activities, as noted in Table 5. Research by (Iqbal et al., 2021; Lewar et al., 2022; Lubis et al., 2023) has shown that such land use changes, particularly the conversion of natural or rural areas into industrial or government land, can lead to alterations in physical conditions, such as reduced vegetation cover, increased soil erosion, and declining water quality. The loss of forested and agricultural land, as seen in Kalimacan and Wonorejo, exacerbates environmental degradation and may disrupt ecological balance, including biodiversity loss and microclimate changes.

The shifts in land use also have significant social and economic implications. Studies by (Chen & He, 2022; Doyle et al., 2021) indicate that land use changes driven by industrial expansion, such as mining, often lead to social stratification and displacement of rural communities. The reduction of agricultural areas can undermine local food security and limit traditional livelihoods. In contrast, increased economic activities, like mining and urban infrastructure development, may create new job opportunities but often benefit external stakeholders more than local populations. The uneven land use trends in the studied villages, with some experiencing growth (e.g., Samberembe) and others decline (e.g., Kalimacan), reflect these contrasting dynamics. The redistribution of land use resources can strain social cohesion as communities adapt to the shifting economic landscape.

Cultural and traditional practices are also impacted by land use changes. Graveyards, which hold significant cultural value, and agricultural land, central to many rural traditions, face pressure from conversion to mining or government land. Research by (Yang & Loopmans, 2023) emphasizes that rapid land transformations can erode cultural identity, disrupt long-standing community practices, and lead to conflicts over resource management. Balancing economic development with the preservation of cultural and environmental integrity is essential. To achieve this, policies must integrate sustainable land use planning that prioritizes the needs of both the ecosystem and the local communities, ensuring equitable outcomes for all stakeholders.

3.2. Factors Influencing Land Use Changes in the Study Area

Land use changes that occurred in Kalijambe District were in the rice fields and plantation sectors, which of course had an impact on the surrounding community who made the sector a source of income to meet family needs. The results of the interview resulted in factors causing changes in land use including human accessibility, regional expansion, and licensing.

According to the community and village officials, the frequency of licensing in Kalijambe District reaches 100%, with the licensing rate showing the same value. This high percentage indicates that many non-building lands have been converted into buildings to meet the growing demand for human-supporting facilities. The strict adherence to the licensing process reflects the increasing level of development in the area, driven by the community's need for improved infrastructure.

The types of development that are widely carried out in Kalijambe District include health facilities, factories, and housing. These developments are primarily driven by rapid population growth, which increases the need for essential public services. As the population continues to expand, so does the demand for housing, healthcare, and employment opportunities, making infrastructure development a necessity to support human activity.

Furthermore, the Solo-Ngawi toll road mega project has had a significant impact on Kalijambe District, particularly on the agricultural and plantation sectors. Many farmlands and plantations have been converted to accommodate this large-scale infrastructure project. This has led to a reduction in arable land, posing challenges for local farmers and affecting the local economy, which heavily depends on agriculture. The toll road development highlights the trade-off between infrastructure expansion and the preservation of the agricultural sector.

Based on the data, the frequency and rate of licensing reach a maximum value of 100%. This reflects a high level of awareness among the community and village officials regarding the importance of licensing in the development process. Furthermore, the significant conversion of non-building lands into buildings highlights an urgent need for facilities to support the growing population. The increase in health facilities, factories, and housing is driven by the rapid population growth in the area. As the population grows, the demand for basic facilities such as living spaces, healthcare services, and jobs also increases to meet the needs of the community. The Solo-Ngawi toll road project has a considerable impact, particularly on the agricultural sector in Kalijambe. Many farmlands and plantations have been converted into infrastructure for the toll road, posing new challenges for farmers and landowners. This situation affects the local economy, which heavily relies on the agricultural sector.

4. Conclusion

This study concludes that significant land use changes occurred in Kalijambe District, Sragen Regency, between 2013 and 2023. The total area of land affected by these changes reached 1181.3 hectares, which accounts for 28.05% of the total area. Meanwhile, 3201.2 hectares or 72.93% of the land remained unchanged during the same period. The increase in land conversion is primarily driven by the issuance of permits for changes in land use. As the population grows, the demand for residential areas and various public facilities also increases, leading to further land development.

Kalijambe District is considered a region with a relatively high rate of land use change. This is attributed to its strategic location near the city of Surakarta, the presence of toll gates, and the establishment of new factories in the area. These factors contribute to the ongoing urban and industrial development in Kalijambe, accelerating the transformation of agricultural and non-urban lands into built-up areas.

A key strength of this research is its ability to provide detailed quantitative data on land use changes over a decade. The analysis offers valuable insights into the extent and drivers of land transformation in Kalijambe District. Additionally, the study identifies the critical role of population growth and infrastructure development in influencing land use patterns, which is crucial for regional planning and policy-making.

However, the research also has some limitations. One notable weakness is the lack of qualitative analysis regarding the social and environmental impacts of land use changes. While the study highlights the scale of land conversion, it does not thoroughly explore how these changes affect local livelihoods, ecosystems, or long-term sustainability. Another limitation is that it focuses primarily on historical data without offering predictive models for future land use trends.

Future research could focus on developing predictive models to estimate land use changes over the next decade, incorporating factors such as projected population growth, infrastructure expansion, and industrial development. Additionally, conducting in-depth qualitative studies on the social, economic, and environmental impacts of land use changes would provide a more holistic understanding of the issue. Comparative studies with neighboring regions experiencing similar development pressures could also help identify best practices for sustainable land management and urban planning in Kalijambe District.

References

Al Rosyid, M. F., Yusup, Y., & Wijayanti, P. (2021). Pengaruh Pertumbuhan Penduduk Terhadap Perubahan Penggunaan Lahan Pertanian Ke Non Pertanian Kecamatan Banyudono Kabupaten Boyolali Tahun 2006 - 2018. *(Impact of Population Growth on the Conversion of Agricultural Land to Non-Agricultural Use Between 2006 and 2018 in Banyudono District, Boyolali Regency). GEADIDAKTIKA.* https://doi.org/10.20961/gea.v1i2.47906

Author Contributions

Conceptualization: Diantika Sebti Islamiyati **methodology**: Agus Anggoro Sigit; **investigation**: Nirma Lila Anggani; **writing—original draft preparation**: Diantika Sebti Islamiyati ; **writing—review and editing**: Nirma Lila Anggani ; **visualization**: Diantika Sebti Islamiyati . All authors have read and agreed to the published version of the manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest.

Alwedyan, S. (2023). Monitoring Urban Growth and Land Use Change Detection with Gis Techniques In Irbid City, Jordan. *International Review for Spatial Planning and Sustainable Development*. https://doi.org/10.14246/irspsd.11.1_253

Asriana, Z. (2022). Identifikasi Potensi Dan Masalah Sebagai Upaya Pengembangan Desa Berkelanjutan Di Kelurahan Labuang Kabupaten Majene. *(Identifying Potential and Challenges as an Effort Towards Sustainable Village Development in Labuang Village, Majene Regency). Journal of Comprehensive Science (JCS).* https://doi.org/10.59188/jcs.v2i12.551

Brenya, R., & Zhu, J. (2023). Agricultural extension and food security – The case of Uganda. *Global Food Security*. https://doi.org/10.1016/j.gfs.2023.100678

Cai, B., Shao, Z., Fang, S., & Huang, X. (2022). Quantifying Dynamic Coupling Coordination Degree of Human–Environmental Interactions during Urban–Rural Land Transitions of China. *Land*, 11(6), 935. https://doi.org/10.3390/land11060935

Chen, Y., & He, Y. (2022). Urban Land Expansion Dynamics and Drivers in Peri-Urban Areas of China: A Case of Xiaoshan District, Hangzhou Metropolis (1985–2020). *Land*, 11(9), 1495. https://doi.org/10.3390/land11091495

Christian, Y., Asdak, C., & Kendarto, D. R. (2021). Analisis Perubahan Penggunaan Lahan di Kabupaten Bandung Barat. *(Analysis of Landuse Change in West Bandung Barat). Jurnal Teknotan*. https://doi.org/10.24198/jt.vol15n1.3

Doyle, C., Beach, T., & Luzzadder-Beach, S. (2021). Tropical Forest and Wetland Losses and the Role of Protected Areas in Northwestern Belize, Revealed from Landsat and Machine Learning. *Remote Sensing*, 13(3), 379. https://doi.org/10.3390/rs13030379

Iqbal, L. O. S. M., Surya, B., & Syafri, S. (2021). Kutub Pertumbuhan Dan Gentrifikasi Pada Kawasan Pinggiran Kota Makassar. *(Growth Poles and Gentrification in the Suburban Areas of Makassar). Urban and Regional Studies Journal*. https://doi.org/10.35965/ursj.v3i1.607

Jumaedi, S. (2016). Nilai Manfaat Hutan Mangrove dan Faktor-Faktor Penyebab Konversi Zona Sabuk Hijau (Greenbelt) Menjadi Tambak Di Wilayah Pesisir Kota Singkawang Kalimantan Barat. *(The Value of Mangrove Forests and the Factors Driving the Conversion of Greenbelt Zones into Fish Ponds in the Coastal Area of Singkawang City, West Kalimantan). Sosiohumaniora*. https://doi.org/10.24198/sosiohumaniora.v18i3.10104

Lewar, P. N., Sari, Y. I., & Kurniawati, D. (2022). Analisis Perubahan Penggunaan Lahan Dengan Memanfaatkan Sistem Informasi Geografis Di Kecamatan Sukun. *(Analysis of Land Use Change Using Geographic Information Systems in Sukun District). Dinamika Sosial: Jurnal Pendidikan Ilmu Pengetahuan Sosial*. https://doi.org/10.18860/dsjpips.v1i2.1740

Lubis, D. P., Permana, S., Rahmadi, M. T., Milanda, D. A., Pratama, A., & Halim, J. (2023). Analisis Perubahan Penggunaan Lahan di Kecamatan Besitang Kabupaten Langkat Tahun 2015-2021. *(Analysis of Land Use Change beetwen 2015 and 2021 in Besitang District, Langkat Regency). Media Komunikasi Geografi*, 24(2), 114–125. https://doi.org/10.23887/mkg.v24i2.60671

Oktavilia, S., Fafurida, F., Pujiati, A., Aulia, Y., & Firmansyah, F. (2022). Industrialization and Land Conversion in Indonesia. *Environment and Ecology Research*, 10(6), 627–634. https://doi.org/10.13189/eer.2022.100601

Ridwan, I. R. (2016). Faktor-Faktor Penyebab Dan Dampak Konversi Lahan Pertanian. *(Factors Causing and the Impacts of Agricultural Land Conversion). Jurnal Geografi Gea*. https://doi.org/10.17509/gea.v9i2.2448

Sianturi, R. S. (2022). Komparasi Metode Klasifikasi Tersupervisi untuk Pemetaan Lahan Terbangun dan NonTerbangun Menggunakan Landsat 8 OLI dan Google Earth Engine (Studi Kasus: Kota Malang). *(Comparison of Supervised Classification Methods for Mapping Built-Up and Non-Built-Up Land Using Landsat 8 OLI and Google Earth Engine (Case Study: Malang City). Jurnal Penataan Ruang*. https://doi.org/10.12962/j2716179x.v17i2.13434

Sumitro, S., Irwansyah, I., & Syukurman, S. (2023). Pola Interaksi Sosial Dan Konflik Agraria Antara Masyarakat Adat Cek Bocek Dengan Pt. Amnt Di Sumbawa. *(Patterns of Social Interaction and Agrarian Conflict Between the Cek Bocek Indigenous Community and PT. AMNT in Sumbawa). EDU SOCIATA (Jurnal Pendidikan Sosiologi),* 6(1), 265–273. https://doi.org/10.33627/es.v6i1.1182

Tyczewska, A., Twardowski, T., & Woźniak-Gientka, E. (2023). Agricultural biotechnology for sustainable food security. Trends in Biotechnology, 41(3), 331–341. https://doi.org/10.1016/j.tibtech.2022.12.013

Xin, Y., & Tao, F. (2019). Optimizing genotype-environment-management interactions to enhance productivity and eco-efficiency for wheat-maize rotation in the North China Plain. *Science of the Total Environment*. https://doi.org/10.1016/j.scitotenv.2018.11.126

Xu, Y., Hu, L., Gao, S., Wang, M., Ding, J., Qiu, Y., Zhang, F., Du, Z., & Liu, R. (2022). Perception of urban population characteristics through dietary taste patterns based on takeout data. Cities. https://doi.org/10.1016/j.cities.2022.103910

Yang, R., & Loopmans, M. (2023). Land dispossession, rural gentrification and displacement: Blurring the rural-urban boundary in Chengdu, China. *Journal of Rural Studies*. https://doi.org/10.1016/j.jrurstud.2022.11.017