

A Study of Green Open Space in Pematang Raya City in Supporting the Development of Simalungun Regency, North Sumatra Province

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Keywords:	Abstract
Green open space; Spatial planning; Sustainable development; Regional development; Pematang raya city	Urban development in Indonesia faces increasingly complex challenges, particularly in balancing infrastructure expansion with environmental sustainability. This study aimed to assess the existing conditions of green open space (GOS) in Pematang Raya, Simalungun Regency, North Sumatra Province, identify factors affecting its availability and management, and formulate strategies to optimize its contribution to sustainable regional development. A descriptive qualitative approach was employed, with data collected through direct field observations, in-depth interviews with key informants, including government officials, green open space managers, and local community members, and reviews of official spatial planning documents. Data were analyzed through data reduction, data display, and conclusion drawing. The findings indicated that the provision and management of green open space in Pematang Raya remained suboptimal in terms of quantity, quality, and spatial distribution. The study identified a shortfall relative to the minimum green open space allocation of 30% of urban area stipulated in Law No. 26 of 2007 concerning Spatial Planning, comprising 20% public green open space and 10% private green open space. Green open spaces were unevenly distributed, with greater concentration around government administrative centers and limited availability in densely populated residential areas. The principal constraints included increasing development pressure, land-use conversion, limited budget allocations, inadequate interagency coordination, and insufficient community participation. The study recommended strengthening green open space provisions in spatial planning policies, identifying suitable land for green corridors and riverbank vegetation while observing applicable land-use restrictions, improving the quality and accessibility of existing green spaces, and adopting green city planning principles to integrate ecological protection, social well-being, and economic development. These strategies could support more equitable green open space provision and contribute to sustainable development in Simalungun Regency.

INTRODUCTION

Urban development in Indonesia faces increasingly complex challenges, particularly in balancing infrastructure expansion with environmental sustainability (Novita Suratman &

Darumurti, 2021). Population growth, expanding economic activities, and the development of built-up areas have accelerated land-use conversion in urban regions (Pratama, 2025). These changes have contributed to environmental degradation, including rising urban temperatures, reduced rainwater infiltration, and declining air quality. Green open space (GOS) has therefore become an essential component of urban spatial planning, helping maintain ecological balance between natural environments and developed areas (Hanan & Ariastita, 2020).

Green open space encompasses vegetated areas arranged in linear corridors or concentrated spaces, including naturally occurring vegetation and deliberately cultivated landscapes (Abdiyanto, 2022b; Abidah & Irawanto, 2024). Its provision plays a strategic role in supporting environmental sustainability and improving urban living conditions (Prameswara et al., 2025). Ecologically, green open spaces contribute to carbon sequestration, oxygen production, stormwater management, and urban microclimate regulation (Amiin et al., 2022). Their functions extend beyond environmental protection to include social benefits, such as opportunities for recreation and community interaction; economic benefits, including potential improvements in property values and tourism attractiveness; and aesthetic benefits that enhance urban landscape quality and public comfort (Achmad et al., 2024). Consequently, accessible and well-maintained green open spaces are important components of livable and environmentally sustainable urban environments (Devi & Santosa, 2022).

Within Indonesia's regulatory framework, Law No. 26 of 2007 concerning Spatial Planning established a minimum green open space allocation of 30% of the total urban area, comprising 20% public green open space and 10% private green open space (Saragih et al., 2021). Public green open spaces include urban parks, urban forests, and green corridors, whereas private green open spaces may include residential yards and landscaped areas within privately managed properties (Novita Suratman & Darumurti, 2021; Parid Pakaya & Baderan, 2024). However, achieving these spatial planning requirements remains challenging because of limited land availability, urbanization pressures, inadequate interagency coordination, and insufficient public awareness of environmental conservation (Arifiah, 2022).

Simalungun Regency, particularly Pematang Raya as its administrative center, has experienced physical development associated with the expansion of government facilities, infrastructure, and residential areas. These developments have increased pressure on existing green spaces through land-use conversion, potentially reducing vegetation cover, limiting rainwater infiltration, and increasing environmental vulnerability (Tarigan et al., 2025). Furthermore, the uneven spatial distribution of green open spaces has constrained public accessibility, particularly in residential areas with limited recreational and environmental facilities. Addressing these challenges requires integrated green open space management encompassing spatial planning, appropriate land utilization, regulatory compliance, and systematic monitoring of land-use changes (Djaba et al., 2025; Ramadhan et al., 2024).

Effective green open space management requires coordinated and sustainable measures involving preventive maintenance, corrective improvements, and the development of additional green infrastructure (Setiadhi et al., 2024). These measures should prioritize the optimization of

available land, integration of green open space provisions into the Regional Spatial Plan (Rencana Tata Ruang Wilayah, RTRW) and Detailed Spatial Plan (Rencana Detail Tata Ruang, RDTR), and consideration of alternative greening solutions, such as vertical gardens and green roofs, in areas with limited land availability (Azra, 2024). Beyond government responsibilities for planning, regulation, and infrastructure management, community participation is essential for maintaining green spaces, preventing environmental degradation, and encouraging responsible use of public facilities (Siregar et al., 2024).

Accordingly, the assessment considered both existing management constraints and potential opportunities for improving the availability, accessibility, and quality of green open spaces in Pematang Raya.

The strengths, weaknesses, opportunities, and threats (SWOT) analysis identified several internal and external factors influencing green open space management in Pematang Raya. The principal strengths included the availability of potentially suitable land for green space development and existing local government policy support. However, significant weaknesses remained, particularly the reported inadequacy of green open space provision relative to regulatory requirements, insufficient supporting facilities, and limited budget allocations for development and maintenance. Opportunities included growing public awareness of environmental sustainability and the potential development of green spaces as recreational and environmentally oriented tourism attractions. Meanwhile, population growth, infrastructure expansion, and continued conversion of vegetated land into built-up areas represented major threats to long-term green space availability. These findings highlighted the need for integrated management strategies that capitalize on existing resources and institutional support while addressing spatial, financial, and environmental constraints.

From a regional development perspective, optimizing green open space provision in Pematang Raya could contribute to the achievement of the Sustainable Development Goals (SDGs), particularly Goal 11, which emphasizes inclusive, safe, resilient, and sustainable cities and human settlements, and Goal 13, which addresses climate action (Filifin et al., 2023). Effective implementation requires coordinated institutional responsibilities, systematic planning, and continuous monitoring of green infrastructure development (Pratama et al., 2022). Assessing green open space performance through indicators of area, spatial distribution, accessibility, and physical quality provides a more comprehensive understanding of its contribution to urban sustainability (Abdiyanto, 2022a; Sinatra et al., 2022). Accordingly, integrated management approaches are necessary to align environmental conservation objectives with infrastructure development and community needs (Siregar, 2024; Waisnawa, 2022; Widyarti & Fardani, 2022). Against this background, the present study examined the existing conditions and management challenges of green open spaces in Pematang Raya to formulate strategic recommendations supporting sustainable development in Simalungun Regency.

The specific contribution of this study lay in integrating assessments of green open space availability, spatial distribution, physical quality, and institutional management rather than relying exclusively on the statutory area allocation target. This multidimensional perspective was

important because the availability of potentially suitable land did not necessarily ensure equitable public access, adequate facilities, or effective environmental management. The analysis therefore distinguished observed conditions and stakeholder-reported constraints from strategic recommendations developed through the qualitative SWOT framework. Because the study did not provide a verified quantitative inventory of green open space areas, its assessment of compliance with statutory allocation requirements was treated as a qualitative indication of potential deficiencies rather than a definitive measurement of the extent of noncompliance. This approach provided a context-specific foundation for identifying management priorities and developing more inclusive, environmentally sustainable green open space strategies for Pematang Raya and the wider Simalungun Regency.

METHOD

This study employed a descriptive qualitative approach to examine the existing conditions of green open space (GOS) and its contribution to sustainable regional development in Pematang Raya, Simalungun Regency, North Sumatra Province. The approach was used to assess green open space availability, spatial distribution, accessibility, physical quality, and management practices. Following Sugiyono (2018), the research examined green open space planning, utilization, and regulatory oversight, with particular attention to the roles of local government institutions and other relevant stakeholders.

The research was conducted in Pematang Raya, the administrative center of Simalungun Regency, focusing on urban green spaces, including public parks and green corridors. The location was selected because of reported limitations in green space availability, land-use conversion pressures, and uneven spatial distribution, which could affect environmental quality and community well-being. Informants were selected through purposive sampling based on their responsibilities, knowledge, and involvement in green open space planning, management, and utilization (Abdi Sugianto L. S. & Periansya, 2024). The informants included local government officials responsible for spatial planning, environmental management, and public works; technical personnel involved in green space maintenance; approximately 30 community members who used green open spaces; and representatives from academic institutions or the private sector.

Data were collected through field observations, in-depth interviews, and document analysis. Field observations focused on vegetation conditions, spatial accessibility, public use, maintenance practices, and supporting facilities within existing green open spaces. In-depth interviews were conducted with selected informants to identify factors affecting green space availability, institutional management challenges, community participation, and potential improvement strategies. Document analysis included the Regional Spatial Plan (Rencana Tata Ruang Wilayah, RTRW), relevant government reports, and photographic documentation of field conditions. Information obtained from these sources was compared to identify recurring themes and corroborate the findings.

The collected qualitative data were organized and interpreted using a strengths, weaknesses, opportunities, and threats (SWOT) framework. The SWOT categories were developed from

themes identified through observations, interviews, and documentary evidence and were used to summarize internal management conditions and external factors affecting green open space development. The analysis was qualitative and did not involve numerical weighting or statistical scoring. The statutory minimum green open space allocation was used as a regulatory benchmark; however, because the study did not provide a verified spatial inventory, no independently calculated percentage of green open space coverage was reported. Similarly, the approximate number of community informants was retained as described in the research materials without assuming an exact number of completed interviews.

RESULT AND DISCUSSION

Table 1. SWOT analysis of green open space management in Pematang Raya City

No	Factor	Description
1	Strengths	a. Pematang Raya City still has several green areas with potential for development. b. There is local government support for urban environmental development. c. GOS has ecological, social, and aesthetic functions for the community.
2	Weaknesses	a. The area of GOS does not yet meet the standard requirement for urban green space. b. Supporting facilities and infrastructure in some GOS are still inadequate. c. GOS maintenance and management are not yet optimal due to limited budget and management personnel.
3	Opportunities	a. There are government policies on environmentally oriented urban development. b. Public awareness of the importance of green space is increasing. c. There is potential to develop GOS as recreational and urban tourism areas.
4	Threats	a. The growth of residential and commercial center development reduces green land. b. The increasing population puts pressure on land use. c. Some community members have low awareness of keeping GOS clean and preserved.

Source: Qualitative synthesis of observations, interviews, and documentation described in this manuscript.

Existing Condition of Green Open Space (GOS) in Pematang Raya City

Pematang Raya City, as the capital of Simalungun Regency, has a strategic role in supporting governmental, economic, and social activities. Along with the fairly rapid development of the region, the need for land for housing and infrastructure development continues to increase. This has reduced the availability of Green Open Space (GOS), which should be an important element in maintaining urban environmental balance. The existing condition of GOS in Pematang Raya City shows an imbalance between the need for green space and the actual conditions in the field.



Figure 1. Regional Map (Illustration of Infrastructure and Distribution of Areas)

Based on the results of observation and analysis, the existence of GOS in Pematang Raya City still faces various problems, in terms of both quantity and quality. In general, the available GOS consists of city parks, open fields, green belts along roads, and community-owned yards. However, the available GOS area does not yet fully meet the minimum requirement of 30% of the total area as stipulated in spatial planning policy.

In addition, the distribution of GOS in Pematang Raya City is also uneven. GOS tends to be concentrated in certain areas such as the center of government and public facilities, while in densely populated residential areas, the presence of green open space remains very limited. This condition means that some community members do not yet have adequate access to green space for recreation, social interaction, and improved quality of life.

1683In terms of quality, the management of existing GOS is still not optimal. Several green open spaces appear poorly maintained, have minimal supporting facilities, and have not been able to carry out their ecological functions to the fullest, such as in absorbing rainwater and reducing air temperature. Lack of maintenance and supervision is one of the main factors causing this condition.



Figure 2. Illustration of Urban Environmental Conditions with Minimal GOS and Potential Environmental Problems

Environmental conditions in several areas of Pematang Raya City show the impact of limited GOS, such as waterlogging, potential flooding, and declining quality of the residential environment. This is exacerbated by land-use conversion that continues to occur without being balanced by the provision of adequate green open space.

Nevertheless, there is still potential for developing GOS in Pematang Raya City, such as utilizing vacant land, developing green belts, and optimizing community yards as private GOS. With more planned and sustainable management, the presence of GOS can be increased in terms of both area and quality. The existing condition of GOS in Pematang Raya City shows that more comprehensive efforts are still needed in its planning and management. This is important to support the creation of a sustainable, comfortable, and livable urban environment for the community, as well as to optimally support the development of Simalungun Regency.

Factors Influencing the Availability and Management of Green Open Space (GOS) in Pematang Raya City

Based on the results of observation, interviews, and documentation studies, there are several main factors that influence the availability and management of Green Open Space (GOS) in Pematang Raya City. These factors include physical, policy, institutional, social, and economic aspects that are interrelated.

1) Population Growth and Development Pressure Factor

Continuously increasing population growth in Pematang Raya City drives the need for land for housing, public facilities, and infrastructure. This condition causes land-use conversion, including land that previously had the potential to become GOS being turned into built-up areas.

High development pressure is one of the main factors in the reduced availability of green open space.

2) Land Limitations

The availability of vacant land that can be allocated as GOS is increasingly limited, especially in already dense urban areas. Relatively high land prices are also an obstacle for the local government in providing new GOS, so the development of green open space cannot be carried out optimally.

3) Spatial Policy and Planning

Although there are regulations governing the provision of a minimum of 30% GOS, the implementation of these policies at the regional level is still not optimal. This is caused by a lack of supervision, weak enforcement of rules, and the fact that GOS planning has not yet been comprehensively integrated into regional development.

4) Institutions and Inter-Agency Coordination

GOS management involves various government agencies, such as the environment agency, the public works agency, and other related agencies. However, coordination among these institutions is still not running effectively, so program overlaps or poorly synchronized policies in GOS management often occur.

5) Budget Constraints

The development and maintenance of GOS require considerable costs, whether for land acquisition, facility construction, or maintenance. Limited regional budgets are one of the obstacles to improving the quality and quantity of GOS in Pematang Raya City.

6) Community Participation and Awareness

Low public awareness of the importance of GOS is also a factor influencing its management. Community behavior that is unsupportive is still found, such as littering in open areas or not taking care of the facilities that have been provided. In addition, community participation in the development of private GOS, such as yard greening, is still not optimal.

7) Management and Maintenance Factor

Some of the GOS that has been provided is not yet managed to the fullest. The lack of routine maintenance, minimal supporting facilities, and the absence of a sustainable management system cause GOS quality to decline and to not function optimally.



Figure 3. Factors Influencing the Availability and Management of Green Open Space (GOS) in Pematang Raya City

Conformity of Green Open Space (GOS) Availability with Spatial Planning Provisions

Based on the results of the analysis of the existing condition of Green Open Space (GOS) in Pematang Raya City, it is known that the availability of GOS in this area does not yet fully meet

the minimum requirement mandated in spatial planning policy, namely 30% of the total urban area, consisting of 20% public GOS and 10% private GOS.

The results of observation and documentation studies show that the available GOS area is still below the established standard. This is evident from the limited number of city parks, green belts, and other public open spaces that can be accessed by the community. In addition, the presence of private GOS such as home yards and privately owned open spaces has also not made a significant contribution to meeting the overall need for green space.

The failure to meet this GOS proportion is influenced by various factors, such as the high rate of land conversion into residential and infrastructure areas, limited available land, and the not-yet-optimal implementation of spatial planning policy at the regional level. In practice, the control of spatial use that should safeguard the existence of GOS is still not running effectively.

In addition to quantity, the nonconformity is also seen in the distribution and function of GOS. Some existing GOS has not been able to carry out its ecological, social, and aesthetic functions optimally. This shows that meeting GOS requirements is related not only to land area but also to its quality and utilization.

Based on interviews with relevant parties, information was obtained that the local government has a commitment to increasing GOS availability but still faces various obstacles, such as budget constraints, urgent development needs, and low community participation in the development of private GOS. Thus, this condition shows a gap between policy and implementation in the field, so that more serious efforts are needed in controlling spatial use and developing planned and sustainable GOS in Pematang Raya City.

Distribution of Green Open Space (GOS) in Meeting Community Needs

Based on field observations, interviews, and documentation analysis, the distribution of Green Open Space (GOS) in Pematang Raya City shows an uneven pattern and tends to be concentrated in certain areas. GOS is found more in the government center, public facilities, and certain areas with public service functions, while in densely populated residential areas, GOS availability is relatively limited.

This unequal distribution means that not all community members have the same access to green open space. People who live around the city center tend to have easier access to city parks or other open spaces, whereas people in outskirts areas or dense areas must travel greater distances to access GOS. This condition shows that accessibility to GOS remains a major problem.

In addition, in terms of size and capacity, the available GOS is not yet fully able to accommodate community needs. Some existing green open spaces are relatively small and have limited facilities, so they are not yet optimal in supporting community social, recreational, and sporting activities. This indicates that GOS distribution is related not only to the spread of locations but also to the capacity of those spaces to meet user needs.

From interviews with the community, it is known that some residents complain about the lack of green open space in their neighborhoods. Many people make do with open spaces such as house yards, road shoulders, or unorganized vacant land as alternative spaces for activities. This shows a high need for the provision of GOS that is more evenly distributed and easily accessible.

On the other hand, there is potential that can be utilized to improve GOS distribution, such as developing neighborhood-scale open spaces (neighborhood parks), utilizing vacant land, and optimizing green belts along roads and riverbanks. This approach can be a solution for improving the equitable distribution of GOS without depending entirely on the construction of large-scale city parks.

In general, the distribution of GOS in Pematang Raya City can be concluded as follows:

- The spread of GOS is uneven and tends to be centralized
- Community access to GOS is not yet equitable
- The capacity and quality of GOS are not yet able to meet community needs
- There is still a gap between the need for and the availability of GOS

Thus, the distribution of GOS in Pematang Raya City is not yet fully able to meet community needs fairly and evenly. Therefore, a GOS equalization strategy is needed that considers accessibility, population needs, and regional characteristics, so that the social and ecological functions of GOS can be felt by all segments of society.

The Role of Green Open Space (GOS) Management in Improving Environmental Quality and Community Quality of Life

The management of Green Open Space (GOS) has a very important role in improving environmental quality as well as the community's quality of life in Pematang Raya City. Based on the results of observation, interviews, and documentation studies, it can be seen that the existence and management of GOS have a significant impact in terms of ecological, social, and public health aspects.

In terms of the environment, GOS plays a role in improving air quality through pollutant absorption and oxygen production. Vegetation in green open spaces is also able to lower air temperatures in urban areas, thereby creating a cooler and more comfortable microclimate. In addition, GOS functions as a water catchment area that can reduce the risk of waterlogging and flooding, especially in the rainy season. However, this role is not yet fully optimal in Pematang Raya City because of the limited area and quality of the available GOS.

In terms of social aspects, GOS serves as a space for community interaction that can strengthen social relations among residents. City parks and other open spaces are used as places to gather, exercise, and engage in various recreational activities. The presence of GOS also gives the community a space to relieve fatigue from daily activities, thereby contributing to improved psychological well-being.

Furthermore, in terms of health, GOS plays a role in supporting a healthy lifestyle for the community. A green and clean environment can reduce stress levels, increase physical activity, and lower the risk of diseases caused by environmental pollution. However, limited access to and quality of GOS mean that these benefits are not yet felt evenly by the entire community.

Interviews with the community show that the presence of well-maintained GOS greatly helps improve the comfort of the residential environment. Conversely, poorly managed GOS tends to go unused and may even give rise to new problems, such as illegal dumping sites or unsafe areas.

In addition, good GOS management can also provide added economic value, such as increasing the attractiveness of an area and potentially supporting local economic activities, for example small traders around city parks. However, this potential has not been utilized optimally in Pematang Raya City. Based on the research results, it can be concluded that:

- GOS plays an important role in improving environmental quality (air, temperature, water)
- GOS supports social interaction and community activities
- GOS contributes to the community's physical and mental health; however, this role is not yet optimal due to limitations in management and distribution

GOS management in Pematang Raya City has a very strategic role in improving environmental quality and the community's quality of life. However, for these benefits to be felt to the fullest, more optimal and sustainable management is needed, involving the active participation of the community and the support of the local government.

Contribution of Green Open Space (GOS) in Supporting the Regional Development of Simalungun Regency

Green Open Space (GOS) makes a significant contribution to supporting the regional development of Simalungun Regency, particularly through its role in Pematang Raya City as a center of government and community activity. Based on the results of observation, interviews, and documentation studies, the contribution of GOS can be seen from various aspects, namely ecological, social, economic, and regional spatial planning.

From the ecological aspect, GOS functions as an environmental balancer in the process of regional development. The vegetation in GOS is able to maintain air quality, reduce pollution, and serve as an important water catchment area in reducing flood risk. Thus, GOS is an important element in maintaining environmental sustainability amid the rapid development of Simalungun Regency.

From the spatial planning aspect, GOS plays a role as an important component in the urban spatial structure. The presence of GOS helps control land use so that not all land is converted into built-up areas. In addition, GOS can also function as a buffer zone between areas and support order and balance in regional development. This is very important in realizing planned and sustainable urban spatial planning.

Furthermore, from the social aspect, GOS contributes to improving the community's quality of life, which ultimately supports regional development indirectly. An environment that is comfortable, healthy, and provides space for social interaction will increase community productivity and strengthen social cohesion.

From the economic aspect, the presence of GOS can increase the attractiveness of the region, both for the local community and for outsiders. Well-organized GOS can become an attraction in its own right, thereby potentially supporting the local economic sector, such as small-scale trade, local tourism, and increased property values in the surrounding area. Thus, GOS can be one of the supporting factors in improving the competitiveness of Simalungun Regency. Nevertheless, the contribution of GOS in supporting regional development in Simalungun Regency, particularly in Pematang Raya City, is still not optimal. This is due to the limited area of

GOS, uneven distribution, and management that is not yet maximal. Therefore, the potential of GOS as an instrument of regional development has not yet been fully utilized.

Based on the research results, the contribution of GOS can be summarized as follows:

- Supporting environmental sustainability (ecological function)
- Serving as an important part of spatial structure and spatial planning control
- Improving the community's quality of life and social interaction
- Contributing to local economic growth and regional attractiveness, although this contribution is not yet optimal

Strategies for the Sustainable Development and Management of Green Open Space (GOS)

Based on the analysis of the existing condition, the influencing factors, and the role and contribution of GOS in Pematang Raya City, a comprehensive strategy is needed to optimize the sustainable development and management of GOS. This strategy must encompass planning, institutional, community participation, and effective spatial utilization aspects.

1) Strengthening GOS-Based Spatial Planning

The local government needs to integrate GOS development more firmly into spatial planning documents. GOS zoning must be determined clearly and consistently, and followed by supervision of land use so that uncontrolled land-use conversion does not occur.

2) Optimizing the Utilization of Potential Land

GOS development does not always have to involve clearing new land but can be carried out by utilizing available land, such as:

- Vacant government-owned land
- Riverbanks
- Green belts along roads
- Neighborhood-scale open spaces (neighborhood parks)

This approach is considered more realistic under conditions of limited land in urban areas.

3) Improving the Quality and Function of GOS

In addition to increasing area, it is also important to improve the quality of existing GOS through:

- Better vegetation arrangement
- Provision of supporting facilities (seating, lighting, play areas)
- Routine and sustainable maintenance

4) Strengthening Institutions and Inter-Agency Coordination

More effective coordination among relevant agencies in GOS management is needed. The division of tasks and responsibilities must be clear to avoid program overlaps. In addition, a special unit or institutional strengthening focused on GOS management is needed.

5) Increasing Community Participation and Awareness

The community has an important role in supporting the sustainability of GOS. Therefore, the following need to be carried out: education on the importance of GOS, community-based greening programs, and utilization of yards as private GOS. Active community participation will help maintain the sustainability of GOS in the long term.

6) Provision of Budget and Policy Support

The local government needs to allocate an adequate budget for the development and maintenance of GOS. In addition, strong policy support is also needed to ensure that program implementation runs effectively.

7) Implementing the Green City Concept

GOS development can be directed toward the green city concept, which integrates environmental, social, and economic aspects. This concept can serve as a basis for creating a sustainable and livable city.

CONCLUSION

Based on the research findings, this study concluded that the provision and management of green open space (GOS) in Pematang Raya, Simalungun Regency, remained suboptimal in terms of availability, physical quality, and spatial distribution. The findings indicated that existing green open space provision was insufficient relative to the minimum allocation of 30% of urban area stipulated in Indonesia's spatial planning framework, comprising 20% public green open space and 10% private green open space. However, the absence of a verified spatial inventory prevented an independent quantitative assessment of compliance with this requirement. The uneven distribution of green open spaces, which were concentrated in certain areas, also limited equitable accessibility for residents across different neighborhoods. These conditions were associated with several interconnected challenges, including population growth, increasing development pressures, land-use conversion, limited land availability, inadequate interagency coordination, budgetary constraints, and insufficient community participation in green space maintenance and management.

Although green open space played an important role in supporting environmental sustainability and improving community well-being, its potential contribution to regional development in Simalungun Regency had not been fully realized because of limitations in maintenance, infrastructure provision, and institutional management. Green open spaces offered ecological benefits through vegetation conservation, stormwater management, and urban microclimate regulation, alongside social and economic opportunities associated with recreation, public interaction, and improved environmental amenities. To address the identified challenges, the study recommended strengthening green open space provisions within spatial planning policies, optimizing suitable land for green infrastructure development, improving the quality and accessibility of existing facilities, enhancing interagency coordination, and encouraging active community participation in conservation and maintenance activities. Integrating these measures into long-term regional development planning could support more equitable green space provision, strengthen environmental resilience, and contribute to sustainable and inclusive development in Pematang Raya and the wider Simalungun Regency.

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