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SPATIAL DYNAMICS OF URBAN SPRAWL AND THE CHALLENGES OF TRANSBOUNDARY GOVERNANCE IN BOGOR'S PERI-URBAN

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Abstract

Bogor City, as a satellite of the Jakarta Metropolitan Area, is experiencing demographic pressure and rapid urbanization. This growth has triggered massive spillover effects, manifesting as urban sprawl beyond administrative boundaries into the outskirts of Bogor Regency. This study aims to analyze the spatial dynamics of urban sprawl and analyze the challenges that arise for transboundary governance. Through a mixed-methods approach, this study uses Remote Sensing analysis with assessment by Normalized Difference Built up index (NDBI) and the sprawl index to measure built-up area expansion. Local Indicators of Spatial Association (LISA) analysis to detect significant spatial clusters of development from 2001 to 2023. Interpretative Structural Modelling (ISM) analysis is used to structure the constraints and challenges that occur. The analysis results identify that High-High clusters are located along the northern and western administrative boundaries, indicating that functional urban expansion has been detached from formal spatial planning. It also reveals a significant regulatory gap between city and district governments in the study area. The study concludes that the current rigid administrative-based planning is inadequate to manage peri-urban dynamics. Transformative transboundary governance, which emphasizes cross-jurisdictional synchronization and functional spatial management, is urgently needed to mitigate the negative externalities of uncontrolled urban sprawl and ensure regional sustainability.

Keywords: Index Sprawl, ISM, LISA, NDBI, *Peri-urban area, Transboundary Governance, Urban Sprawl.*

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INTRODUCTION

Rapid urban growth has become an inevitable global phenomenon, with the United Nations (UN) projecting a global increase in the urban population of 2.5 billion by 2050, 90% of which will occur in Asia and Africa (UNDESA, 2019). This rapid growth in urban populations across these two continents often exceeds the capacity of governments to plan and provide housing in city centers (Sudhira et al., 2007). In Southeast Asia, contemporary urbanization is no longer limited to rural-to-urban migration, as noted by McGee (2017); this process has evolved into area-based urbanization, where development spills beyond the boundaries of the core city to form functionally integrated metropolitan areas. This situation has given rise to peri-urban areas, a transitional zone between rural and urban centers characterized by mixed land use, blurred boundaries, and the integration of urban economic activities with rural-style activities (Rakodi, 1998; Webster, 2002; Sahana et al., 2023), where these peri-urban areas serve as preferred residential zones and encourage inefficient land use (Rustiadi et al., 2014) resulting in uncontrolled and haphazard development known as the phenomenon of urban sprawl. Population growth and increasing demands lead to a rise in urban activities, a situation that is accompanied by a significant increase in the need for urban space (Pacione, 2009). As a manifestation of geographical space that accommodates human activity, a city will always experience growth. According Firman (2004), urban growth in Indonesia is physically characterized by rapid expansion in peri-urban. This physical expansion occurs through the phenomenon of urban sprawl, which is a spatial manifestation resulting from the spillover effect that crosses city boundaries; this causes peri-urban areas to act as a receptacle for pressures that can no longer be accommodated (Hudalah et al., 2020).

The urbanization rate in Indonesia reached 56.7% in 2020 and is predicted to reach 66.6% by 2045 (BAPPENAS, 2023). This burden has a direct impact on land conversion in suburban areas. This situation indicates that urban sprawl is not merely a demographic shift, but a tangible pressure on space and ecosystems in peri-urban areas as buffer zones. The City of Bogor and Bogor Regency form part of the Jabodetabek metropolitan area, which has experienced the conditions described above; the physical growth of Bogor City has surpassed its administrative boundaries, encroaching into the peri-urban areas situated within the jurisdiction of Bogor Regency. Within the regional constellation of the Jabodetabek Metropolitan Area, the City of Bogor no longer functions merely as a self-sufficient city but has transformed into a strategic buffer hinterland for DKI Jakarta. The spatial significance of this region over the past decade reflects the pressures of global urbanization, which have triggered massive shifts in land use. Based on primary demographic data, the population of the City of Bogor is

recorded to have grown from 1,013,017 people in 2013 to 1,137,018 people in 2023. This increase in demographic pressure has fueled aggressive dynamics in the peri-urban area, where the need for residential space has overridden environmental carrying capacity considerations.

This consistently high rate of population growth is the main driver of radical physical changes in land cover. The ever-increasing demand for space in these urban areas is fueling the phenomenon of urban sprawl in peri-urban areas. Urban sprawl presents a major challenge for spatial planning, potentially leading to more complex problems such as a decline in environmental quality due to the negative impacts of uncontrolled land conversion. The current trajectory of peri-urban development in Bogor poses significant management challenges, as evidenced by symptoms such as environmental degradation, congestion, disaster risk, and the unpreparedness of government officials to manage these impacts. Therefore, understanding the growth processes at play is essential for creating integrated regional development that does not burden the environment, but rather constitutes a sustainable functional expansion. Although the phenomenon of urban sprawl in the Jakarta Metropolitan area has been extensively studied, the integration of peri-urban spatial dynamics with the institutional capacity of local governments in spatial planning has received insufficient attention. This study aims to address this gap by analyzing the dynamics of peri-urban growth arising from the phenomenon of urban sprawl and formulating management guidelines based on the local government's capacity to plan and control spatial planning.

LITERATURE REVIEW

Urbanization and Urban Development

Traditionally, urbanization has been understood as a demographic process involving the movement of people from rural areas to cities (rural-to-urban migration). However, in the contemporary context, particularly in Asia, this phenomenon has evolved into area-based urbanization. McGee (2017) introduced the concept of Desakota, where in the intensity of interaction between urban and rural activities creates new functional spaces no longer constrained by administrative boundaries. Urbanization today occurs not only through natural growth or migration, but also through the physical expansion of cities that encroach upon surrounding areas (UNDESA, 2019). A city is not a static entity; it is the geographical manifestation of human activity that continues to evolve in line with increasing demand for space (Pacione, 2009). Urban growth is driven by two main forces: centripetal factors (the pull of the city center) and centrifugal factors (outward pressure from the city).

Characteristics of urban sprawl in Peri-urban Areas

Jaeger et al. (2010) explain that urban sprawl is the expansion of built-up areas marked by dispersed and fragmented development and a disproportionately high consumption of land relative to the population indicating inefficient land use. Dadashpoor and Shahhassein (2024) defines urban sprawl as the unplanned, random, and diffuse expansion of the city's physical form into peri-urban areas. Thus, growth in peri-urban areas is not merely a geographical phenomenon of territorial expansion, but also a manifestation of people's need for affordable living space. When this phenomenon is not managed properly, the result is uncontrolled and sporadic development. Visual identification is undertaken as an initial step because urban sprawl is an expression of deviation from compact urban development. Spatially, urban sprawl occurs when physical urban development exceeds the boundaries of city planning or administration (Ewing, 2008). While this step is relatively straightforward, it can identify the physical overflow of urban areas in general. Peri-urban areas are defined as transitional zones between urban centers and rural areas that possess unique characteristics (Jaquinta and Drescher, 2000). Urban sprawl impacts spatial dynamics by fragmenting urban areas and diminishing the efficiency of land use, integration of peri-urban spatial dynamics with the institutional capacity of local governments in spatial planning has received insufficient attention. As suggested by Labuz (2025), the effectiveness of spatial planning strategies is heavily dependent on the integration of monitoring tools and institutional control mechanisms to curb land dispersion. These areas are not merely administrative boundaries, but functional zones where urban economic activities and rural lifestyles interact intensively (Rakodi, 1998). According Webster (2002) and Asli et.al. (2022) emphasizes that peri-urban areas are characterized by mixed land use and increasingly blurred spatial boundaries. In the context of major cities in Indonesia, peri-urban areas function as a receptacle for development pressures that can no longer be accommodated by the city center (Firman, 2004). This dynamic is often driven by the need for housing on more affordable land, which ultimately triggers the massive conversion of productive agricultural land. If left unmanaged, this growth will be sporadic and create inefficiencies in the provision of public infrastructure (Yunus, 2008; Roosni et al. 2016).

Institutional Governance Capacity in Spatial Planning

The challenges in managing peri-urban areas are institutional fragmentation. Physical growth that extends beyond administrative boundaries is often not accompanied by strong inter-regional coordination (Hudalah, 2020; Gallent, 2006). Weak institutional capacity in terms of supervision and control means that spatial planning instruments (such as the RTRW and RDTR) remain merely administrative documents lacking strong enforcement power on the ground.

Consequently, the phenomenon of urban sprawl continues unchecked, disregarding environmental carrying capacity and threatening the sustainability of the region (OECD, 2022). Spatial planning measures often fail to keep pace with spatial changes on the ground due to inconsistencies in the application of regulations (Hidayat et al., 2014; Andari et al., 2022). Currently, the spatial planning control system in Indonesia is based on zoning regulation in accordance with the Spatial Planning Act and its developments under the Job Creation Act. The implementation of policies following the Job Creation Law has introduced a new paradigm in spatial planning, namely the transition to the Spatial Utilization Activity Compliance (KKPR) system. The capacity of local governments is now being tested as they adapt to the integrated digital licensing system (OSS), which demands accurate digital spatial data and a faster bureaucratic response to mitigate the impacts of urban growth.

Interpretative Structural Modelling (ISM)

The limitations of the government's capacity mean that spatial planning and control directives cannot be implemented as intended; peri-urban areas are transition zones governed by complex and overlapping institutional frameworks, each with differing levels of autonomy, vision, governance style and capacity (Hudalah, 2020; Gallent 2006). This situation poses a challenge to the management of peri-urban areas; through the ISM method, the resulting structural model will capture the complexities of a condition through patterns carefully designed using graphics and text (Eriyatno, 2003). Based on Eriyatno and Sofyar (2006), the first step involves analyzing the structural hierarchy within peri-urban area management programs, which are divided into elements and further broken down into sub-elements. In this study, two elements were used: the constraints faced and the changes expected. The selection of these elements was based on a review of relevant policies and research, as well as expert interviews. Subsequently, based on the results of the expert interviews, a Structural Self-Interaction Matrix (SSIM) was compiled, followed by the creation of a Reachability Matrix (RM) through calculations based on transitivity rules, whereby the SSIM matrix was adjusted until a closed matrix was achieved. This involved levelling the sub-elements within each element according to both vertical and horizontal hierarchies, and the compilation of a Driver Power Dependence (DPD) matrix for each sub-element which are divided into four: Quadrant 1 (Autonomous), Quadrant 2 (Dependent), Quadrant 3 (Linkage) and Quadrant 4 (Independent). A hierarchical structure was then established.

RESEARCH METHODOLOGY

The study area is the peri-urban area of Bogor, comprising nine sub-districts surrounding the city of Bogor. Administratively, these fall within the administrative boundaries of Bogor Regency, namely the sub-districts of Bojonggede, Caringin, Ciawi, Cijeruk, Ciomas, Dramaga, Kemang, Sukaraja and Tamansari, covering a total area of 9,713.56 ha.

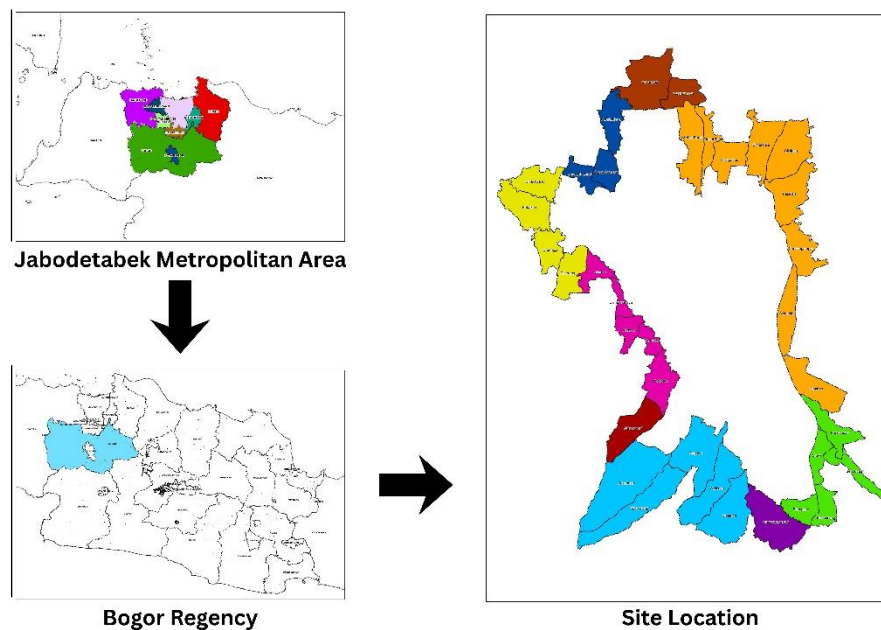


Figure 1: Study area

The analysis comprises the following two stages: 1) spatial analysis of urban sprawl dynamics, development using Landsat satellite imagery covering the years 2001, 2013 and 2023. represent Bogor's transition phase from the urbanization explosion resulting from decentralization to the synchronization of spatial planning through Law No. 6 of 2023 as the basis for development 2025–2045. A multi-temporal spatial analysis was conducted using satellite imagery: Landsat 7 ETM+ (2001), Landsat 8 OLI (2013), and Landsat 9 OLI-2 (2023), all with a spatial resolution of 30 meters. Each selected image underwent a standard pre-processing workflow prior to analysis, including geometric, radiometric, and atmospheric corrections. The calculation of built-up area for each year was performed using the Normalized Difference Built-Up Index (NDBI) method in

Google Earth Engine (GEE), which yielded effective and efficient results, with an overall accuracy values ranging from 75% to 90%.

The sprawl index is determined using the sub-district unit. The calculation of the urban sprawl index in study area covers 9 sub-districts are calculated using the following formula:

$$\text{Urban Sprawl Index} = \frac{\text{Percentage of built-up areas}}{\text{Percentage of population growth}}$$

This study employs a manual classification method (user defined methods) to categorize Urban Sprawl Index values into three classes: Non-Sprawl, Low Sprawl, and Strong Sprawl. This approach is justified by the mathematical nature of the ratio formula itself, wherein a value of 1 represents the equilibrium point between physical urban expansion and demographic growth. The manual setting of class (thresholds values ≤ 1 for the non-sprawl category, values 1.01–1.49 for the low sprawl category and values ≥ 1.50 for the strong sprawl category) was deliberately established to ensure a consistent, objective, and spatially comparable assessment standard across the City and Regency of Bogor, while also serving as a basis for rigorous spatial planning control instruments.

The analysis of local spatial patterns in this study employs the Local Indicators of Spatial Association (LISA) method to identify the presence of spatial clusters, as represented by the following calculation:

$$I_i = \frac{n \sum_{j=1}^n W_{ij} (x_i - \bar{x})(x_j - \bar{x})}{Z_x^2 \sum_{j=1}^n W_{ij}}$$

I_i = Local Indicators of Spatial Association (LISA);

$\bar{x}$ = percentage of built up area at the sub-district level, where i represents sub-district i and j represents neighboring sub-district;

W_{ij} = spatial proximity matrix representing the degree of spatial adjacency between sub-district and its neighboring sub-district; and

$Z_x^2/\bar{x}$ = variance of the percentage of built up area at the sub-district level.

The calculation results classify the study area into four spatial indicator quadrants (Moran Quadrants): 1) High-High (Hotspot): a district with a high sprawl index value surrounded by other districts that also exhibit high values; 2) Low-Low (Coldspot): a district with a low sprawl index value surrounded by other districts that also exhibit low values; 3) High-Low (Outlier): a district with a high sprawl index value that is isolated, being surrounded by districts with low

values; and 4) Low-High (Outlier): a district with a low sprawl index value surrounded by districts with high values. To ensure that the observed patterns did not arise by chance, a significance test was conducted using the Conditional Random Permutation method.

2) The Interpretative Struktural Modelling (ISM) analysis was conducted by gathering data based on the subjective assessments of experts competent in the field; these experts were selected via purposive sampling based on the following criteria: (1) possessing academic or practical expertise relevant to the research topic, (2) having at least three years of work or policy-making experience, and (3) being willing to fully participate in completing the research instrument. The panel of experts comprised one academic, two government officials, and two practitioners; their perceptions were elicited through structured interviews using a questionnaire designed based on identified elements and sub-elements—specifically, the Existing constraints/challenges element consist of 11 sub-elements and the Expected changes element consist of 12 sub-elements. A Structural Self-Interaction Matrix (SSIM) was constructed to assess the direction of contextual relationships between sub-element *i* and sub-element *j* based on expert consensus, utilizing the four symbols V (if sub-element *i* influences or leads to sub-element *j*), A (if sub-element *j* influences or leads to sub-element *i*), X (if sub-elements *i* and *j* mutually influence each other), and O (if there is no relationship between sub-elements *i* and *j*) (Eriyatno & Sofyar, 2006). Subsequently, a Reachability Matrix was created by converting the SSIM symbols into binary values (1 or 0) based on ISM substitution logic and transitivity rules, iterating until a closed matrix was achieved. ISM modeling was then performed by calculating the Driving Power (horizontally) and Dependence Power (vertically) for each sub-element; based on these values, all sub-elements within each element were mapped onto a Cartesian graph divided into four quadrants and a hierarchical structure.

ANALYSIS AND DISCUSSION

The rate of development of built-up areas in the study area from 2001 to 2013 was 19.18% and from 2013 to 2023 was 77.56 %, when compared with the average population growth rate of 1.72%, this indicates a spatial imbalance between physical land development and population growth, resulting in inefficient land use, and built-up areas are spread out horizontally with low density. The increase in the NDBI in the study area, indicates that Bogor Regency functions merely as a spill over for the development of Bogor City and from a governance perspective, this suggests that spatial control instruments have not been able to stem the flow of capital in land acquisition. This situation confirms that the phenomenon of urban sprawl has occurred in the study area.

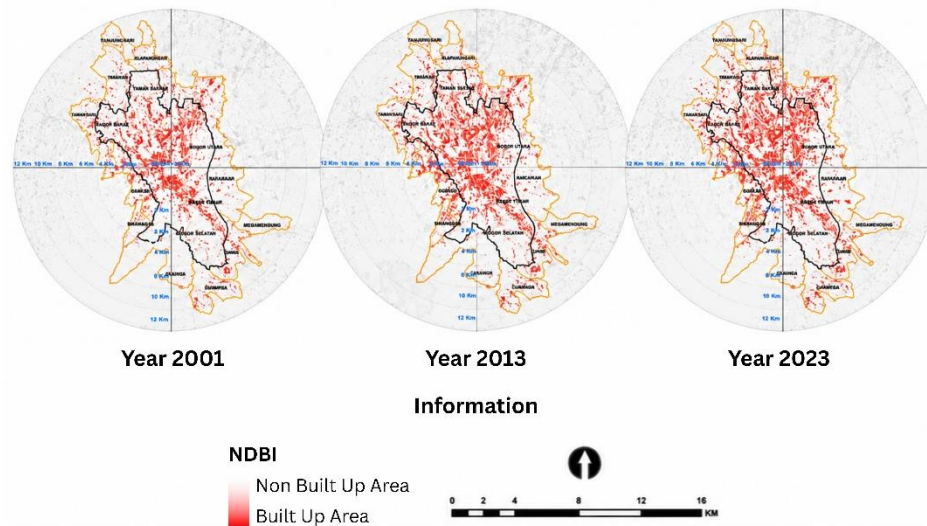


Figure 2: Land use changes in the Bogor City 2001 2013 and 2023
 Source: Landsat image processing result

The spatial distribution of urban sprawl from 2001 to 2013 and from 2013 to 2023 in the study area, based on the sprawl index values, is presented in Table. 1 and Figure. 3 below.

Table 1: Area and margin of urban sprawl

Index urban sprawl	Year 2001-2013 (ha)	Year 2013-2023 (ha)	Margin (ha)
Non-Sprawl: < 1	0	0	0
Low Sprawl: 1.01 – 4.99	559.38	152.77	- 406.61
Strong Sprawl: > 5	487.71	1,706.43	1,218.72
Total	1,047.09	1,859.20	812,11

Source: Author's Calculation

Based on Table. 1 and Figure. 3, there has been a decrease in the area of low sprawl accompanied by an increase in the area of strong sprawl. This indicates that during the 2001 - 2013 period the study area still exhibited controlled physical growth however during the 2013 - 2023 period, it became an area characterized by highly irregular and dispersed building density, as well as aggressive growth. During the 2013 - 2023 period, the strong sprawl category dominated the built-up area, thus the analysis indicates that the spatial structure in the study area is now dominated by inefficient development patterns characterized by elongated or scattered layouts that consume vast tracts of land.

The absence of non-sprawl areas indicates that in both periods there was no development in the study area following a planned growth pattern, and all physical development that emerged from 2001-2023 was of a scattered nature.

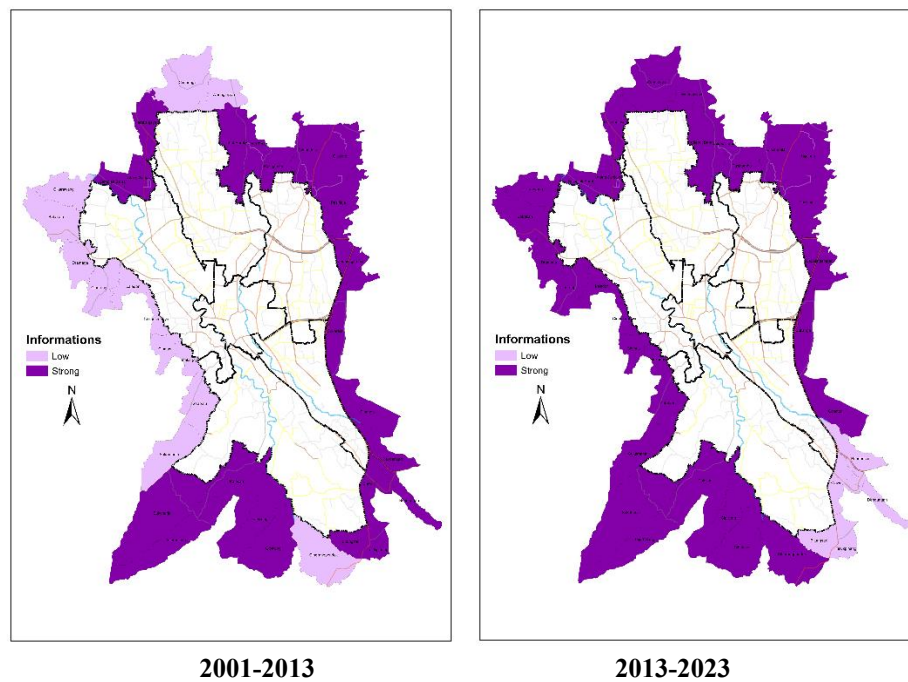


Figure 3 : Distribution of the sprawl index values in 2001-2013 and 2013-2023
Source: Author's Calculation

The LISA analysis groups regions into four quadrants based on the values of variables within those regions when compared to the average of the surrounding regions. The result of LISA analysis are as follow of Table. 3 and Figure. 4 in the next page.

Table 3: Results of the LISA analysis of the sprawl index in the study area

LISA Year 2001 – 2013	LISA Year 2013 – 2023
High-High Quadrant (Hotspots) Areas with a high urban sprawl index, surrounded by areas with a high tendency for urban sprawl, constitute centers of massive physical growth, including: 1. Kemang Sub-district, which exhibits highly uncontrolled and extensive land development. 2. Cijeruk Sub-district, which shows significant land conversion, 3. Sukaraja Sub-district, classified as a high-growth area, driven by accessibility to the city center, which has triggered widespread new housing development.	High-High Quadrant (Hotspot) Areas with a high sprawl index surrounded by areas with a high tendency for massive urban expansion include: 1. Cijeruk Sub-district indicates a very strong center of sprawl growth. 2. Kemang Sub-district shows a high intensity of land conversion. 3. Bojong Gede Sub-district, which borders directly on the growth center, consistently falls into the high-growth category due to the concentration of physical growth
Low-Low Quadrant (Cold spot) Areas with a low sprawl index, surrounded by areas with a low tendency and which are relatively more physically stable, include: 1. Darmaga Sub-district indicates a more controlled or compact land-use pattern. 2. Caringin Sub-district shows slow physical growth. 3. Tamansari Sub-district remains well below the average sprawl index.	Low-Low Quadrant (Cold spot) An area with a low sprawl index surrounded by areas with a low tendency. This area is relatively more physically stable, comprising: 1. Ciawi and Ciomas sub-districts show more controlled physical growth compared to the northern sub-districts, 2. Caringin sub-district indicates a land-use pattern that is not yet overly fragmented. Spatially, this area tends to be more stable or has better development control compared to the northern areas
Low-High & High-Low Quadrants (Outliers) Areas exhibiting characteristics that contrast with those of their neighboring groups include: 1. Ciawi Sub-district is at increased risk due to its proximity to high-growth zones such as Sukaraja Sub-district. 2. Although Bojong Gede and Ciomas Sub-districts are densely populated, their growth is more concentrated	High-Low & Low-High Quadrants (Outliers) Areas with characteristics opposite to those of their neighbors include: 1. Dramaga and Tamansari sub-districts are below average but close to the High-High area, which is at risk of future sprawl pressure due to its strategic location. 2. Sukaraja sub-district is below average but has strong spatial links to growth centers such as Cibinong and the city of Bogor.

Source: Author's Analysis

The dynamics of spatial sprawl during the study period in the study area indicate increasingly haphazard urban expansion, with the center of gravity of sprawl shifting from the Kemang sub-district (north-west) towards the Cijeruk and Bojong Gede sub-districts (central-south). This suggests that infrastructure development in the city of Bogor significantly influences the physical distribution of buildings in the study area. Sub-districts with a high surge

in sprawl—namely Dramaga, Bojong Gede and Caringin—show a worsening of sprawl conditions, whilst relatively stable areas include Sukaraja, Ciawi, Ciomas and Tamansari, as their irregularity has decreased and they have successfully curbed the rate of land expansion, likely due to the limited remaining land.

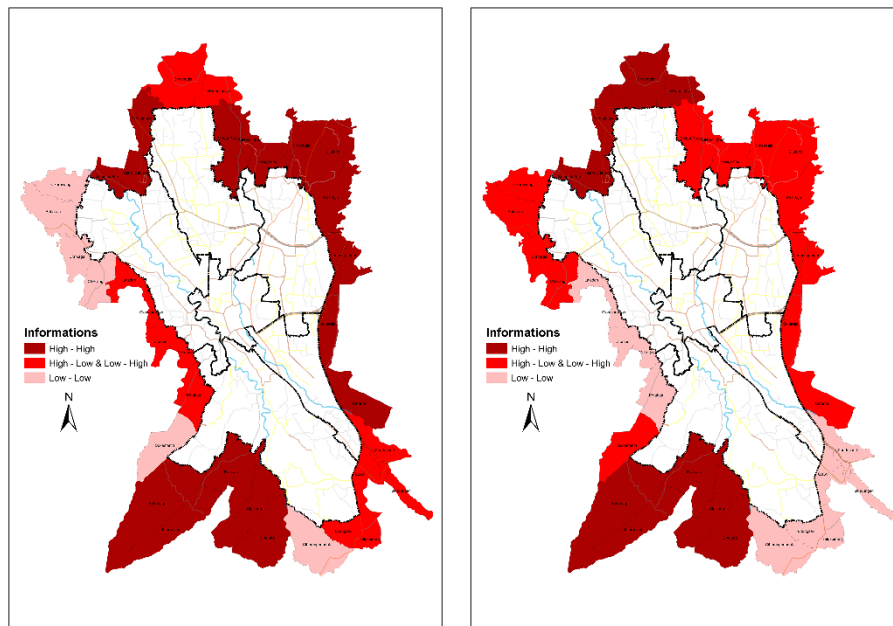


Figure 4: Distribution of Lisa scores for 2001–2013 and 2013–2023
Source: Author's Calculation

The study area is a region characterized by dynamic, rapid and haphazard growth during the period 2001–2023, indicating that it has not yet been able to maintain a regular pattern of growth. This limitation has resulted in spatial planning and control directives not being implemented as they should be. To identify issues relating to governance in the study area, an analysis was conducted of the existing constraints and the changes required for effective management. The element and sub element can be seen Tabel. 4 in the next page.

Table 4: Governance elements and sub-elements

Element: Existing constraints/challenges	Element: Expected changes
Sub-elements: 1. Coordination and cooperation between relevant agencies remain weak 2. Consistency in the implementation of spatial planning remains weak 3. Enforcement against violations is weak 4. Detailed plans are not yet in place 5. Existing spatial plans do not meet requirements 6. Unplanned development of built-up areas 7. Enforcement of the law regarding spatial planning violations remains weak 8. Low public awareness regarding land use in accordance with regulations 9. High interest in development within the study area 10. Zoning regulations as a tool for controlling land use and spatial management are not yet in place 11. Limitations in the development and management of infrastructure	Sub-elements: 1. Participatory spatial planning 2. Translation of the Regional Spatial Plan (RTRW) into detailed plans and the preparation of micro-zoning maps 3. improved coordination between agencies responsible for spatial planning 4. Harmonization of spatial plans across administrative regions 5. Consistent application of regulations relating to spatial control 6. Public awareness of area management programmed through dialogue among stakeholders 7. Cooperation in the provision of infrastructure and environmental conservation across administrative regions 8. Urban growth limits through the establishment of buffer zones 9. Increasing carrying capacity through improvements to Floor Area Ratio (FAR), Building Coverage Ratio (BCR), and Public Open Space (POS) 10. Incentives and disincentives to strengthen the Regional Regulation on Sustainable Food Agricultural Land (LP2B) to safeguard local food security 11. Digital monitoring using periodic satellite imagery to monitor land cover changes in real-time in hotspot areas 12. Implementation of green infrastructure

Source: Author's Analysis

Based on the results of the ISM analysis of existing constraints reveals a simple hierarchical structure (comprising only two levels) that highlights two primary issues: weak coordination (sub-element 1) and the absence of zoning regulations (sub-element 10). This identifies the factor with the highest driving power that is difficult to influence via other sub-elements yet is crucial to the system's overall success and triggers a domino effect on other sub-elements. The structure indicates a bureaucratic and regulatory impasse wherein development occurs in the study area not merely due to non-compliance or rules go unheeded, but because the government has failed to provide detailed zoning regulations and

inter-agency coordination is lacking; this confirms that the root of the governance deadlock lies in the regulatory aspect. Consequently, there is a need for an institutional arrangement in the form of an Integrated Cross-Sectoral Working Group tasked with synchronizing spatial policies across administrative boundaries and accelerating the formulation of legally binding Detailed Spatial Plans (RDTR). Institutional strengthening is imperative, as detailed zoning regulations serve as the primary prerequisite (trigger) to halt the domino effect of spatial planning violations at the operational level. Public non-compliance and ignorance regarding building construction in the study area are classified as consequences of the absence of regulatory guidance. Therefore, institutional arrangements at the site level should focus on dissemination and participatory oversight. Local governments must establish a publicly accessible zoning information system, supported by strengthening the roles of sub-district and urban village officials as the frontline of supervision, thereby ensuring governance accountability from the upstream (regulation) to the downstream (public compliance).

Table 5: Level of ISM, Institutional Transformation and Output of Existing Constrains Element

Level of ISM	Focus of sub-elements	Institutional Transformation	Output
Level 1 (driver/root cause)	• Weak inter-administrative coordination. • Absence of detailed zoning regulations.	Collaborative and Legislative Functions • Establishing a Joint Committee spanning administrative boundaries and planning authorities.	• Official Detailed Spatial Plan (RDTR) and zoning regulation. • Inter-regional spatial planning Memorandum of Understanding (MoU).
Level 2 (outcome)	• Lack of public awareness regarding regulations. • Uncontrolled development in the study area.	Dissemination and Surveillance Functions • Involving licensing agencies, the communications and informatics department, and sub-district or village-level government bodies.	• Interactive digital zoning map platform. • Local-level spatial planning patrol team.

Source: Author's Analysis

Based on the ISM analysis of the expected changes element, a three-tiered hierarchical structure emerges. For effective management, Level 3 (the foundation) focuses on managerial (coordination) and legal (zoning regulations) sub-elements; Level 2 (the process) focuses on technical implementation, public awareness, and administrative coordination sub-elements; and Level 1 (the final outcome) focuses on realizing an ideal physical environment. This underscores that the primary issue in the study area lies not in technical-physical aspects, but rather in weak governance (coordination) and the absence of control instruments (zoning regulations). The most effective strategy is to prioritize institutional and legal reforms before proceeding to physical interventions. Practical institutional implementation must follow a structured hierarchy, beginning with the strengthening of Level 3 (Foundation) through the issuance of a Cross-Sector Spatial Planning Committee Decree and the ratification of a Detailed Spatial Plan (RDTR) Regional Regulation to produce valid legal spatial planning documents and synchronized territorial boundaries. This legal framework is then operationalized at Level 2 (Process) by activating Cross-Agency Field Working Groups and providing Spatial Planning Clinic services at the sub-district level, thereby tightening permit oversight and ensuring public education prior to building construction. Through consistency across these two stages, governance culminates at Level 1 (Final Outcome) in the institutionalization of a Spatial Planning Audit System and the use of a Citizen Participation Complaint Application; these measures can concretely curb the growth of unauthorized structures while creating a well-organized and ideal physical environment.

Table 6: Level of ISM, Actional Institutional and
 Output of the expected changes element

Level of ISM	Focus of Sub-elements	Actionable Institutional	Outputs
Level 1 (Fondation)	Policies and Zoning Regulation	Decree of the Cross-Sector Spatial Planning Committee Regional Regulation on Detailed Spatial Plans (RDTR)	Valid spatial planning documents and synchronized territorial boundaries.
Level 2 (Process)	Technical Aspect and Public Awareness	Cross-Agency Field Working Group Spatial Planning Clinic Services at the District Level	Public education prior to construction; stricter oversight of permits.

Level of ISM	Focus of Sub-elements	Actionable Institutional	Outputs
Level 3 (Final)	Ideal Physical Environment	Spatial Planning Audit System (Zoning incentive & disincentive System) Citizen Participation Complaint Application	Reduction in illegal structures; creation of well-organized physical spaces

Source: Author's Analysis

The planning instruments for the City of Bogor and Bogor Regency are legally linked through their respective Regional Spatial Plans (RTRW) and are hierarchically coordinated by the West Java Provincial RTRW and the Jabodetabekpunjur National Strategic Area Spatial Plan. There is an ecological interdependence in which Bogor Regency serves as the upstream area and a buffer zone for the City of Bogor; consequently, planning decisions at the regency level significantly affect the city's ecological stability. Similarly, the regional connectivity and infrastructure systems outlined in the City of Bogor's RTRW must be synchronized with Bogor Regency's RTRW to ensure smooth accessibility throughout the region. At the operational level, land use along administrative boundaries is regulated by the Detailed Spatial Plan (RDTR) and the zoning regulations of each respective area; inconsistencies among these instruments trigger land-use conflicts. Peri-urban areas—the transition zones between these two regions—are experiencing uncontrolled development and sporadic urban sprawl, leading to inconsistencies in land-use designations. This situation undermines the effectiveness of land-use controls.

CONCLUSION

This study examines the development of the study area through an analysis of built-up area growth and the calculation of an urban sprawl index to highlight uncontrolled growth resulting from the spillover effects of the city of Bogor, as well as the phenomenon of urban sprawl during the period 2001–2023. The current growth and governance conditions in the study area present constraints and challenges that require a structured approach.

The analysis results identify that High-High clusters are located along the northern and western administrative boundaries, indicating that functional urban expansion has been detached from formal spatial planning. It also reveals a significant regulatory gap between city and district governments in the study area.

The results of the ISM analysis indicate that the main challenges and issues in the study area do not lie in physical technical aspects, but rather in weak

governance (coordination) and the absence of control instruments (zoning regulations); therefore, the most effective approach to achieving appropriate environmental conditions and quality is to priorities institutional and legal reforms before proceeding to physical interventions.

As physical development in the study area continues to increase, it is hoped that stricter law enforcement will be implemented, ensuring compliance by all relevant parties as stipulated in Presidential Regulation No. 60 of 2020 on the Spatial Plan for the Jabodetabekpunjur National Strategic Area. Further studies are required, focusing on collective action, regulations, and community engagement regarding management in the study area, as well as to ensure that these measures can be applied to peri-urban locations in other regions.

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