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Green Open Space Zoning in Supporting Sustainable Urban Environmental Management: A Case Study of the Distribution of Tribes and Indigenous Regions in Mountainous Papua (LAPAGO)

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Abstract

This study aims to analyze the zoning of green open spaces (GOS) within the LAPAGO region, which represents the customary territories of the Papua Mountains, and to explore their existence, distribution, and contribution to sustainable urban environmental management. The research further seeks to identify and document local wisdom practices applied by indigenous tribes in managing green open spaces, emphasizing how traditional ecological knowledge and cultural values can be integrated into regional planning and environmental governance. A qualitative analytical approach was employed, combining field observations with data collected from both primary and secondary sources, including Focus Group Discussions (FGDs) conducted during the spatial planning (RTRW) process of the Papua Mountains region. The findings reveal that traditional practices such as communal cooperation (gotong royong), respect for sacred natural sites, and collective land stewardship play an essential role in maintaining ecological balance and sustaining green open spaces. These cultural mechanisms not only support environmental sustainability but also strengthen community cohesion and indigenous identity. Ultimately, this study highlights the importance of incorporating local wisdom into spatial planning and policy frameworks to achieve ecologically sustainable, socially inclusive, and culturally grounded urban environmental management in the Papua Mountains region..

Keywords: design; urban, environment; strategic; sustainable;

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I. Introduction

Green open spaces (GOS) play a crucial role in sustainable urban environmental management (Sinaga, 2025). Amidst rapid urban growth, GOS has become increasingly important for maintaining ecosystem balance, improving people's quality of life, and providing space for social and recreational activities (Edeigba, 2024; Jain, 2024; Ojobo, 2024). Effective zoning of green open spaces is necessary to ensure that these areas are well-managed and provide maximum benefits to the community (Mapura, 2025).

Papua, particularly its mountainous regions, is a region rich in biodiversity and culture (McRobin, 2025; Sheil, 2021; Purwanto, 2020; Tekege, 2022). Beneath its natural beauty lies a diverse array of tribes and indigenous communities with unique perspectives and environmental management practices. One area of interest to research is LAPAGO (Papua Mountains Customary Institution), which reflects local wisdom in natural resource management.

Based on a preliminary survey analyzing green open space zoning within the context of urban environmental management in the LAPAGO region, exploring the distribution of ethnic groups and indigenous territories can contribute to the relocation of green open space. This can then become a better management strategy, one that considers not only ecological aspects but also the social and cultural aspects existing within the community (Saputra, 2025; Iwuanyanwu, 2024; Mardikaningsih, 2024).

Effective green open space zoning is necessary to ensure that areas are well-managed and provide maximum benefits to the community (Utami, 2024; Saragih, 2025; Herath, 2024). Papua, particularly its mountainous regions, is a region rich in biodiversity and culture, where various tribes and indigenous communities have unique perspectives and environmental management practices.

This study **aims** to analyze green open space zoning in the LAPAGO (Papua Mountains Customary Institution) region and reveal its existence and distribution in the context of sustainable urban environmental management. Furthermore, this study also aims to identify local wisdom applied by tribes in the Mountains region in managing green open spaces, so that cultural values can be integrated into regional planning and management. This study will cover the social and ecological impacts of green open space zoning on local communities, as well as develop policy recommendations that can be used by local governments and stakeholders in sustainable and inclusive green open space management.

Therefore, a research entitled Green Open Space Zoning in Supporting Sustainable Urban Environmental Management is needed: A Case Study of the Distribution of Tribes and Traditional Areas of Mountainous Papua (LAPAGO). This research will form a framework that can be implemented by stakeholders, including local governments, spatial planners, and communities, to improve the resilience and survival of Jayawijaya Regency in the future.

The importance of this research lies in its effort to bridge the gap between indigenous ecological knowledge and formal urban spatial planning. Despite abundant cultural wisdom and natural resources, there has been little integration of customary practices into regional environmental policy. Addressing this gap is crucial for ensuring that urban sustainability strategies in Papua are not only ecologically effective but also socially just and culturally grounded, making this study highly relevant and significant for future spatial development in Indonesia's highland regions.

II. Literature Review

2.1. Green Open Space and Sustainable Urban Environmental Management

Green Open Spaces (GOS) have long been recognized as critical ecological infrastructures that enhance urban sustainability through multiple ecosystem services—such as regulating microclimate, reducing flood risks, improving air quality, and supporting biodiversity. Scholars such as Beatley (2016) and Gómez-Baggethun et al. (2017) emphasize that well-planned urban green networks function not merely as decorative areas but as living systems that maintain ecological balance and promote community well-being. In developing countries, including Indonesia, the integration of green infrastructure into urban zoning systems is essential to counteract rapid land conversion and environmental degradation. According to Indonesia's Spatial Planning Law (Law No. 26/2007), urban areas are legally required to allocate a minimum of 30% of total land for GOS, comprising both public and private spaces. This statutory requirement underlines the government's commitment to sustainable urban management, yet implementation remains inconsistent due to spatial, institutional, and socio-cultural challenges, especially in peripheral and mountainous regions such as Papua.

In the context of sustainable urban environmental management, zoning strategies serve as a regulatory tool to guide spatial distribution, land-use efficiency, and environmental carrying capacity. Scholars advocate that zoning GOS not only preserves ecological corridors but also supports community resilience to climate change through heat reduction, water retention, and disaster mitigation (Kabisch et al., 2017). Integrating these ecological functions with urban planning aligns with the Sustainable Development Goals (SDG 11)—making cities inclusive, safe, resilient, and sustainable. However, in regions like Mountainous Papua, where urban and traditional land systems coexist, zoning cannot rely solely on administrative delineations; it must embed indigenous values, territorial rights, and participatory decision-making.

2.2 Indigenous Land Tenure, FPIC Principles, and Participatory Zoning in Papua

Land in Papua holds profound socio-cultural significance governed by ulayat (customary) rights that define ownership, stewardship, and spiritual ties between people and their environment. Literature on indigenous land governance (Bakker, 2008; Moniaga, 2019) highlights that failure to recognize customary land systems in state-led spatial planning often leads to conflict, alienation, and ecological decline. In response, the principle of Free, Prior, and Informed Consent (FPIC)—as recommended by the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP, 2007)—has become a normative standard in development planning involving indigenous territories. FPIC ensures that communities are adequately informed and have the autonomy to accept or reject interventions that may affect their ancestral

lands. In Papua, implementing FPIC within GOS zoning processes enables inclusive environmental governance and strengthens the legitimacy of spatial policies.

Recent studies (Anderson et al., 2020; Barliana & Jatisunda, 2023) demonstrate that integrating Participatory Geographic Information Systems (PGIS) or Public Participation GIS (PPGIS) approaches helps bridge the gap between scientific and local knowledge systems. Through participatory mapping, indigenous communities can delineate sacred sites, subsistence zones, and ecological corridors that must be preserved as part of green space zoning. This integration promotes culturally responsive planning—often referred to as "culture-sensitive zoning"—which respects local cosmology, land ethics, and ecological stewardship practices. Moreover, PGIS supports data transparency and collaborative decision-making, essential in complex terrains like the LAPAGO region, where topography, cultural boundaries, and administrative borders are highly intertwined.

2.3. Cultural Ecosystem Services and Adaptive Zoning for Mountainous Papua

Beyond the ecological and legal dimensions, the cultural ecosystem services (CES) framework highlights the non-material benefits provided by natural landscapes—spiritual enrichment, identity formation, recreation, and traditional knowledge (Chan et al., 2012; Milcu et al., 2013). For indigenous Papuan communities, green spaces are not simply "urban parks" but are deeply woven into rituals, social gatherings, and cosmological worldviews. Recognizing these dimensions is critical for ensuring that zoning reflects both ecological sustainability and cultural continuity. In the Mountainous Papua (LAPAGO) context, CES can be operationalized through indicators that identify cultural landmarks, communal gardens, and sacred forest patches as part of the formal GOS network. Such an approach aligns with the principles of biocultural diversity, which advocate the integration of biological conservation with cultural heritage preservation (Maffi, 2018).

Geographically, the mountainous morphology of Papua—comprising valleys, ridges, and steep slopes—presents technical and spatial challenges in implementing standard GOS typologies. Adaptive zoning strategies are therefore needed, such as riparian green belts, slope stabilization forests, and small-scale "pocket parks" within dense settlements. Integrating traditional ecological knowledge (TEK) with scientific land classification enables context-sensitive zoning that harmonizes hydrological, cultural, and social systems. The combination of FPIC-based governance, PGIS participatory mapping, and CES assessment offers a holistic model for sustainable urban environmental management in indigenous territories. Nevertheless, empirical studies in Papua remain limited, making the LAPAGO case study crucial to conceptualizing a framework for green open space zoning that is legally compliant, ecologically sound, and socially legitimate.

III. Methodology

1. Research Approach

This research uses a qualitative approach focused on an in-depth understanding of green open space zoning and local wisdom in environmental management. This approach allows for exploration of the social, cultural, and ecological aspects associated with green open space in the LAPAGO area.

Tools and materials

The tools used in this research included geographic analysis (GIS) software for green open space zoning maps, as well as recording devices such as cameras and audio devices to document interviews. Required materials included area maps, statistical data, and related literature.

3. Types of Data Sources

The types of data and data sources collected in this study consist of:

Primary data and secondary data, namely Primary Data is data obtained through direct measurements in the field in the form of direct measurement results about Direct observation will be conducted to assess conditions through interviews, observations, and group discussions . Meanwhile, secondary data is a general description of Jayawijaya Regency. This data is obtained from the results of relevant previous research, books, journals and library sources. Furthermore, using the data to formulate sustainable social policies, in accordance with the preparation of the spatial planning of the Papua Mountains Province for 2024-2044.

4. Participants

The research participants consisted of representatives from various stakeholder groups relevant to green open space management in the LAPAGO region. Local government officials were included to provide insights into existing policies, regulatory frameworks, and the implementation of spatial planning at the regional level. Participants also included professionals and practitioners involved in open space zoning and urban planning, whose perspectives helped to identify current challenges and practical solutions in managing green spaces. In addition, members of indigenous communities—such as community elders, traditional leaders, and local residents with deep knowledge of customary land management and cultural practices—were engaged to capture the local wisdom embedded in environmental governance. The total number of participants was determined flexibly, based on the depth and relevance of information required to achieve the research objectives.

5. Data Collection

Data for this study were collected using several complementary methods to ensure the accuracy and depth of information. A literature review was first conducted to examine relevant documents, policies, and reports related to the zoning and management of

green open spaces (RTH) in the Papua Mountains region. Direct field observations were then carried out to assess the physical condition of existing green open spaces, their accessibility, and maintenance practices, allowing for a more comprehensive understanding of their current state. In addition, semi-structured interviews were conducted with selected participants to obtain detailed insights regarding local experiences, challenges, and traditional management approaches. Furthermore, Focus Group Discussions (FGDs) were organized with key stakeholders as part of the 2024–2044 Papua Mountains Province Spatial Plan (RTRW) deliberations, providing a collaborative platform to validate findings and explore policy-oriented solutions for sustainable and inclusive green open space management.

6. Data Analysis

Data analysis in this study was carried out through several systematic stages to obtain accurate and meaningful results. A descriptive analysis was first conducted to portray the existing conditions of green open space zoning within the distribution of tribes and traditional territories in the LAPAGO region. This process helped to visualize spatial relationships and highlight variations across different indigenous areas. Subsequently, thematic analysis was employed to identify recurring themes, patterns, and key insights emerging from interview transcripts and questionnaire responses, providing an in-depth understanding of participants' perspectives on environmental and cultural aspects of green space management. Finally, data triangulation was applied by cross-verifying information from multiple sources—literature reviews, observations, interviews, and FGDs—to enhance the credibility, accuracy, and validity of the research findings.

IV. Results and Discussion

4.1 Administrative Conditions of the Papua Mountains Region

The Papua Mountains Province is a division of Papua Province and covers an area of **5,121,333 hectares** . The boundaries of the Papua Mountains Province are as follows:

- North : Bordering Mamberamo Raya Regency, Sarmi, Jayapura, and Keerom Regency
- East : Bordering the country of Papua New Guinea
- South: Bordering Boven Digoel Regency and Asmat Regency
- West: Bordering Puncak Jaya Regency, Puncak Regency, and Mimika Regency.

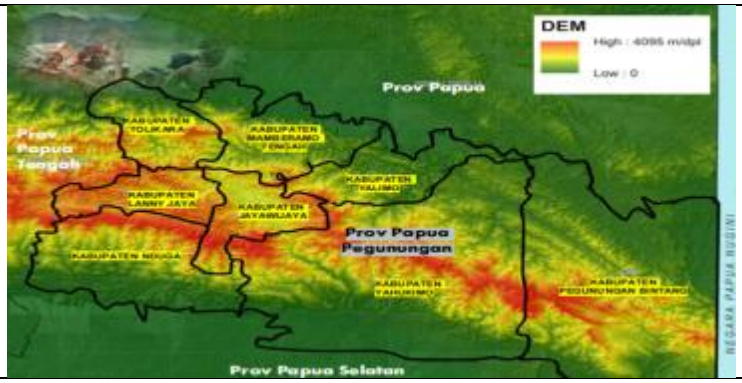

Figure 1. Administrative Conditions of Jayawijaya Regency
Source: Personal Image from the Papua Mountains Province RTRW (2024).

4.2 Population

The population of several districts in the Papuan Highlands shows significant trends in projections through 2044. In 2024, the population of Jayawijaya Regency is estimated to reach 281,090, while Lanny Jaya, Central Mamberamo, Nduga, Pegunungan Bintang, Tolikara, Yahukimo, and Yalimo each have varying population projections. Population density in each district also varies, with Yahukimo recording the highest percentage at 25%, followed by Tolikara at 17%, and Lanny Jaya at 14%. Population projections show continued growth, with the total population across all districts estimated to reach nearly 600,000 by 2044.

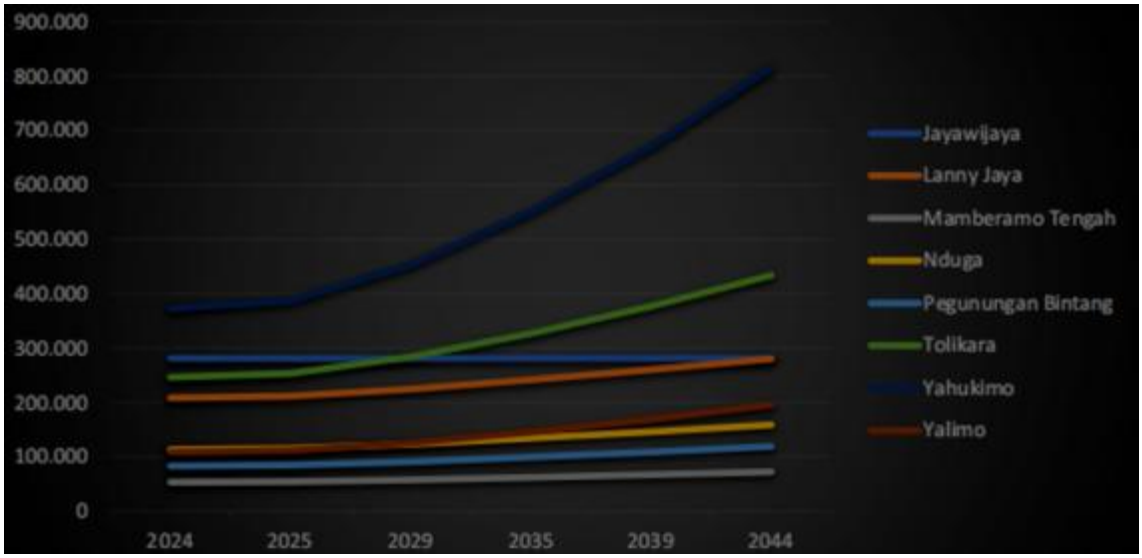

Figure 2. Population 2019-2024.
Source: Personal Image from the Papua Mountains Province RTRW (2024).

The increasing population in the Papua Highlands region, particularly in regencies like Jayawijaya and Yahukimo, has a significant impact on the management of green open spaces (GOS). With population growth, the need for space for social activities,

recreation, and residential areas will increase. This can put pressure on existing GOS, potentially reducing the size and quality of open spaces available to the community.

Increasing population density can lead to increased conversion of open land into built-up areas, which in turn can disrupt local ecosystems and reduce biodiversity. For example, densely populated districts, such as Yahukimo, may be at risk of losing green spaces crucial for conservation.

Furthermore, social impacts also need to be considered. Through population growth, the potential for conflicts over land use and natural resources can increase, especially if local communities are not involved in the green open space management process. Therefore, it is important to involve the community in the planning and management of green open spaces so that local needs and wisdom can be accommodated.

Furthermore, projected population growth, estimated at nearly 600,000 people by 2044, underscores the importance of a sustainable green space management strategy. Policies supporting appropriate zoning and green space protection must be developed to ensure community needs are met without compromising the environment. Therefore, effective green space management is essential to improve the quality of life for residents and support the ecosystem in the Papuan Highlands region.

This relates to research by Pambudi (2024; Aduko, 2025; Lingye, 2024) which shows that the conversion of open land into built-up areas often results in environmental degradation and loss of biodiversity in urban areas. This is also in line with research findings by Lasaiba, 2024; Patel, 2024; Zikusani, 2024), which emphasize that rapid urbanization without proper planning can lead to the loss of open space that is essential for local ecosystems. Furthermore, research by Shaumi (2025) found that local community involvement in green space management planning is crucial for reducing conflict and ensuring that community needs are accommodated. This involvement also creates a greater sense of ownership of green open spaces.

4.3 Customary Territories on Papua Island

Indigenous territories on the island of Papua possess a rich uniqueness, reflecting the cultural diversity, traditions, and wisdom of their local communities **(Figure 3)** . As part of social and cultural identity, indigenous territories play a role not only in cultural preservation but also in the management of natural resources and the environment.

Figure 3. Customary Areas on Papua Island - Jayawijaya Regency
Source: Personal Image from the Papua Mountains Province RTRW (2024).

Figure **3** above shows that customary areas on Papua Island, especially in the LA PAGO region, encompass several districts, including Jayawijaya, Pegunungan Bintang, Lanny Jaya, Tolikara, Nduga, Yalimo, Yahukimo, and Central Mamberamo. In this region, tribes such as the Dani, Nayak, Nduga, and Yali have a strong connection to land and natural resources, which are crucial for green open space (GOS) management. In the context of GOS management, superior commodities such as coffee, sweet potatoes, red fruit, onions, agarwood, rubber, pineapple, oranges, and highland vegetables reflect the ability of indigenous communities to utilize natural resources sustainably. Community involvement in sustainable agricultural practices can increase the effectiveness of GOS management, as emphasized in research by Hanifah (2025; Zahroh, 2025; Bressane, 2024). This aligns with the objective of this study to design GOS zoning that takes local wisdom into account.

Furthermore, annual events such as the Baliem Valley Festival and the Jayawijaya Peak Festival not only serve as cultural celebrations but also raise awareness of the importance of preserving green open spaces. Research by Rachman and Sari (2019); (Wang, 2024; Lin, 2024) shows that cultural activities can contribute to better resource management, supporting the idea that green open space management must involve the cultural and social elements of the community.

Annual events such as the Baliem Valley Festival and the Jayawijaya Peak Festival also serve as platforms for celebrating and preserving local culture. These festivals not only attract tourists but also raise public awareness of the importance of preserving and conserving their cultural heritage and environment. This is in line with research by Kasman (2024) and Siburian (2018); Alam (2025); and Mteti (2025), which shows that cultural activities can contribute to better resource management and support for indigenous territories. However, challenges remain, particularly in addressing the impacts of urbanization and land conversion that can threaten the sustainability of indigenous territories. Research by Rifiyanti (2024) and Arifin (2024), and Osborne

(2024) indicates that the need for legal recognition of indigenous peoples' rights is becoming increasingly urgent in the context of rapid environmental and social change.

This also relates to previous research by Farina (2024) and Nadish (2025) that emphasized the importance of recognizing indigenous peoples' rights in natural resource management. This research supports the argument that environmental aspirations in Papua are highly dependent on recognizing and respecting indigenous territories and managing them. This is relevant to the title of this study, which emphasizes the importance of green open space zoning for sustainable environmental management.

4.4 Lapago customs

The customs and traditions of the LAPAGO (Papua Valley) region reflect the rich culture and traditions of the community, passed down from generation to generation. These customs not only serve as guidelines for social life but also play a vital role in the management of natural resources and the environment. In the context of research on green open space zoning, understanding these customs is crucial to ensuring that environmental management aligns with local cultural values (**Figure 4**).

Figure 4. Lapago Customs
Source: Personal Image (2024).

Customs in the LAPAGO region are strongly influenced by collective values, particularly the practice of mutual cooperation (gotong royong), which is at the heart of community life. The concept of mutual cooperation, manifested in various activities such as building traditional houses, farming, and cultural celebrations, reflects strong solidarity among community members. This can strengthen social bonds and support sustainable natural resource management (Figure 4) . In the management of green open spaces (RTH), mutual cooperation plays a crucial role in land management and environmental conservation. Research by Khumairoh (2025) and Sele (2024) shows that community-based approaches, including the practice of mutual cooperation, have proven effective in preserving natural resources. Community involvement in

maintaining forests and agricultural land, as well as in reforestation and ecosystem preservation efforts, reflects a collective commitment to environmental conservation.

Furthermore, mutual cooperation activities are also integrated into cultural festivals, such as the Baliem Valley Festival, which involves active community participation in celebrating local traditions and wisdom. Research by Ramadhan (2024) and Radzuan (2024) confirms that community participation in cultural activities can raise awareness of the importance of environmental and traditional preservation. Through the practice of mutual cooperation, communities can maintain their cultural heritage and recognize the importance of green open spaces. However, challenges arising from modernization and urbanization can threaten the sustainability of these mutual cooperation practices. External influences often change how communities view traditional values. Therefore, recognizing mutual cooperation as part of LAPAGO customs can make a significant contribution to sustainable environmental management and cultural preservation in the Papua Highlands region. This finding reinforces social capital theory, which posits that collective actions and shared norms within a community enhance resource governance and environmental sustainability—indicating that the traditional practice of gotong royong in LAPAGO serves as both a cultural mechanism and a practical model for sustainable environmental management.

V. Conclusion

This study analyzes the zoning of green open spaces (GOS) in the LAPAGO (Papua Mountains Customary Institution) region to reveal their existence and distribution in sustainable environmental management. This zoning includes sustainable agriculture, conservation, culture, recreation, and green housing, all of which play a vital role in supporting natural resource sustainability and cultural preservation. The practice of community mutual cooperation, seen in agricultural activities and cultural festivals such as the Baliem Valley Festival, demonstrates community solidarity and raises awareness of the importance of environmental preservation. However, the challenges of modernization can threaten these traditional values. Therefore, this study also identifies local wisdom that can be involved in GOS planning, with the hope of creating sustainable environmental management and cultural preservation in the Papua Mountains region. This research is expected to be a guide for policy makers in formulating Green Open Space (RTH) zone plans and supporting Sustainable Urban Environmental Management and improving the quality of life of the community

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