

# THE RELATIONSHIP BETWEEN RESIDENTIAL LAND COVER CHANGE AND URBAN POLICY IN MALANG CITY: CASE STUDIES AND RECOMMENDATIONS

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**Kevie Desderius<sup>1\*</sup>, Arief Hargono<sup>2</sup>, Aditya Prana Iswara<sup>3</sup>**

<sup>1\*</sup> Master of Disaster Management, Graduate School, Airlangga University, [kevie.desderius-2023@pasca.unair.ac.id](mailto:kevie.desderius-2023@pasca.unair.ac.id)

<sup>2</sup> Master of Disaster Management, Graduate School, Airlangga University, [arief.hargono@fkm.unair.ac.id](mailto:arief.hargono@fkm.unair.ac.id)

<sup>3</sup> Master of Disaster Management, Graduate School, Airlangga University, [aditya.prana@pasca.unair.ac.id](mailto:aditya.prana@pasca.unair.ac.id)

\*Corresponding

**Kevie Desderius**

Corresponding author's email:

[kevie.desderius-2023@pasca.unair.ac.id](mailto:kevie.desderius-2023@pasca.unair.ac.id)

author:

## ABSTRACT

This study aims to analyse the relationship between changes in residential land cover and urban policy dynamics in Malang City. With rapid population growth and increasing urbanisation, demand for residential land has surged. The methods used in this study are spatial analysis of satellite imagery and a qualitative approach to evaluate policies implemented by local governments. The results of the study show that changes in residential land cover in Malang City are closely related to existing spatial planning policies that are often not aligned with the community's need for decent housing. In addition, recommendations are offered to improve integration between land-use planning and settlement policies, creating a more sustainable urban environment that is responsive to social dynamics. This research is expected to contribute to the development of more effective urban policies in the future.

**Keywords:** Land Cover, Malang City, Urban Policy, Settlement, Spatial Planning

## 1.0 INTRODUCTION

The development of settlements in Malang City has become a major concern in urban planning, particularly amid rapid urbanisation and population growth (Wagistina & Antariksa, 2019). Malang City, one of the main urban centres in East Java, faces significant challenges in managing land cover changes amid high housing demand (Rachmansyah & Halim, 2019). These changes are often out of control and have the potential to disrupt the balance of the environment and urban spatial planning. In this context, it is important to understand how urban policies shape changes in residential land cover and, conversely, how these changes affect policy decision-making (Yasin et al., 2020).

Previous studies have shown that spatial planning policies in many developing cities are often less adaptive to changing societal needs (Hurliman et al., 2021). In Malang City, this phenomenon is reflected in the emergence of informal settlement areas and the mismatch between the regional spatial plan (RTRW) and the reality on the ground (Adrianto, 2022). Related studies also indicate that the lack of integration between spatial planning and settlement policies can exacerbate socio-economic problems, such as inequality of access to decent housing (Kajiita & Kang'ethe, 2024). Therefore, this study seeks to fill this gap by exploring in greater depth the relationship between urban policy and residential land cover change.

This study hypothesises that there is a significant relationship between residential land cover change and urban policy in Malang City. To test this hypothesis, the study used a spatial analysis approach based on satellite imagery to map changes in land cover over time (Latue, 2023). In addition, qualitative methods, through in-depth interviews with stakeholders and document studies, are used to understand the development of urban policies in Malang City. This approach allows research to identify spatial patterns of land change while evaluating the effectiveness of policies in responding to community needs.

The results of this study are expected to contribute to a better understanding of the interaction between urban policy and settlement development dynamics. The findings can also provide strategic recommendations for local governments in formulating more responsive and sustainable spatial planning policies. By understanding the patterns of land cover change and their impact on society, the government can design spatial planning strategies that are not only oriented towards physical development but also take into account social and environmental aspects (Thahir, 2023; Siregar et al., 2025).

The article begins with a review of the literature on settlement development and urban policy, providing a theoretical context for this research. The next section describes the research methodology, including the spatial and qualitative data collection techniques used. The findings will be presented in detail in the results and discussion section, where an in-depth analysis will be conducted to answer the research questions. This article concludes with a summary of the main findings and policy recommendations to support more effective spatial management in Malang City.

With this interdisciplinary approach, this research not only makes an academic contribution but also offers practical implications for future urban planning. The city of Malang can serve as an example of how integrating spatial analysis and policy evaluation can yield innovative solutions to urban challenges. This research is expected to serve as a reference for policymakers and academics in creating an urban environment that is more inclusive, sustainable, and adaptable to society's socio-economic dynamics.

## **2.0 LITERATURE REVIEW**

### **2.1 Changes in Residential Land Cover**

Land cover change, especially in urban areas, is often associated with urbanisation and population growth (Zhai et al., 2021). A study in Kedungkandang, Malang, shows that infrastructure plays an important role in land cover change. Technology-based prediction models, such as Artificial Neural Networks (ANNs), achieve high accuracy in mapping these changes (Hariyanto et al., 2024). Another study in Malang also revealed that the conversion of agricultural land to settlements has increased significantly over the past two decades, driven by the need for housing due to rapid population growth (Darmawan et al., 2024). This trend aligns with the global trend, in which urbanisation leads to the expansion of built-up areas and the decline of green land, increasing surface temperatures and contributing to environmental degradation (Arshad et al., 2022).

### **2.2 Urban Policy and Its Influence**

Urban policies have an important role in regulating land cover change. In Chengdu, China, spatial planning policies integrated with economic reforms and housing markets have successfully guided the city's growth in a more targeted manner (Lu et al., 2022). Conversely, the lack of coordination between spatial planning policies and community needs can exacerbate socio-economic problems, such as inequality in access to decent housing (Abascal et al., 2022). A study in Chennai, India, highlighted the importance of policies that support green development to mitigate the negative impacts of land-use change on water resources (Razi et al., 2024). This research shows that spatial data-driven policies can help governments design more effective mitigation strategies.

### **2.3 Sustainable Development Theories**

Sustainable development theory is a framework that integrates economic, social, and environmental aspects in a balanced manner to achieve development that not only meets the needs of today but also ensures the fulfilment of future generations' needs (Hariram et al., 2023). In the context of urban planning, this theory emphasises the need for effective and inclusive resource management that ensures social welfare while preserving the environment (Gupta & Vegelin, 2016). This approach demands cross-sector coordination and community participation as key success factors. The application of sustainable development principles is an important foundation in formulating spatial planning policies and settlement management that are adaptive to social and environmental changes (Schetke et al., 2012). This theory is highly relevant to the study of land cover dynamics in urban areas within a sustainable development framework.

## 2.4 Urban Spatial Planning Theories

Spatial planning theory concerns regulating the use of space through policies and regulations that direct regional development in a structured and systematic manner (Acheampong, 2018). This theory links spatial policy to land-use change, focusing on regulating land functions to meet ecological, social, and economic needs (Gomes et al., 2024). This approach positions physical planning as the primary instrument for achieving integrated development and management of regional resources (Harahap et al., 2023). Urban spatial planning is the foundation for the arrangement of settlements, green areas, and infrastructure to create a harmonious, efficient, and sustainable urban environment (Wang et al., 2023). The integration of this theory is important in understanding how urban policies affect patterns of land cover change in developing cities.

## 2.5 Complex Adaptive Systems (CAS) Theories

Complex Adaptive Systems Theory views cities as dynamic, complex systems in which various elements and actors interact and adapt to changing internal and external conditions (Shi et al., 2021). In the context of changing land cover, the CAS approach helps explain how factors such as policies, community behaviour, economics, and the environment interact and shape changing patterns of settlement and land use (Daba & You, 2022). This theory emphasises the importance of flexibility, adaptability, and the ability of systems to learn from change to achieve long-term balance and sustainability (Alzoraiki et al., 2024). The CAS approach provides a holistic perspective for designing planning interventions that can accommodate the uncertainty and complexity of urban dynamics.

## 2.6 Concept of "Verbrechting Village" and "Indlansche Gementee"

*Verbrechting Village* is a village concept introduced by the Dutch colonial government to prevent the spread of disease outbreaks from slums. This system aims to control and separate people based on social status (Tucunan et al., 2018). Meanwhile, *Indlansche Gementee* is a Dutch colonial local government system for ordinary citizens, in contrast to *Stads Gementee* for the *priyayi* (Javanese aristocratic) and elites. This system reflects the colonial government's efforts to regulate and segregate communities based on social status (Kusumastuti, 2017).

## 2.7 Methodological Approach in the Study of Land Change

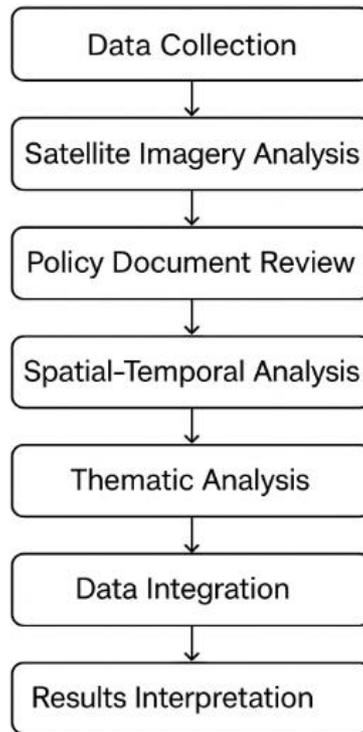
Studies analysing land cover changes commonly rely on satellite imagery and spatial analytical tools to capture temporal dynamics effectively (Abebe et al., 2022; Furusawa et al., 2023; Rambe et al., 2024). Models such as the Patch-Generating Land Use Simulation (PLUS) have been utilised to forecast land cover changes under varying socio-economic scenarios (Tian et al., 2022). Supervised classification techniques have proven effective for accurate land-use monitoring, as demonstrated in regions such as Balochistan and Sindh (Raza et al., 2024). These approaches provide essential evidence for informed urban planning and land management decisions.

## 2.8 Theoretical Framework for Urban Land Change Analysis

Urban land change analysis requires integrating socio-economic, environmental, and policy dimensions under dynamic frameworks. Sustainable development theory, urban spatial planning, and CAS collectively underpin a comprehensive framework that explains land cover change not simply as a physical transformation but as the outcome of complex interactions among human behaviours, policy governance, and ecosystem responses. This integrated theoretical perspective guides the interpretation of spatial data and policy assessment, enabling a nuanced understanding of how urban policies shape land use patterns while responding to environmental and social sustainability imperatives. Employing this framework strengthens the connection between empirical findings and policy recommendations in urban land management.

## 3.0 METHODOLOGY

This study employs a mixed-methods approach, integrating quantitative spatial analysis with qualitative policy analysis, to explore the relationship between residential land cover change and urban policy in Malang City (Sarfio et al., 2022). The research is structured into three main stages: (1) mapping land cover change using satellite imagery processed with machine learning algorithms, (2) analysing policies through document reviews and stakeholder interviews, and (3) integrating spatial and qualitative data to identify patterns of linkage (Figure 1).



**Fig. 1:** Research Method Flowchart  
(Source: Researchers' Analysis, 2025)

### **Spatial Data Collection**

The spatial data collection utilises an integrated approach via the Google Earth Engine (GEE) cloud computing platform to access multitemporal satellite imagery from the USGS Earth Explorer and the Copernicus Open Access Hub (Amani et al., 2020). The dataset includes Landsat 5-7 imagery at 50-meter resolution (1979–2000) and Landsat 8-9 imagery at 30-meter resolution (2000–2025). Land cover classification is performed using the Random Forest (RF) algorithm within GEE, categorising land into three primary classes: built-up areas (settlements and infrastructure), green areas (vegetation and agricultural land), and water bodies (rivers, lakes, reservoirs) (Pande et. al., 2024). This method has been validated in multiple studies as efficient and accurate for land cover classification, benefiting from GEE's capability for processing large satellite datasets with high spatial and temporal resolution

### **Policy Study Analysis**

The policy analysis focuses on reviewing settlement policies in Indonesia with a specific emphasis on Malang City, periodised into the Independence Era, New Order, and Reform periods. A thematic analysis method is employed to systematically identify key policy themes related to slum improvement, housing accessibility, and environmental sustainability (Batra, 2021). Policy data are gathered from official government documents, prior research, and scientific publications, including central government policies, regional regulations (Perda), and the Regional Medium-Term Development Plan (RPJMD). To enhance the validity of the findings, in-depth interviews were also conducted with key stakeholders involved in urban planning and policy implementation. These interviews provided contextual insights and helped triangulate the documentary analysis.

### **Thematic Analysis**

The thematic analysis was conducted through several interrelated steps. First, key themes were identified, and settlement policies were categorised by period and central issue. Subsequently, the data were coded and organised using qualitative analysis techniques to ensure consistency and depth of interpretation. Finally, a chronological policy periodisation was prepared to highlight the shifts in strategic approaches to settlement development over time.

## **Contextualisation**

The periodisation of settlement policy development in Indonesia can be divided into three major phases. The Independence Era (1945–1966) was characterised by efforts to establish the initial legal and policy foundations related to settlements. During the New Order period (1966–1998), the focus shifted to large-scale infrastructure expansion and mass housing programs, with significant impacts on urban communities. In the Reform Era (1998–present), settlement policies underwent a paradigm shift toward greater inclusivity, emphasising sustainability and community participation in planning and development. The integration of spatial and policy data adopts a qualitative descriptive approach to correlate land cover changes detected via multitemporal satellite imagery (Landsat and Sentinel) with policy evolution (Liu & Cai, 2012). Thematic key policy points are linked to observed spatial patterns of land change.

## **Data Validation and Interpretation**

Data triangulation is conducted through in-depth interviews with relevant stakeholders, including city planners and local communities, to validate findings (Ogunkan & Akinpelu, 2025). This integrated methodological approach provides a comprehensive understanding of the interplay between urban policy and land cover dynamics, thereby supporting the formulation of evidence-based, sustainable settlement policy recommendations.

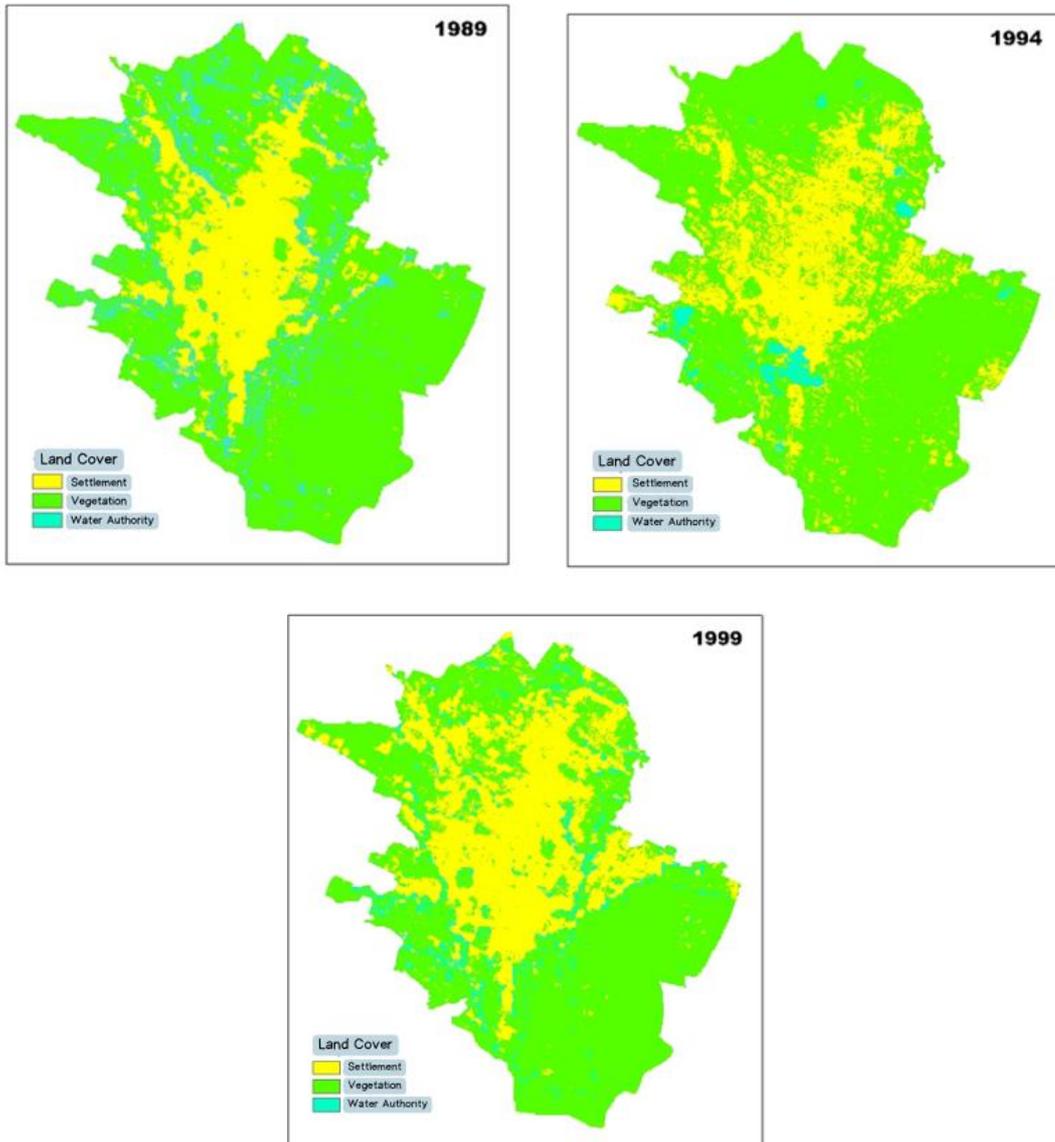
## **4.0 RESULTS**

### **Results of Land Cover Changes in Malang City**

The results of the land cover analysis in Malang City for 1989, 1994, and 1999 show significant changes in land classification, including settlements, vegetation, and water bodies (Figure 2). In 1989, it was visually evident that the largest area was vegetation, followed by residential areas, while water bodies had the smallest area. In 1994, residential areas began to spread, especially in the northern and southern areas, and expanded to the east and west sides of Malang City. The decrease in vegetated land that year can be attributed to the expansion of residential areas and the increase in areas classified as water bodies.

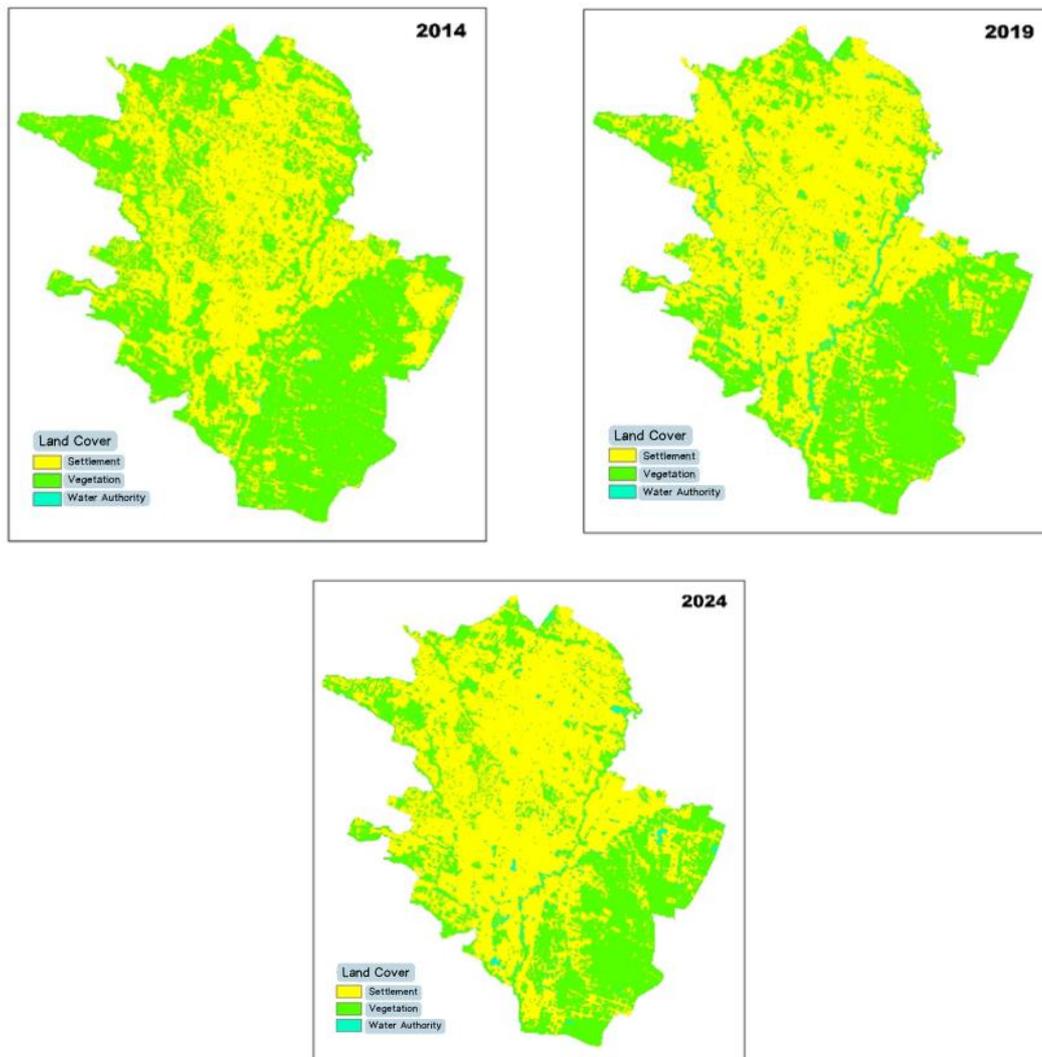
Furthermore, based on 1999 land cover data, residential development occurred more in the northern part of Malang City. Compared to the previous two periods, residential areas are expanding, while vegetated areas are decreasing. This change indicates the ongoing urbanisation trend in Malang City, which has the potential to affect the balance of the ecosystem and environmental quality. Therefore, it is important to consider sustainable land management strategies to maintain green open space and reduce the negative impacts of settlement expansion.

The results of the land cover analysis in Malang City (Figure 3) show that in 2014, residential areas dominated the city, with vegetation conditions declining. In that year, although there was still vegetated land on some of the north and south sides, the development of settlements was becoming clearly visible. Then, in 2019, settlement expansion extended into previously vegetated areas on the north and south sides, reducing the area of vegetated land through conversion to settlements.



**Fig. 2:** Land Cover of Malang City, Indonesia for the Period of 1989, 1994 and 1999  
 (Source: Researchers' Analysis and Interpretation of USGS Landsat Imagery, 2025)

In 2024, land cover shows that residential areas are expanding across various areas of Malang City, while vegetated areas are concentrated in the southern part of the city. These changes reflect the ongoing urbanisation trend and show a significant impact on local ecosystems. A decrease in vegetation area can affect environmental quality and the balance of ecosystems. Hence, the government needs to formulate policies that manage settlement growth sustainably and protect the remaining green open space.



**Fig.3:** Land Cover of Malang City, Indonesia for the Period of 2014, 2019 and 2024  
 (Source: Researchers' Analysis and Interpretation of USGS Landsat Imagery, 2025)

### Policies Assessment

Several key policies were analysed to understand their influence on changes in residential land cover in Malang City, including the Regional Spatial Plan (RTRW), the KOTAKU and PNPM programs, and the Regional Regulations on settlement planning and green open space management. The Malang City Regional Spatial Plan (RTRW) has served as a strategic planning document governing land use and spatial management within the city for over 20 years. It functions as the principal guideline for urban development, aiming to maintain a balance between residential growth, economic zones, and the preservation of green open spaces in support of sustainable development. The KOTAKU (City Without Slums) and PNPM (National Program for Community Empowerment) programs represent national initiatives focused on improving settlement quality, particularly in slum areas. KOTAKU emphasises revitalising residential environments through community and stakeholder participation, while PNPM promotes grassroots empowerment in planning and managing neighbourhood infrastructure and facilities. Complementing these, the Regional Regulation (Perda) on settlement planning and green open space provides more detailed provisions for land-use control, spatial organisation, and environmental preservation. This regulation reinforces legal protection for urban green areas, supports ecological and social functions, and establishes sustainability standards in the residential sector.

### Development of Settlement Policy in Malang City

The development of settlement policy in Malang City is discussed in four (4) periods: before Independence, the independence era, the New Order era, and the Reform era.

Before Independence, settlement policies in Indonesia, including in Malang City, originated during the Dutch colonial period. At that time, the *Verbrechting Village* concept was introduced to prevent the spread of infectious diseases from slum areas. Society was classified into social strata, with the *Indlansche Gementee* system applied to ordinary citizens and the *Stads Gementee* reserved for the *priyayi*, or Javanese aristocratic and bureaucratic elites. This policy reflected the colonial government's effort to control and segregate communities based on social status while addressing public health issues arising from poor living conditions.

During the Independence Era, following Indonesia's Independence, the government launched the *Kampung Improvement Program (KIP)* in the 1960s. This initiative aimed to enhance the physical and infrastructural quality of residential areas, particularly in underdeveloped urban neighbourhoods. Despite limited financial and technical resources, the program marked an important shift toward improving community welfare, especially in slum areas requiring immediate intervention.

In the New Order Era, settlement development was guided by the *Repelita (Five-Year Development Plan)*, which adopted the *Tribina* and *Tridaya* approaches. The *Tribina* concept emphasised physical, economic, and social development, while *Tridaya* focused on strengthening environmental, economic, and social capacities. In 1989, the government introduced the *Group-Based Housing Development Program (P2BK)*, promoting community participation and self-reliance in managing settlements. This approach encouraged local communities to play an active role in developing and maintaining their living environments.

During the Reform Era, continuous evaluations were conducted to enhance the effectiveness and relevance of urban settlement policies. For instance, the *Kampung Improvement Program* evolved into *KIP-K* in Surabaya, serving as a more comprehensive model later adopted nationwide. The government subsequently launched the *National Program for Community Empowerment (PNPM)*, which integrated various initiatives to improve urban settlements. Under President *Joko Widodo's* administration, particularly during his first term, the *KOTAKU (City Without Slums)* program was introduced as part of the 2015–2019 *National Medium-Term Development Plan (RPJMN)*. This program focused on reducing and revitalising urban slums through community-based, sustainable development strategies.

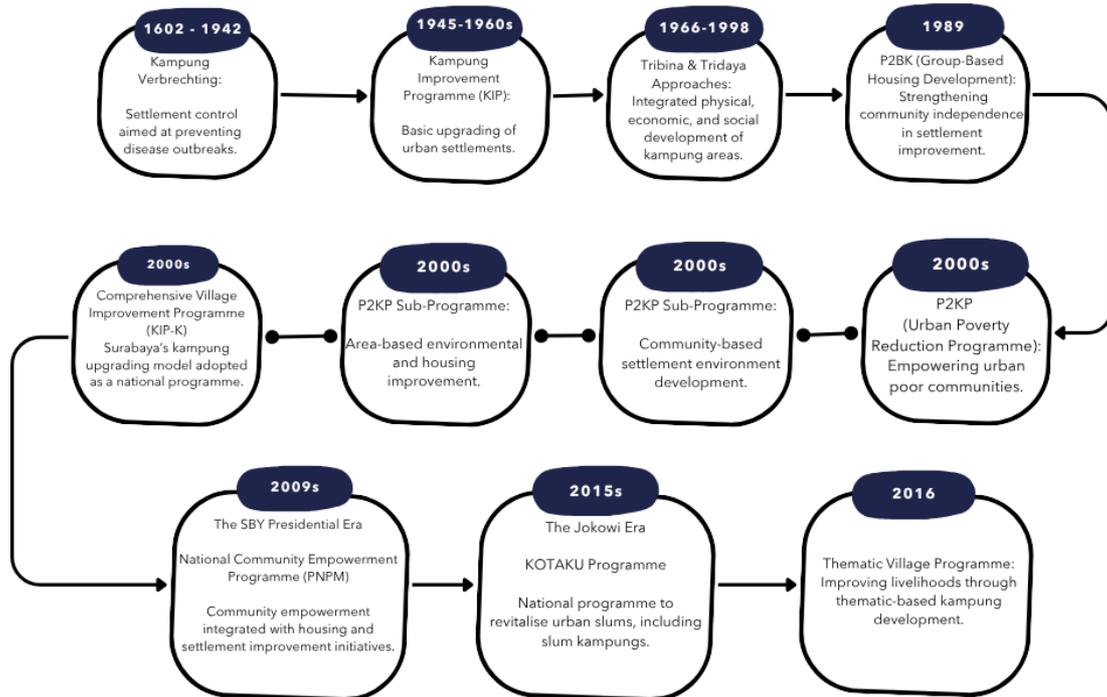
**Table 1: Development policies that affect land change**

Period	Key Policies	Impact on Land Change
Pre-Independence	<i>Verbrechting Village</i> , <i>Indlansche Gementee</i>	Social segregation and controlled settlement
Independence Era	<i>Kampung Improvement Program (KIP)</i>	Focus on physical infrastructure
New Order	<i>Tribina-Tridaya</i> , <i>P2BK Program</i>	Mass housing development
Reform Era	<i>PNPM</i> , <i>KOTAKU Program</i>	Participatory and sustainable approach

Source: Researchers' Analysis, 2025

In line with the *KOTAKU* program at the national level, the Malang City Government also designed and initiated the *Thematic Village Program* to improve the living standards of people in various marginalised areas. Through this approach, a better, more sustainable environment can be created for the people of Malang City.

## The development of village policies in Malang City



**Fig.4: Timeline of Settlement Policy Development in Malang City, Indonesia**  
(Source: Researcher's Analysis of Various Policy Literature, 2025)

## 5.0 DISCUSSIONS

The results of this study strengthen the hypothesis that residential land cover changes in Malang City are closely related to urban policy dynamics over the past few decades. Spatial analysis reveals significant settlement expansion from the late 1980s to 2019, particularly in the city's northern and southern parts. This growth aligns with sustainable development theory, which holds that urban expansion driven by socio-economic needs should be balanced with environmental conservation. However, in Malang, it has led to a substantial reduction in vegetation and green open spaces (Isdianto et al., 2025). Such loss affects ecological balance and challenges the environmental dimension of sustainability frameworks.

During the New Order era, urban policies emphasised physical infrastructure and economic development, following a top-down spatial planning approach (Tjondronegoro, 1978). This approach neglected broader socio-economic impacts and environmental integration, a detail explicated in urban spatial planning theory, which warns against overly rigid land-use regulations detached from community needs. Consequently, social inequalities and spatial planning problems emerged due to this disjointed governance. This statement highlights the risks of non-adaptive planning, which fails to address the complex, multidimensional nature of urban systems.

During the Reform era, a paradigm shift toward participatory, sustainable policy approaches emerged, reflecting adaptive spatial planning concepts that emphasise flexibility and inclusivity (Haqi, 2023). Nevertheless, challenges such as weak cross-sector coordination and limited local government capacity slowed effective implementation. The gap between formal plans and on-ground realities persists, indicating the difficulty in achieving truly adaptive and community-responsive urban governance. This gap exacerbates informal settlement growth and misaligned land-use change.

A significant issue identified is the lack of synchronisation between the Regional Spatial Plan (RTRW) and the community's actual needs, which drives unplanned expansions outside designated zones. This problem, coupled with weak law enforcement, accelerates the conversion of green areas to residential land. From an Urban Heat

Island perspective, such loss of vegetation increases urban heat accumulation, contributing to higher localised temperatures and degraded living comfort—a pattern observed globally, where reduced green cover intensifies urban climatic stresses (Singh et al., 2020).

The growth of informal settlements due to planning inconsistencies raises serious socio-economic challenges, including unequal access to public services and increased disaster vulnerability. Sustainable urban development theory suggests that such issues require integrative policy frameworks that link physical, social, and environmental aspects cohesively (Ajrotutu et al., 2024). Addressing these challenges demands participatory planning and policies that explicitly incorporate equity and resilience principles.

In-depth interviews conducted during this study further validate the long-standing dynamics of land-use change in Malang City's marginal areas. A representative from the Spatial Planning Division of the Malang City Planning Office confirmed that "the development of settlements in marginal areas is part of a long-standing dynamic. The agency is only responsible for ensuring no new construction occurs in these areas, while enforcement lies with the mayor's office and the municipal police. For instance, riverbank zones also involve other authorities such as the Provincial Government, Perum Jasa Tirta, and the Brantas River Basin Authority." This policy highlights the fragmented institutional responsibilities that complicate enforcement and coordination in managing marginal lands.

Community perspectives also reveal deep-rooted historical settlement patterns. A resident representative from a riverbank tourism village stated, "We have lived here for a long time, since our parents and grandparents. So we are simply continuing to live here." This statement underscores the intergenerational nature of informal settlement in marginal areas, where tenure is shaped more by legacy than legality.

Additionally, a local spatial planning academic emphasised that "the development of settlements in marginal areas of Malang City is a consequence of high urbanisation rates and the city's role as a national activity centre in East Java, alongside Surabaya." This statement reinforces the structural pressures driving land conversion and the need for more adaptive, inclusive, and anticipatory planning responses.

Remote sensing technologies and spatial data analytics used in this study are vital for accurately capturing land cover dynamics and enabling informed, evidence-based decision-making. Combining spatial data with thorough policy evaluation helps identify priority intervention zones, supporting the development of effective land management strategies. This integration is crucial for building adaptive governance systems in line with contemporary spatial planning research.

Post-Reform policy reforms have increased opportunities for community participation and focus on sustainability, echoing multi-stakeholder governance frameworks. Collaboration among government, society, and the private sector enhances planning responsiveness and counters centralist inefficiencies. This participatory governance model is fundamental to effectively managing the growing complexities of urban life and environmental constraints.

This study underscores the essential integration of spatial planning, settlement policy, and environmental protection. Unregulated residential land cover change threatens both urban livability and long-term sustainability. In response, urban policies must evolve towards adaptive, data-driven, and ecologically sensitive approaches that embody sustainable development and adaptive spatial planning principles. Strengthening the partnership between spatial and socio-economic policies is urgently needed to resolve informal settlement issues and access inequalities. An inclusive, data-supported governance approach can boost policy effectiveness and equity, promoting just and sustainable urban development. Furthermore, robust supervision, regulatory enforcement, institutional capacity development, and community empowerment remain key to realising democratic and adaptive urban spatial planning.

Overall, this research offers a comprehensive understanding of the complex interplay between land cover change and urban policy in Malang City. The findings provide a theoretically grounded and practical basis to formulate more effective policy strategies, applicable not only locally but also in similar urbanising contexts. Future research should deepen explorations of adaptive governance mechanisms and further leverage spatial technologies to advance sustainable urban futures.

## 6.0 CONCLUSION

This study reveals that spatial planning policies significantly influence residential land cover changes in Malang City; however, these policies have historically emphasised physical development without adequate integration of social and environmental dimensions. Such an approach has contributed to declining environmental quality and uneven community welfare. Nevertheless, advances in spatial technologies and post-Reformation policy reforms have created opportunities for more participatory, inclusive, and sustainable settlement planning. The rapid expansion of residential areas between 1989 and 2024 underscores the urgent need for adaptive urban planning strategies that balance physical growth with socio-environmental resilience.

Specific policy recommendations are proposed to promote more sustainable settlement development in Malang City. First, implementing smart growth principles through compact development and mixed-use zoning is essential to prevent uncontrolled urban sprawl. Establishing green belt policies, supported by strict enforcement mechanisms, is also necessary to preserve the remaining vegetated areas, particularly in the southern part of the city. Furthermore, community-based settlement planning should be strengthened by integrating local participation into decision-making processes to ensure social inclusivity and local relevance. In addition, urban heat island mitigation strategies should be developed through the enforcement of mandatory green space requirements for new residential projects. Finally, inter-agency coordination among spatial planning, environmental, and housing authorities must be enhanced to achieve coherent, well-integrated urban policies.

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## REFERENCES

- Abascal, A., Rothwell, N., Shonowo, A., Thomson, D. R., Elias, P., Else, H., ... & Kuffer, M. (2022). "Domains of deprivation framework" for mapping slums, informal settlements, and other deprived areas in LMICs to improve urban planning and policy: A scoping review. *Computers, environment and urban systems*, 93, 101770.
- Abebe, G., Getachew, D., & Ewunetu, A. (2022). Analysing land use/land cover changes and their dynamics using remote sensing and GIS in Gubalafito district, Northeastern Ethiopia. *SN Applied Sciences*, 4(1), 30.
- Acheampong, R. A. (2018). The concept of spatial planning and the planning system. In *Spatial planning in Ghana: origins, contemporary reforms and practices, and new perspectives* (pp. 11–27). Cham: Springer International Publishing.
- Adrianto, D. (2022). *Peri-Urbanisation and the Emergence of Integrated Spatial Planning and Governance- Managing the Growth of Peri-Urban Areas in the Secondary City-Regions of Indonesia* (Doctoral dissertation, The University of Manchester (United Kingdom)).
- Ajirotutu, R. O., Adeyemi, A. B., Ifechukwu, G. O., Iwuanyanwu, O., Ohakawa, T. C., & Garba, B. M. P. (2024). Designing policy frameworks for the future: Conceptualising the integration of green infrastructure into urban development. *Journal of Urban Development Studies*, 2.
- Alzoraiki, M., Milhem, M., Ateeq, A., Almeer, S., & Hussein, T. M. (2024). Strategic flexibility: an essential capability for innovation and sustainable performance in times of technological uncertainty. In *Business Development via AI and Digitalisation: Volume 1* (pp. 271–281). Cham: Springer Nature Switzerland.
- Amani, M., Ghorbanian, A., Ahmadi, S. A., Kakooei, M., Moghimi, A., Mirmazloumi, S. M., ... & Brisco, B. (2020). Google Earth Engine cloud computing platform for remote sensing big data applications: A

- comprehensive review. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 13, 5326–5350.
- Arshad, S., Ahmad, S. R., Abbas, S., Asharf, A., Siddiqui, N. A., & ul Islam, Z. (2022). Quantifying the contribution of diminishing green spaces and urban sprawl to the urban heat island effect in a rapidly urbanising metropolitan city of Pakistan. *Land use policy*, 113, 105874.
- Batra, R. (2021). A thematic analysis to identify barriers, gaps, and challenges for the implementation of public-private partnerships in housing. *Habitat International*, 118, 102454.
- Daba, M. H., & You, S. (2022). Quantitatively assessing the future land-use/land-cover changes and their driving factors in the upper stream of the Awash River based on the CA–Markov model and their implications for water resources management. *Sustainability*, 14(3), 1538.
- Darmawan, A. A., Sejati, W., Mahabella, L. S., & Adibah, A. N. (2024, May). Changes in Runoff Coefficient Index as a Result of Land Use Change (Case Study: Malang City). In *IOP Conference Series: Earth and Environmental Science* (Vol. 1343, No. 1, p. 012031). IOP Publishing.
- Furusawa, T., Koera, T., Siburian, R., Wicaksono, A., Matsudaira, K., & Ishioka, Y. (2023). Time-series analysis of satellite imagery for detecting vegetation cover changes in Indonesia. *Scientific reports*, 13(1), 8437.
- Gomes, E., Costa, E. M. D., & Abrantes, P. (2024). Spatial planning and land-use management. *Land*, 13(1), 94.
- Gupta, J., & Vegelin, C. (2016). Sustainable development goals and inclusive development. *International environmental agreements: Politics, law and economics*, 16(3), 433–448.
- Haqi, F. I. (2023). From policies to actions: Mayoral leadership and local government's impact on urban resilience in Indonesia. *Journal of Resilient Economies*, 3(2), 62-76.
- Harahap, M. A. K., Tanipu, F., Manuhutu, A., & Supriandi, S. (2023). Relations between Architecture, Urban Planning, Environmental Engineering, and Sociology in Sustainable Urban Design in Indonesia (Literature Study). *J. Geosains West Sci*, 1(02), 77-88.
- Hariyanto, A. D., Yudono, A., & Wicaksono, A. D. (2024). Comparison of Land Cover Change Prediction Models: A Case Study in Kedungkandang District, Malang City. *Geoplanning: Journal of Geomatics and Planning*, 1.
- Hariram, N. P., Mekha, K. B., Suganthan, V., & Sudhakar, K. (2023). Sustainalism: An integrated socio-economic-environmental model to address sustainable development and sustainability. *Sustainability*, 15(13), 10682.
- Hurlimann, A., Moosavi, S., & Browne, G. R. (2021). Urban planning policy must do more to integrate climate change adaptation and mitigation actions: *Land Use Policy*, 101, 105188.
- Isdianto, A., Hasyim, A. W., Sukojo, B. M., Alimuddin, I., Anggraini, I. A., & Fatahillah, E. R. (2025). Integrating Urban Design with Natural Dynamics: Enhancing Ecological Resilience in Malang City over a Decade. *International Journal of Sustainable Development & Planning*, 20(3).
- Kajiita, R. M., & Kang'ethe, S. M. (2024). Socio-Economic Dynamics Inhibiting Inclusive Urban Economic Development: Implications for Sustainable Urban Development in South African Cities. *Sustainability*, 16(7), 2803.
- Kusumastuti, K. (2017). The old phase of Javanese villages was an early form of participatory democratic governance in Indonesia—*Journal of Regional and City Planning*, 28(3), 220.
- Latue, P. C. (2023). Analisis Spasial Temporal Perubahan Tutupan Lahan di Pulau Ternate Provinsi Maluku Utara Citra Satelit Resolusi Tinggi. *Buana Jurnal Geografi, Ekologi Dan Kebencanaan*, 1(1), 31-38.
- Liu, D., & Cai, S. (2012). A spatial-temporal modelling approach to reconstructing land-cover change trajectories from multi-temporal satellite imagery. *Annals of the Association of American Geographers*, 102(6), 1329–1347.
- Lu, W., Li, Y., Zhao, R., & Wang, Y. (2022). Using remote sensing to identify urban fringe areas and their spatial pattern of educational resources: A case study of the Chengdu-Chongqing economic circle. *Remote Sensing*, 14(13), 3148.
- Ogunkan, D. V., & Akinpelu, O. P. (2025). Methodology mayhem in urban planning research: a call for methodological triangulation. *Quality & Quantity*, 1-26.
- Pande, C. B., Srivastava, A., Moharir, K. N., Radwan, N., Mohd Sidek, L., Alshehri, F., ... & Zhran, M. (2024). Characterising land use/land cover change dynamics by an enhanced random forest machine learning model: a Google Earth Engine implementation. *Environmental Sciences Europe*, 36(1), 84.
- Rachmansyah, A., & Halim, L. F. (2019). Sustainable Development Approach To Residential Planning In The Rapid Growth Urban Area: A Case Study In Singosari District, Malang Region, East Java Province. *Geographia Technica*, 14.
- Rambe, M. M. S., Alvisyahrin, T., & Sugianto, S. (2024). Analisis Penggunaan Lahan Eksisting Berdasarkan Pola Ruang Menggunakan Citra Satelit dengan Metode Visual On Screen (Studi Kasus: Tapanuli

- Tengah). *Jurnal Ilmiah Mahasiswa Pertanian*, 9(4), 433-441.
- Raza, A., Syed, N. R., Fahmeed, R., Acharki, S., Aljohani, T. H., Hussain, S., ... & Abdo, H. G. (2024). Investigation of changes in land use/land cover using principal component analysis and supervised classification from operational land imager satellite data: a case study of underdeveloped regions, Pakistan. *Discover Sustainability*, 5(1), 73.
- Razi S. P. V., Elango, L., Rinisha Kartheeshwari, M., & Keerthan, L. (2024). Forecasting land use/cover changes and their influence on groundwater recharge in Chennai, India: Recommendations for sustainable urban development. *Urban Water Journal*, 21(1), 45–64.
- Sarfo, I., Shuoben, B., Otchwemah, H. B., Darko, G., Kedjanyi, E. A. G., Oduro, C., ... & Ndafira, G. C. (2022). Validating local drivers influencing land use cover change in Southwestern Ghana: a mixed-method approach. *Environmental Earth Sciences*, 81(14), 367.
- Schetke, S., Haase, D., & Kötter, T. (2012). Towards sustainable settlement growth: A new multi-criteria assessment for implementing environmental targets into strategic urban planning. *Environmental Impact Assessment Review*, 32(1), 195-210.
- Shi, Y., Zhai, G., Xu, L., Zhou, S., Lu, Y., Liu, H., & Huang, W. (2021). Assessment methods of urban system resilience: From the perspective of complex adaptive system theory. *Cities*, 112, 103141.
- Singh, N., Singh, S., & Mall, R. K. (2020). Urban ecology and human health: implications of urban heat island, air pollution and climate change nexus. In *Urban ecology* (pp. 317–334). Elsevier.
- Siregar, D. R., Azzahra, N., Fajri, M., Amini, A., Asri, H. H., Setiawan, A., ... & Kamal, E. (2025). The Function Of Spatial Planning In Maintaining The Environmental Preservation Of West Pasaman District. *Jurnal Ilmiah Platax*, 13(1), 144-154.
- Thahir, B. (2023). Memahami Kebijakan Rencana Tata Ruang Wilayah Di Provinsi Banten. *Jurnal Ilmu Pemerintahan Widya Praja*, 49(1), 102-115.
- Tian, L., Tao, Y., Fu, W., Li, T., Ren, F., & Li, M. (2022). Dynamic simulation of land use/cover change and assessment of forest ecosystem carbon storage under climate change scenarios in Guangdong Province, China. *Remote Sensing*, 14(10), 2330.
- Tjondronegoro, S. M. (1978). Recent Indonesian rural development: dilemma of a top-down approach. *Southeast Asian Affairs*, 139-148.
- Tucunan, K. P., Ridwan, Y. H., Putri, A. S., & Soedjono, E. S. (2018, November). Sustainable kampong model in Kelurahan Keputih, Kejawan Putih Tambak and Gebang Putih of Surabaya City. In *IOP Conference Series: Earth and Environmental Science* (Vol. 202, No. 1, p. 012075). IOP Publishing.
- Wagistina, S., & Antariksa, A. (2019). Urban sprawl and residential segregation in Western Suburb Area of Malang City, East Java, Indonesia. *Jurnal Pendidikan Geografi: Kajian, Teori, dan Praktek dalam Bidang Pendidikan dan Ilmu Geografi*, 24(1), 2.
- Wang, J., Yu, C. W., & Cao, S. J. (2023). Planning for sustainable and ecological urban environment: Current trends and future developments. *Indoor and Built Environment*, 32(4), 627–631.
- Yasin, M. Y., Yusoff, M. M., Abdullah, J., & Noor, N. M. (2020). Is urban sprawl a threat to sustainable development? A review of characteristics and consequences. *Geografia*, 16(4).
- Zhai, H., Lv, C., Liu, W., Yang, C., Fan, D., Wang, Z., & Guan, Q. (2021). Understanding spatio-temporal patterns of land use/land cover change under urbanisation in Wuhan, China, 2000–2019. *Remote Sensing*, 13(16), 3331.