GeoEdu Insight Journal: Geography and Education Geography
Vol. 1, No. 1, April 2026, pp. 44~50
ISSN: xxxx-xxxx, DOI: xx.xxxx/ GEdIJ.vxix.x

Socio-Economic Transformation of Households Due to the Development of the New Joho Housing Complex in Joho Village, Sukoharjo

Glory Muzdhalifah[1], Nur Aisyah Zulkifli[2]
[1]Geography Teacher, State Senior High School 8 Pekan Baru, Riau, Indonesia
[2]Geography Education Study Program, Faculty of Teacher Training and Education, Sultan Syarif Kasim State Islamic University of Riau, Riau, Indonesia

Article Info

Article history:

Received Jan 6, 2026
Revised Feb 3, 2026
Accepted Feb 19, 2026
Online First Marc 2, 2026

Keywords:

Housing Development
Household Economy
Rural Change
Socio-Economic Transformation
Urban Expansion

ABSTRACT

Purpose of the study: This study aims to examine the socio-economic transformation of households following the development of the New Joho Housing Complex in Joho Village, Sukoharjo, between 2003 and 2011, focusing on land-use change, livelihood shifts, welfare levels, and social interaction patterns.

Methodology: This study employed a descriptive quantitative design with a spatial approach. Land-use change was analyzed using Geographic Information System (GIS) overlay techniques with ArcView version 3.3. Data were collected through observation, documentation, and structured interviews. Sampling used purposive and random sampling methods, with 140 household heads selected using Isaac and Michael's formula.

Main Findings: The results show significant conversion of irrigated rice fields into residential areas, with 21.17 hectares transformed between 2003 and 2011. Agricultural employment declined by 15.71%, while non-agricultural occupations increased proportionally. Household welfare levels improved, particularly in the Prosperous Family Stage III category. However, the proportion of households with very strong social interaction decreased, indicating emerging social cohesion challenges.

Novelty/Originality of this study: This study integrates GIS-based spatial overlay analysis with quantitative household socio-economic assessment within a single peri-urban locality over an extended period. By simultaneously examining land conversion, livelihood transition, welfare change, and social interaction patterns, it provides a multidimensional empirical framework that advances understanding of development-induced transformation in peri-urban communities.

Corresponding Author:
Nur Aisyah Zulkifli,
Geography Education Study Program, Faculty of Teacher Training and Education, Sultan Syarif Kasim State Islamic University of Riau
Sultan Syarif Kasim State Islamic University of Riau, Riau, 28293, Indonesia
Email: aisyahzulkifli48@gmail.com

1. INTRODUCTION

The development of residential areas significantly influences the spatial organization and socio-economic conditions of surrounding communities. Geography, particularly human geography, examines the interaction between humans and their environment, highlighting how human activities shape and are shaped by space [1], [2]. In recent decades, the growth of new housing complexes has become a notable phenomenon in Indonesia, driven by population increase and urbanization [3]. Housing is a fundamental human need, and the

availability, quality, and location of residential areas directly affect household welfare. This study focuses on the socio-economic transformation of households caused by the establishment of the New Joho Housing Complex in Joho Village, Sukoharjo.

The rapid emergence of new residential developments often leads to land-use changes that disrupt traditional livelihoods, particularly in agricultural communities. In Joho Village, the conversion of farmland into housing has reduced the availability of land for cultivation, causing shifts in household income sources. Such changes affect the economic stability of local residents, who must adapt to new employment opportunities or relocate [4], [5]. Social interactions are also impacted, as newcomers bring different lifestyles and socio-economic backgrounds. These dynamics raise concerns about inequality, community cohesion, and long-term sustainability in the area.

Previous studies have explored the impacts of urban expansion on rural communities, emphasizing land-use change, income diversification, and social adaptation. However, most research has focused on large metropolitan areas, leaving peri-urban villages like Joho underexplored [6]. Existing literature has highlighted the economic effects of housing developments but often overlooks the interplay between social interactions and household welfare. Additionally, prior studies rarely integrate spatial analysis with socio-economic data to capture comprehensive transformations [7], [8]. This gap indicates the need for a localized, quantitative investigation combining geospatial methods with household socio-economic assessment.

While housing development is a common feature of regional growth, its nuanced impacts on small communities remain insufficiently understood. In Joho Village, the establishment of the New Joho Housing Complex has potentially altered both economic conditions and social behaviors among households. There is limited empirical evidence documenting the extent and nature of these transformations over time [9]. Furthermore, prior studies have not fully addressed how land conversion, income shifts, and social interactions intersect within a single framework [10]. Addressing this gap is essential to provide insights for planners and policymakers about peri-urban development consequences.

Understanding the socio-economic transformation of households is crucial for sustainable community planning and policy formulation [11]. Insights from this study can inform local governments and developers about potential inequalities and social challenges arising from new housing developments. Additionally, it provides evidence-based guidance for balancing economic growth with the preservation of traditional livelihoods [12], [13]. The findings can support interventions that foster social integration between new and original residents. Ultimately, this research contributes to achieving more equitable and resilient peri-urban development in Sukoharjo and similar regions.

This study presents a novel approach by combining geospatial analysis with quantitative socio-economic assessment of households over an extended period (2003–2011). Unlike previous research, it specifically examines the New Joho Housing Complex and its localized impact on both economic and social dimensions [14], [15]. The integration of land-use overlay techniques with household survey data allows for precise mapping of transformation patterns. Moreover, the study highlights the interplay between income diversification, social interactions, and spatial changes [16]. These innovative aspects provide a comprehensive understanding of how residential development shapes peri-urban communities.

2. RESEARCH METHOD

2.1. Research Design and Approach

This study employed a descriptive quantitative research design with a spatial approach. The descriptive design aims to present phenomena as they occur in the field, while the quantitative approach emphasizes numerical data obtained through measurement and calculation [17], [18]. The spatial perspective focuses on human activities and their interaction with the environment, particularly in areas experiencing land-use transformation [19]. This approach enables a comprehensive analysis of socio-economic changes associated with residential development. The research specifically examines the socio-economic transformation of households following the development of the New Joho Housing Complex.

2.2. Study Area and Variables

The research was conducted in Joho Village, Sukoharjo, which was selected due to significant land-use changes triggered by the establishment of the New Joho Housing Complex. Built in 1989, the housing complex covers approximately 12 hectares and consists of two neighborhood units (RW) divided into nine community units (RT), with around 650 households. Data collection was carried out from December 2011 to January 2012. The study analyzed three main variables: land-use change (type and extent), household socio-economic conditions (occupation and welfare level), and changes in social interaction patterns. These variables were examined to understand the transformation process between 2003 and 2011.

2.3. Population and Sampling Technique

The study population consisted of two components: land areas surrounding the New Joho Housing Complex and households residing in Joho Village. From several hamlets within the village, Randusari, Mojotegalan, and Joho were selected using purposive sampling, totaling 293 households. The sample size was determined using Isaac and Michael's formula with a 10% margin of error, resulting in 140 household heads as respondents. Random sampling was then applied to select households within the chosen hamlets. This sampling procedure ensured representativeness while maintaining research feasibility.

2.4. Data Collection and Analysis Techniques

Data were collected through observation, documentation, and structured interviews with selected household heads. Land-use changes were analyzed using an overlay technique by superimposing land-use maps from 2003 and 2011 within a Geographic Information System (GIS) environment using ArcView version 3.3 [20], [21]. The overlay analysis produced spatial representations of land conversion patterns during the study period. Household socio-economic data were analyzed using descriptive quantitative methods, including single-frequency and cross-tabulation tables. The integration of spatial and socio-economic analyses provided a comprehensive understanding of household transformation resulting from housing development.

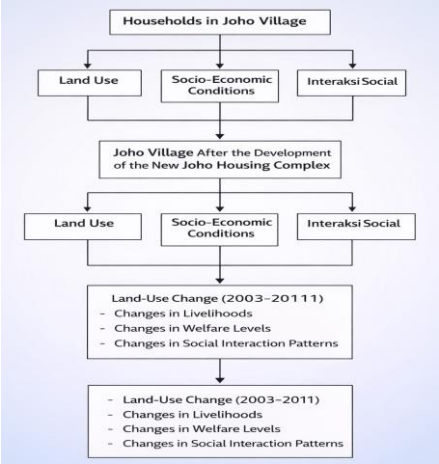

Figure 1. Conceptual Framework of Socio-Economic Transformation Due to the Development of the New Joho Housing Complex (2003–2011)

The conceptual framework illustrates the logical relationship between land-use change, socio-economic conditions, and social interaction patterns before and after the development of the New Joho Housing Complex. The framework demonstrates how residential development functions as a driving force that influences spatial transformation and subsequently reshapes household livelihoods, welfare levels, and patterns of social interaction in Joho Village.

3. RESULTS AND DISCUSSION

3.1. Land-Use Change in Joho Village (2003–2011)

The spatial analysis using GIS overlay revealed significant land-use transformation in Joho Village between 2003 and 2011. In 2003, irrigated rice fields dominated land use, covering 128.61 hectares (59.41%). By 2011, residential land became the dominant category, expanding to 113.17 hectares (52.28%). Meanwhile, irrigated rice fields decreased substantially to 94.04 hectares (43.44%). These findings confirm a major shift from agricultural to residential land use following the development of the New Joho Housing Complex.

Table 1. Land Use Distribution in Joho Village (2003 and 2011)

Land Use Type	2003 (Ha)	2003 (%)	2011 (Ha)	2011 (%)
Irrigated Rice Field	128.61	59.41	94.04	43.44
Residential Area	85.50	39.50	113.17	52.28
Garden	2.36	1.09	9.26	4.28
Total	216.47	100	216.47	100

Further analysis shows that the largest land conversion occurred from irrigated rice fields to residential areas, covering 21.17 hectares (9.78%). This indicates that urban expansion significantly reduced agricultural

land. The conversion pattern confirms that housing development has been the primary driver of spatial transformation in the study area.

3.2. Changes in Household Livelihoods

Land-use conversion directly influenced household economic activities. The proportion of respondents working in the agricultural sector declined by 15.71% between 2003 and 2011. Conversely, employment in the non-agricultural sector increased by the same percentage. This shift reflects structural economic transformation from agrarian-based livelihoods to urban-oriented occupations.

Table 2. Changes in Main Occupations of Respondents (2003–2011)

Sector	2003 (%)	2011 (%)	Change (%)
Agricultural	35.00	19.29	-15.71
Non-Agricultural	65.00	80.71	+15.71
Total	100	100	0

The most significant decrease occurred among agricultural laborers, while increases were observed in trade and private-sector employment. These findings indicate adaptation strategies among households in response to declining agricultural opportunities.

3.3. Changes in Household Welfare Levels

Welfare levels were measured using the BKKBN welfare classification indicators. The majority of households were categorized as Prosperous Family Stage III in both 2003 and 2011. However, the proportion of households in this category increased from 58.57% to 66.43%. At the same time, households in Prosperous Family Stage II decreased significantly.

Table 3. Changes in Household Welfare Levels (2003–2011)

Welfare Level	2003 (%)	2011 (%)	Change (%)
Prosperous Family Stage II	15.00	2.86	-12.14
Prosperous Family Stage III	58.57	66.43	+7.86
Prosperous Family Stage III+	26.43	30.71	+4.28
Total	100	100	0

These results suggest that although agricultural land declined, household welfare did not deteriorate overall. Instead, economic diversification appears to have contributed to improved welfare status for many respondents.

3.4. Changes in Social Interaction Patterns

Despite improvements in welfare levels, social interaction patterns showed a different trend. The proportion of respondents categorized as having “Very Good” social interaction declined from 32.86% in 2003 to 23.57% in 2011. Meanwhile, respondents categorized as having “Moderate” interaction increased significantly.

Table 4. Changes in Social Interaction Levels (2003–2011)

Social Interaction Level	2003 (%)	2011 (%)	Change (%)
Very Good	32.86	23.57	-9.29
Good	27.86	27.14	-0.72
Moderate	17.14	28.57	+11.43
Poor	22.14	20.72	-1.42
Total	100	100	0

The decline in strong social cohesion may reflect differences in socio-economic background between original residents and newcomers. Increased residential mobility and urban lifestyle patterns likely contributed to reduced intensity of traditional communal activities.

3.5. Integrated Socio-Economic Transformation

The results indicate that the development of the New Joho Housing Complex triggered multidimensional transformation. Spatially, agricultural land decreased while residential areas expanded significantly. Economically, households shifted from agriculture to non-agricultural occupations, accompanied by improved welfare levels. Socially, however, interaction intensity showed signs of decline. These findings

demonstrate that residential development generates both positive economic effects and social adaptation challenges in peri-urban communities.

The spatial analysis demonstrates a substantial transformation of land use in Joho Village between 2003 and 2011, marked by a pronounced decline in irrigated rice fields and a corresponding expansion of residential areas. The conversion of more than twenty hectares of agricultural land into housing indicates a structural shift in the village's spatial organization. Such transformation reflects the growing influence of peri-urban expansion processes in Sukoharjo. The dominance of residential land by 2011 confirms that housing development became a central force reshaping the physical landscape. This pattern illustrates how localized development projects can accelerate rural-to-urban spatial transition.

Economic changes accompanied this spatial restructuring, particularly in the occupational composition of households. The declining proportion of agricultural workers and the parallel rise in non-agricultural employment signify a transition toward a more urban-oriented economic structure. Increased engagement in trade and private-sector activities suggests adaptive responses to reduced agricultural opportunities. Interestingly, welfare indicators show overall improvement despite the contraction of farmland. This condition implies that economic diversification mitigated potential negative impacts of land conversion on household income stability.

The interaction between land-use change and livelihood transformation observed in this study corresponds with broader theories of peri-urbanization, which describe spatial expansion as a catalyst for structural economic adjustment. Empirical research in transitional rural–urban zones similarly reports declining agricultural dependence and expanding service-sector participation [22], [23]. However, while economic indicators improved, the reduction in strong social interaction categories reveals a more complex social consequence. The weakening of traditional communal ties may be associated with demographic heterogeneity introduced by new residents. This dual pattern highlights that economic progress does not automatically guarantee strengthened social cohesion.

By integrating spatial overlay analysis with household-level socio-economic data, this study provides a multidimensional perspective on transformation processes within a single peri-urban locality. The combined examination of land conversion, occupational shifts, welfare levels, and social interaction patterns allows for a more nuanced interpretation of development impacts [24]. Rather than treating spatial and social variables separately, the analysis situates them within an interconnected framework. Such an approach enables clearer identification of how physical landscape changes translate into socio-economic restructuring [25]. This integrative perspective enriches the understanding of development-induced transformation in small-scale community contexts.

From a policy standpoint, the findings underline the importance of anticipating social adjustments alongside economic growth in residential expansion areas. While increased employment diversification may enhance welfare outcomes, attention should be directed toward maintaining community cohesion [26]. Planning strategies that encourage participatory community activities could mitigate social fragmentation between long-term residents and newcomers [27], [28]. Furthermore, balanced land-use regulation remains essential to prevent excessive agricultural land loss. Sustainable peri-urban development therefore requires coordinated spatial, economic, and social considerations.

Despite offering comprehensive quantitative and spatial analysis, the study remains subject to several limitations. The reliance on descriptive quantitative methods constrains deeper exploration of subjective experiences and perceptions of social change. The temporal scope ending in 2011 does not capture subsequent development dynamics that may further alter socio-economic conditions. Additionally, the single-case focus limits comparative generalization to other peri-urban regions [29], [30]. Future investigations incorporating longitudinal data and qualitative inquiry would strengthen interpretative depth. Expanding the geographical scope could also provide broader insight into regional transformation patterns.

4. CONCLUSION

This study demonstrates that the development of the New Joho Housing Complex between 2003 and 2011 significantly reshaped the spatial and socio-economic structure of Joho Village through extensive conversion of irrigated agricultural land into residential areas. The GIS-based overlay analysis confirms that land-use transformation was not merely a physical change but functioned as a structural driver of livelihood transition from agriculture to non-agricultural sectors. The decline in agricultural employment alongside the rise of trade and private-sector activities indicates adaptive economic restructuring among local households. Importantly, improvements in household welfare levels suggest that income diversification mitigated potential negative impacts of farmland reduction. Nevertheless, the observed decline in the proportion of households with very strong social interaction reflects emerging challenges in maintaining social cohesion within an increasingly heterogeneous peri-urban community. Overall, the findings affirm that residential development generates multidimensional transformation encompassing spatial reorganization, economic adjustment, and social

reconfiguration, thereby underscoring the necessity of integrated and socially responsive planning strategies for sustainable peri-urban development.

ACKNOWLEDGEMENTS

The author expresses sincere gratitude to the local government of Joho Village and the respondents who generously contributed their time and information to this research. Appreciation is also extended to academic supervisors and colleagues for their constructive feedback and guidance throughout the research process. This study received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

[1] C. Cho, "Use of photovoice in pre-service geography teachers' conceptions of geography," *Cogent Soc. Sci.*, vol. 9, no. 1, pp. 1–20, 2023, doi: 10.1080/23311886.2023.2235171.
[2] C. Cho, "Semantic network analysis on the geography of food as represented in textbooks: For alternative food education for young people," *Cogent Soc. Sci.*, vol. 8, no. 1, pp. 1–18, 2022, doi: 10.1080/23311886.2022.2148417.
[3] A. Dongzagla, I. Baddianaah, F. A. Avogo, J. Tengbane, and J. Tengbane, "Conformity of filling stations to safe distance guidelines in urban Ghana: A case study of the Wa Municipality," *Cogent Soc. Sci.*, vol. 9, no. 2, pp. 1–18, 2023, doi: 10.1080/23311886.2023.2282473.
[4] D. S. Logayah, M. Ruhimat, R. Arrasyid, and M. R. Fajar, "Item analysis of National Geography Olympiad multiple-choice questions (MCQs) in Indonesia," *Cogent Soc. Sci.*, vol. 10, no. 1, pp. 1–12, 2024, doi: 10.1080/23311886.2024.2354971.
[5] M. Gebrehiwot, B. Demisse, H. Meaza, W. Tafesse, A. G. Abbay, and S. Beyene, "Understanding food security determinants and coping strategies among smallholder farming households in Northern Ethiopia," *Cogent Soc. Sci.*, vol. 10, no. 1, pp. 1–25, 2024, doi: 10.1080/23311886.2024.2354970.
[6] M. A. Arega and E. A. Asfaw, "Understanding the indigenous knowledge-based tub and griddle pan handcrafting business in Dessie, Ethiopia," *Cogent Soc. Sci.*, vol. 10, no. 1, pp. 1–25, 2024, doi: 10.1080/23311886.2024.2316943.
[7] A. Court, A. Kelly, and M. Hardman, "Exploring the need for innovation in greening urban environments: Reflecting on radical practice in Greater Manchester, UK," *Cogent Soc. Sci.*, vol. 8, no. 1, pp. 1–17, 2022, doi: 10.1080/23311886.2022.2109261.
[8] Y. Arbel, Y. Arbel, A. Kerner, and M. Kerner, "Minorities diminished return and walkability: The impact of race on the prevalence of obesity in different urban environments," *Cogent Soc. Sci.*, vol. 11, no. 1, pp. 1–24, 2025, doi: 10.1080/23311886.2025.2579522.
[9] H. Susiati *et al.*, "Criteria and methods in nuclear power plants siting: A systematic literature review," *Cogent Soc. Sci.*, vol. 10, no. 1, pp. 1–20, 2024, doi: 10.1080/23311886.2024.2354976.
[10] E. A. Muhtar, A. Abdillah, and I. Widianingsih, "Smart villages, rural development and community vulnerability in Indonesia: A bibliometric analysis," *Cogent Soc. Sci.*, vol. 9, no. 1, pp. 1–26, 2023, doi: 10.1080/23311886.2023.2219118.
[11] J. He, T. Wang, and H. Zhu, "The logic of recreation space governance in forest parks based on the theory of space production," *Cogent Soc. Sci.*, vol. 8, no. 1, pp. 1–16, 2022, doi: 10.1080/23311886.2022.2137315.
[12] N. Sultana, "Analysis of landslide-induced fatalities and analysis of landslide-induced fatalities and injuries in Bangladesh: 2000-2018," *Cogent Soc. Sci.*, vol. 6, no. 1, pp. 1–27, 2020, doi: 10.1080/23311886.2020.1737402.
[13] H. J. Jumaah *et al.*, "Assessment of corona virus (COVID-19) infection spread pattern in Iraq using GIS and RS techniques," *Cogent Soc. Sci.*, vol. 9, no. 2, pp. 1–16, 2023, doi: 10.1080/23311886.2023.2282706.
[14] G. T. Mekonnen, A. B. Berlie, and M. A. Wubie, "Drivers of surface urban heat island of Gondar City, Ethiopia: A comparative study," *Cogent Soc. Sci.*, vol. 10, no. 1, pp. 1–19, 2024, doi: 10.1080/23311886.2024.2354974.
[15] I. K. Astina, A. Idris, R. Jaya, and T. Bay, "Unveiling the mystic sense of place and ocean literacy: The role of the Torosiaje community in championing marine sustainability in Tomini Bay, Indonesia," *Cogent Soc. Sci.*, vol. 11, no. 1, pp. 1–22, 2025, doi: 10.1080/23311886.2025.2586139.
[16] E. Sadewo and I. Syabri, "Post-suburbia dan tantangan pembangunan di kawasan pinggiran metropolitan: Suatu tinjauan literatur [Post-suburbia and development challenges in metropolitan periphery areas: A literature review]," *Maj. Geogr. Indones.*, vol. 32, no. 2, pp. 130–141, 2018, doi: 10.22146/mgi.33755.
[17] V. Delauer *et al.*, "The impact of natural environments and biophilic design as supportive and nurturing spaces on a residential college campus," *Cogent Soc. Sci.*, vol. 8, no. 1, pp. 1–19, 2022, doi: 10.1080/23311886.2021.2000570.
[18] N. Nzuzo, X. Sifiso, and N. N. Precious, "Land use and land cover change dynamics and local perception in the Dolphin Coast, KwaZulu-Natal," *Cogent Soc. Sci.*, vol. 11, no. 1, pp. 1–22, 2025, doi: 10.1080/23311886.2025.2563785.
[19] A. Armaw and M. B. Molla, "Assessing the trend and magnitude of land cover dynamics and its major driving forces in Omo National Park, Southern Ethiopia," *Cogent Soc. Sci.*, vol. 8, no. 1, pp. 1–18, 2022, doi: 10.1080/23311886.2022.2042055.
[20] R. Tutu, D. Ottie-boakye, and H. N. N. Bulley, "Rethinking and mapping environmental health literacy and contaminants in Old Tulaku, greater Accra region of Ghana," *Cogent Soc. Sci.*, vol. 11, no. 1, pp. 1–21, 2025, doi: 10.1080/23311886.2025.2513465.
[21] F. Baye, "Informal land market mechanisms for accessing and securing land for housing development: the case of peri-urban areas of Woldia Township, Ethiopia," *Cogent Soc. Sci.*, vol. 11, no. 1, pp. 1–30, 2025, doi: 10.1080/23311886.2025.2482115.
[22] P. S. W. R. R. A. N. M *et al.*, "Analisis rencana pemekaran kelurahan mangunsari dan dukuh Kota Salatiga sebagai

upaya perwujudan good governance [Analysis of the planned expansion of Mangunsari and Dukuh sub-districts in Salatiga City as an effort to realize good governance]," *Maj. Geogr. Indones.*, vol. 38, no. 1, pp. 50–59, 2018, doi: 10.22146/mgi.70636.

[23] B. Susilo, M. R. Afani, and S. I. Hidayah, "Integrasi analisis spasial dan statistik untuk identifikasi pola dan faktor determinan perkembangan Kota Yogyakarta [Integration of spatial and statistical analysis to identify patterns and determinants of the development of Yogyakarta City]," *Maj. Geogr. Indones.*, vol. 35, no. 2, pp. 156–162, 2021.

[24] A. E. Sejati, A. Sugiarto, P. T. Anasi, S. Utaya, and S. Bachri, "Tantangan filsafat geografi dalam perkembangan geografi terkini: Kajian on-tologi, epistemologi, aksiologi, dan etika [Challenges of the philosophy of geography in the development of recent geography: A study of ontology, epistemology, axiology, and ethics]," *Maj. Geogr. Indones.*, vol. 36, no. 2, pp. 126–134, 2022, doi: 10.22146/mgi.74942.

[25] I. Ardiansyah and S. Wagistina, "Pola spasial dan keputusan keluarga bermukim di permukiman kumuh pusat kota dan wilayah pinggiran Kota Malang, Jawa Timur [Spatial patterns and family decisions to settle in slum settlements in the city center and suburban areas of Malang City, East Java]," *Maj. Geogr. Indones.*, vol. 35, no. 1, pp. 64–74, 2021.

[26] A. A. Pradana, E. Anggraini, M. K. Pambayun, F. Muhammad, and A. H. Wahyudi, "Analisis tren frekuensi banjir kali Mriwong [Analysis of flood frequency trends in the Mriwong River]," *Maj. Geogr. Indones.*, vol. 39, no. 2, pp. 112–119, 2025, doi: 10.22146/mgi.70636.

[27] M. N. Sadewo and I. Buchori, "Simulasi perubahan penggunaan lahan akibat pembangunan kawasan industri Kendal (KIK) berbasis cellular automata [Simulation of land use changes due to the development of the Kendal Industrial Area (KIK) based on cellular automata]," *Maj. Geogr. Indones.*, vol. 32, no. 2, pp. 142–154, 2018, doi: 10.22146/mgi.33755.

[28] H. Prayogi, H. Setiadi, Supriatna, and Dewayany, "Model prediksi perubahan penutup lahan di Kota Kabupaten Majalengka menggunakan metode cellular automata markov chain [Land cover change prediction model in Majalengka Regency using the Markov Chain cellular automata method]," *Maj. Geogr. Indones.*, vol. 138, no. 2, pp. 114–126, 2024, doi: 10.22146/mgi.70636.

[29] R. P. Dewi and H. E. Putri, "Penurunan minat studi geografi di Indonesia: Tren, tantangan, dan prediksi ke depan [Declining interest in geography studies in Indonesia: Trends, challenges, and future predictions]," *Maj. Geogr. Indones.*, vol. 39, no. 2, pp. 183–191, 2025, doi: 10.22146/mgi.70636.

[30] A. Nurkholis *et al.*, "Analisis MRC untuk karakterisasi akuifer karst di Mataair Mudal, Kabupaten Kuloprogo [MRC analysis for karst aquifer characterization at Mudal Spring, Kuloprogo Regency]," *Maj. Geogr. Indones.*, vol. 33, no. 2, pp. 22–28, 2019.