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Spatial Analysis of Public Green Open Space Availability Based on Area and Population in Tapin Utara Sub-District

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ABSTRACT

This study aims to assess the availability of public green open spaces (GOS) in North Tapin District and to calculate the required GOS based on current population size, land area, and projected demographic growth up to the year 2044. Employing a quantitative descriptive methodology, the research utilizes Geographic Information System (GIS) spatial analysis complemented by field observations and ground truthing to ensure data accuracy. The study area includes all public green open spaces within the district boundaries. Results reveal that the total public GOS area is approximately 35.82 hectares, representing 5.48% of the district's total land area—substantially below the minimum regulatory standard of 20%. Population projections indicate a future GOS demand of 72.16 hectares by 2044, highlighting a significant shortfall in current provision. These findings demonstrate that North Tapin District's existing green open spaces are insufficient to meet both present and anticipated needs, underscoring the urgent requirement for strategic urban planning interventions to expand and optimize green space allocation.

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Introduction

The North Tapin District is strategically located at the administrative center of Tapin Regency, serving as a key hub for regional development owing to its central position along major transportation routes and economic activities. This advantageous location has spurred significant urban growth and infrastructure expansion, reinforcing the district's role as the developmental core of the Regency. According to data from the Tapin Regency Central Statistics Agency (BPS), the district covers an area of 32.62 square kilometers, which is relatively moderate compared to that of neighboring districts. In 2023, North Tapin recorded a population of 25,754, reflecting a steady annual growth rate of approximately 1.7% in recent years. This population increase poses considerable challenges for spatial planning and environmental sustainability, particularly regarding the provision and adequacy of green open spaces (GOS).

Green open spaces refer to areas designated for natural or semi-natural vegetation that contribute to maintaining ecological balance, especially within urban environments characterized by high population density and extensive built-up areas. Standard definitions from the urban planning literature identify GOS as critical for regulating microclimates, producing oxygen, and mitigating excessive solar radiation (Harahap, 2021). In Indonesia, Law No. 26 of 2007 on Spatial Planning and Regulation of the Minister of Public Works No. 5/PRT/M/2008 mandates that at least 20% of urban land should be allocated as public green open space. This legal framework provides a critical benchmark for urban planning and for environmental management.

The integration of GOS into urban spatial planning is essential for achieving sustainable development that balances natural ecosystems with built environments. Beyond their ecological benefits, green open spaces contribute significantly to urban resilience by buffering against environmental hazards and enhancing social well-being through inclusive and accessible recreational areas. Thus, promoting a green urban agenda is both a spatial necessity and a strategic approach to fostering environmental awareness and securing the long-term sustainability of urban ecosystems, aligning with global sustainability frameworks such as the United Nations Sustainable Development Goals (SDGs).

To support these objectives, Geographic Information Systems (GIS) have become indispensable in regional and urban planning. GIS enables the integration and analysis of multiple spatial data layers, facilitating the detailed mapping and assessment of land use . This study employed GIS techniques, including overlay analysis and digitization, to evaluate the spatial distribution and availability of GOS in the North Tapin District. Overlay analysis integrates diverse geographic data to produce comprehensive insights, whereas digitization converts analog maps into precise digital formats for detailed spatial analysis. Moreover, field validation complements GIS by verifying data accuracy on the ground and ensuring robust and reliable findings.

In this context, the present study aimed to analyze the availability and adequacy of public green open spaces in the North Tapin District using GIS technology. The findings are intended to provide spatially detailed and accurate information to guide future urban planning and policymaking efforts, particularly to align land use with demographic trends and regulatory requirements.

Green Open Space (GOS)

Green open spaces (GOS) are defined as land areas designated for parks, fields, cemeteries, urban forests, green road corridors, and other vegetated spaces that contribute to the ecological balance within urban settings. According to the Regulation of the Minister of Public Works No. 5/PRT/M/2008, urban green spaces play a vital role in maintaining environmental quality by mitigating air pollution and functioning as natural ventilation systems that promote urban cooling and enhance air circulation. Additionally, GOS provides significant social and psychological benefits, including aesthetic enhancement, public gathering spaces, facilitation of social interactions across all age groups, stress reduction, and recreational opportunities for residents.

Functions and Benefits of Green Open Space

As a component of green infrastructure, GOS fulfills multiple critical functions (Hanan H. M. & Ariastita P. G., 2020):

1. Ecological Function: GOS supports air circulation, microclimate regulation, shading, oxygen production, rainwater infiltration, and pollutant filtration in air, soil, and water. Empirical studies have demonstrated that these functions are essential for urban environmental sustainability.

2. Socio-Cultural Function: GOS provides inclusive spaces that encourage social interaction among diverse demographic groups, including the elderly, youth, adults, and children, contributing to mental health improvements and community cohesion.
3. Economic Function: The presence of well-maintained green spaces can enhance local economic development by increasing property values, attracting tourists, and improving community welfare.
4. Aesthetic and Architectural Function: GOS improves the visual appeal and comfort of urban landscapes, thereby enhancing the quality of life of residents.

Classification of Green Open Space

GOS are classified primarily by ownership into two categories: public and private green open spaces. This distinction is important for planning and management as it influences accessibility and governance.

1. Private GOS includes residential yards, office and commercial building yards and rooftop gardens.
2. Public GOS includes neighborhood parks (RT-level), community parks (RW-level), sub-district parks, district parks, city parks, urban forests, green belts, road medians, pedestrian walkways, and special function areas such as riverbanks and cemeteries.

Understanding these classifications aids in assessing equitable access to and sustainable maintenance of green spaces.

Table 1. Typology of GOS Ownership

No	*Type*	*Public GOS*	*Private GOS*
1.	*Yard GOS*		
a.	*Residential yards*		✓
b.	*Yards of office buildings, commercial areas, and business premises*		✓
c.	*Rooftop gardens*		✓
2.	*Parks and Urban Forest GOS*		
a.	*Neighborhood parks (RT-level)*	✓	✓
b.	*Community parks (RW-level)*	✓	✓
c.	*Sub-district parks (Kelurahan-level)*	✓	✓
d.	*District parks (Kecamatan-level)*	✓	
e.	*City parks*	✓	
f.	*Urban forests*	✓	
g.	*Green belts (green belt)*	✓	
3.	*Green Road Corridor GOS*		
a.	*Road medians and islands*	✓	✓
b.	*Pedestrian walkways*	✓	✓
c.	*Areas beneath flyovers*	✓	
4.	*Special Function GOS*		
a.	*GOS along railway lines*	✓	
b.	*Green strips under electrical lines*	✓	
c.	*Riparian (riverbank) GOS*	✓	
d.	*Coastal buffer GOS*	✓	
e.	*Water source/spring protection areas*	✓	
f.	*Cemeteries*	✓	✓

Provision of Green Open Space Based on Land Area

According to the Regulation of the Minister of Public Works No. 5/PRT/M/2008, urban areas are required to allocate at least 30% of their total land area to green open spaces, with a minimum of 20% designated as public GOS and 10% designated as private GOS. If an area exceeds these proportions, green space levels must be maintained to preserve environmental quality.

Provision of GOS Based on Population Size

Beyond the total land area, population density is a critical factor influencing the adequacy of the GOS. The per capita standard is essential for estimating green space needs to support oxygen supply and recreational demand. Regulations specify the minimum GOS areas per population unit, which can be used to calculate the total required green space by multiplying population figures with per capita standards. Table 2 outlines these standards, indicating the varying minimum area requirements across the neighborhood, community, sub-district, and district scales.

Table 2. Provision of Green Open Space Based on Population Unit

No	*Population Unit*	*Type of GOS*	*Minimum Area /Unit (m²)*	*Minimum Area /Capita (m²)*	*Location*
1	*250 people*	*Neighborhood Park (RT)*	*250*	*1.0*	*Within the neighborhood (RT area)*
2	*2,500 people*	*Community Park (RW)*	*1,250*	*0.5*	*Community activity center (RW level)*
3	*30,000 people*	*Sub-district Park*	*9,000*	*0.3*	*Near schools/sub-district administrative center*
4	*120,000 people*	*District Park*	*24,000*	*0.2*	*Near schools/district administrative center*
5	*-*	*Cemetery*	*Adjusted accordingly*	*1.2*	*Distributed across the area*

Geographic Information System (GIS)

A Geographic Information System (GIS) is a computer-based platform designed to collect, store, analyze, manage, and visualize geographic data, facilitating the detection of spatial trends, patterns, and relationships (Sari & Ulfiana, 2021). GIS supports comprehensive spatial analyses by integrating multiple data layers, making it indispensable for evidence-based urban and regional planning (Huda et al., 2024).

Google Earth

Google Earth, as a technological innovation, provides high-resolution, multitemporal imagery that is useful for land identification and spatial analysis (Schmidt et al., 2016). Its extensive coverage and visual clarity enable the accurate mapping of spatial features. Collin et al. (2014) demonstrated the high spatial accuracy of Google Earth imagery in mapping seafloor substrates, achieving an accuracy rate of 89.7%. Similarly, Amran (2017) used imagery for detailed seaweed mapping. Although these examples pertain to marine environments, Google Earth’s applications have been widely extended to terrestrial and urban spatial studies, offering valuable support for green open space assessments and monitoring.

Methodology

Research Design

This study employed a descriptive quantitative design supported by Geographic Information Systems (GIS). The quantitative component focuses on analyzing numerical data related to green open spaces (GOS), while the descriptive approach aims to accurately portray the spatial distribution and current conditions of the GOS within the study area. This combination allows for a comprehensive understanding of both statistical and spatial phenomena, in accordance with the frameworks described by Suryani and Hendardi (2015).

Research Location

The North Tapin District, situated in a lowland area with elevations ranging from 0 to 100 m above sea level, covers approximately 32.62 square kilometers. It lies geographically between 114°46'13" to 115°30'33" East Longitude and 2°32'43" to 3°00'43" South latitude. Administratively, the district comprises 16 villages.

Population and Sample

The study population comprised all public green open spaces in the North Tapin District. To verify the spatial data accuracy, purposive sampling was employed to select representative GOS sites for field validation. The selection criteria focused on the GOS types and spatial distribution to ensure representativeness. This sampling approach allows for an effective comparison between remotely sensed data and on-the-ground conditions (Sugiyono, 2009).

Research Variables

The key variables for the analysis included the distribution and availability of public GOS, categorized into subtypes such as city parks, urban forests, green corridors, cemeteries, and riverbank areas. These variables align with the study objectives and were sourced primarily from Google Earth Pro imagery. The details are summarized in Table 3.

Table 3. Research Variables

No	*Objective*	*Variable*	*Sub-Variable*	*Data Source*
1	*Distribution of Public Green Open Space (GOS) in North Tapin District*	*Public Green Open Space*	*1. City Park 2. Urban Forest 3. Green Corridor 4. Cemetery 5. Riverbank Area*	*Google Earth Pro*
2	*Availability of Green Open Space Based on Land Area*	*Public Green Open Space*	*1. City Park 2. Urban Forest 3. Green Corridor 4. Cemetery 5. Riverbank Area*	*Google Earth Pro*
3	*Availability of Green Open Space Based on Population*	*Public Green Open Space*	*1. City Park 2. Urban Forest 3. Green Corridor 4. Cemetery 5. Riverbank Area*	*Google Earth Pro*

Data Collection Techniques

Primary data were collected through field surveys involving digitized mapping, GPS-based area measurements, and photographic documentation of selected GOS. Secondary data included satellite imagery, demographic statistics, land use data, and official government reports, which were used to supplement and validate primary observations.

Research Instruments

The tools used comprised Google Earth Pro for imagery analysis, ArcGIS 10.8 for spatial data processing, handheld GPS units for coordinate and area measurements, and mobile applications such as "GPS Stamp: Add Geotag on Photo" for photographic geolocation. These instruments facilitated accurate data acquisition and integration (Table 4).

Table 4. Research Variables

No	*Type of Data*	*Research Material*	*Research Tools*
1	*Google Earth Pro Satellite Imagery*	*Availability of Green Open Space*	*1.Laptop* *2.Google Earth*
2	*Shapefile (SHP) Data of North Tapin Administrative Boundaries*	*Availability of Green Open Space*	*1.ArcGIS 10.8 Software* *2.GPS* *3.Camera*
3	*Shapefile (SHP) Data of Tapin Regency Administrative Boundaries*	*Availability of Green Open Space*	*1.Avenza Maps* *2.GPS Stamp: Add Geotag on Photo*

Data Analysis

1. Imagery Analysis

a. Digitization. Public GOS features were digitized into shapefiles (*. shp) representing vector spatial data (points, lines, and polygons) according to established protocols (Consortium Aceh Nias, 2007).

b. Calculate Geometry. Using the "Calculate Geometry" function in ArcGIS, the total areas of each GOS category were computed, ensuring precise spatial quantification (Ramadhan et al., 2020).

2. GOS Needs Analysis Based on Land Area

Compliance with Law No. 26 of 2007 was assessed by calculating 20% of the total land area, where L represents the total district land area and K the required GOS area.

$$K = L \times \frac{20}{100}$$

Explanation:
L = Total land area
K = Green open space availability

3. GOS Needs Analysis Based on Population Size

Population projections were calculated using the formula $Pn = Po\ (1 + r)\ n$, where Po is the baseline population (25,754 in 2023), r the annual growth rate (1.7%), and n the number of years until 2044. Subsequently, the required GOS area was estimated by multiplying projected population Pn by the per capita GOS standard of 20 m² ($RTH = P_n \times 20$).

4. Field Validation

Selected GOS locations were ground-truthed using handheld GPS devices for spatial accuracy, and photographs geotagged with the GPS Stamp app were used to document site conditions. This step ensured the reliability of the GIS-derived spatial data.

Research Flowchart

The overall research workflow, detailing each methodological step from data collection to analysis and validation, is depicted in Figure 1.

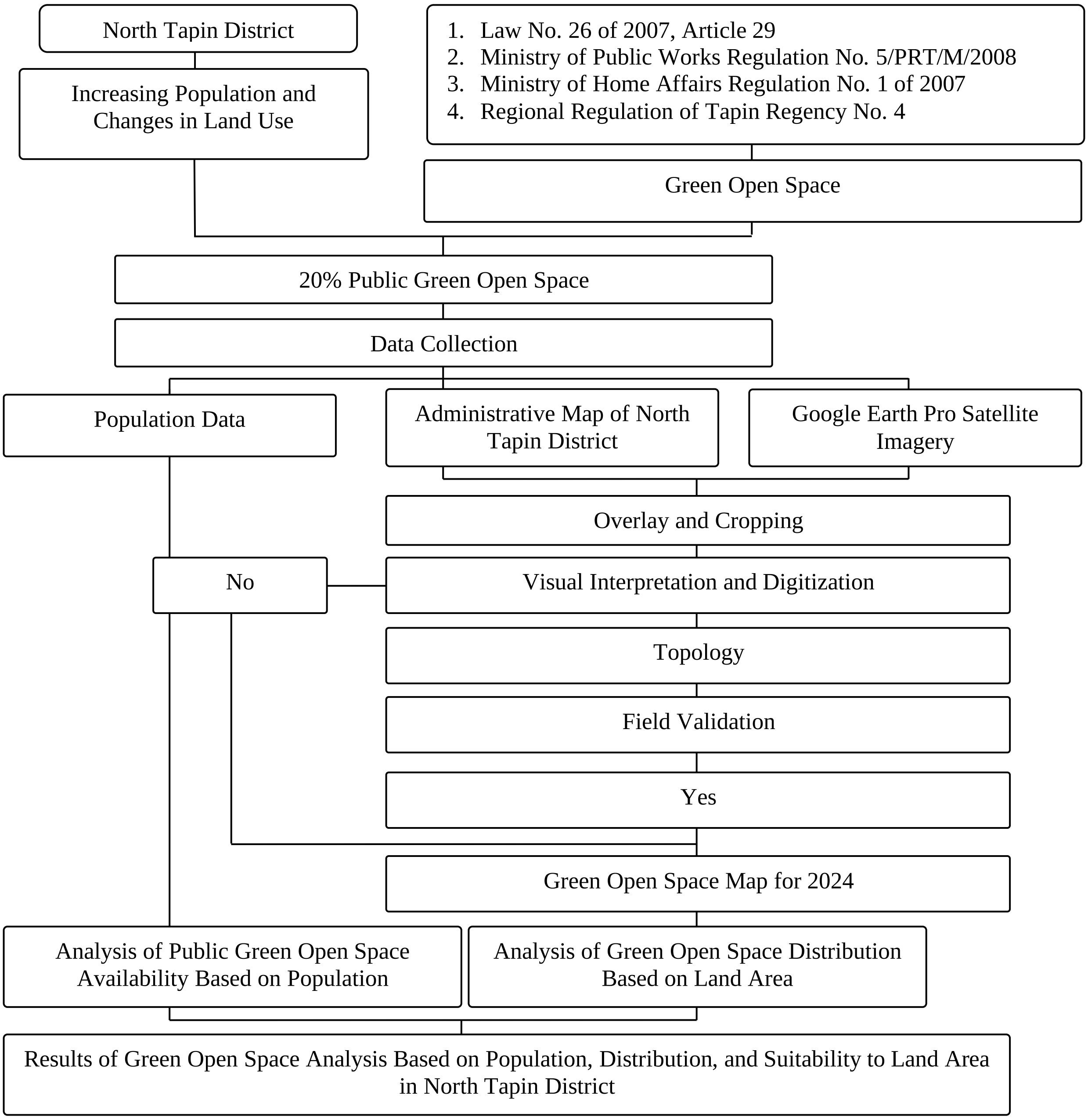

Figure 1. Research Flowchart

Result and Discussion

General Overview of the Study Area

1. Geographical Location

The North Tapin District is predominantly a lowland area located in the eastern part of the Tapin Regency, with an average elevation ranging between 0 and 7 m above sea level. The district spans approximately 32.62 square kilometers and lies geographically between 114°46’13’’ to 115°30’33’’ East Longitude and 2°32’43’’ to 3°00’43’’ South Latitude (see Figure 1). The district is bounded by the Lokpaikat Subdistrict to the north and east, the Bungur Subdistrict to the south, and the Central Tapin Subdistrict to the west. Serving as the administrative center of Tapin Regency, North Tapin houses Rantau, the regency’s capital and primary hub for government and economic activities. It is situated along the banks of the

Tapin River, approximately 82.6 km north of Banjarbaru City, the capital of South Kalimantan Province.

Table 4 details the area distribution of North Tapin's 16 villages/subdistricts, which vary considerably in size, from as small as 0.33 km² in Badaun to 8.26 km² in Rangda Malingkung.

Table 4. Population Data of North Tapin District

No	*Village/Subdistrict*	*Area (km^2)*
1	*Antasari Hilir*	*1.48*
2	*Antasari*	*1.55*
3	*Kupang*	*2.47*
4	*Rangda Malingkung*	*8.26*
5	*Rantau Kiwa*	*4.16*
6	*Perintis Raya*	*0.53*
7	*Rantau Kanan*	*1.67*
8	*Banua Halat Kiri*	*1,76*
9	*Lumbu Raya*	*0.56*
10	*Keramat*	*1.95*
11	*Banua Halat Kanan*	*3.68*
12	*Jingah Babaris*	*0.40*
13	*Kakaran*	*1.07*
14	*Badaun*	*0.33*
15	*Banua hanyar Hulu*	*2.15*
16	*Banua Hanyar*	*0.63*

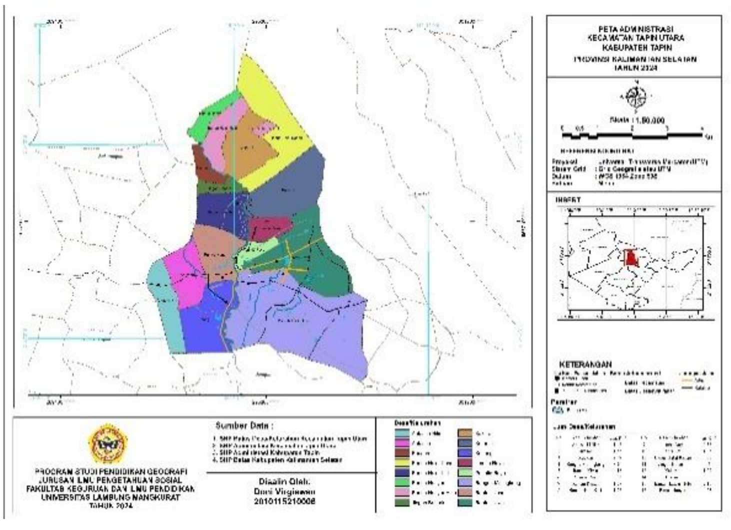

Figure 1. Administrative Map of North Tapin District

2. Physical Conditions

a. Topography

The North Tapin District's terrain is characterized by its predominantly flat, lowland nature, with elevations between 0 and 7 meters above sea level. The district covers an area of approximately 32.62 km² (slightly varying from earlier reports, which should be standardized for consistency). The slope gradient ranged from 0 to 2 percent, indicating gentle inclines conducive to urban development and green space establishment.

b. Geology and Soil Types

Geologically, the district consists mainly of coarse-textured alluvial rock formations. Soil surveys indicate effective soil depths exceeding 30 cm across the region, with approximately 85% of the land having soil depths greater than 90 cm, which supports vegetative growth. No areas with notably shallow soils were reported, suggesting favorable conditions for the sustainability of green spaces.

3. Socio-Demographic Conditions

a. Population Data

According to the 2023 data from the Tapin Regency Population and Civil Registration Office, the North Tapin District has a population of 25,754, comprising 12,824 males and 12,930 females. The district's population has grown at an average annual rate of 1.7% since 2020. The sex ratio in 2022 was 99 males per 100 females (BPS Tapin Regency, 2022), closely reflecting the gender balance. Table 5 presents the population trends from 2020 to 2022, showing steady incremental growth.

Table 5. Population data

North Tapin District	*Year*		
	2020	*2021*	*2022*
Population	*25,396*	*25,628*	*25,754*

Source: Tapin Regency Central Bureau of Statistics

b. Population Density and Distribution

The population density in the North Tapin District was projected to be 789 persons per square kilometer in 2022. However, significant variations exist across villages: Perintis Raya Village exhibits the highest density at 2,545 persons/km², while Banua Halat Kanan Village shows the lowest density at 131 persons/km². Such disparities imply differential pressures on green space availability and urban infrastructure across districts. Table 6 provides detailed density and sex ratio data for all the villages. Notably, a data inconsistency was found with Badaun Village's density reported as 7,721 persons/km², which requires further verification.

Table 6. Population Density and Distribution

No	*Village/Subdistrict*	*Population Percentage*	*Population Density (km²)*	*Population Sex Ratio*
1	*Antasari Hilir*	*3.91*	*680*	*96*
2	*Antasari*	*6.12*	*1,016*	*97*
3	*Kupang*	*12.70*	*1,324*	*102*
4	*Rangda Malingkung*	*26.00*	*811*	*103*
5	*Rantau Kiwa*	*14.80*	*916*	*98*
6	*Perintis Raya*	*5.24*	*2,545*	*94*
7	*Rantau Kanan*	*15.67*	*2,416*	*94*
8	*Banua Halat Kiri*	*3.54*	*518*	*107*
9	*Lumbu Raya*	*1.93*	*888*	*98*
10	*Keramat*	*2.06*	*272*	*99*
11	*Banua Halat Kanan*	*1.87*	*131*	*112*
12	*Jingah Babaris*	*1.23*	*795*	*89*
13	*Kakaran*	*1.19*	*287*	*112*
14	*Badaun*	*0.92*	*7721*	*103*
15	*Banua hanyar Hulu*	*1.31*	*157*	*96*
16	*Banua Hanyar*	*1.52*	*621*	*96*
	North Tapin District	*100*	*789*	*99*

Source: Tapin Regency Central Bureau of Statistics

Digitization Results of Green Open Space in North Tapin District

1. Availability of Green Open Space in North Tapin District

Following the digitization process, the spatial distribution and extent of public green open spaces (GOS) in the North Tapin District were mapped (Figure 2). This analysis enables the assessment of compliance with Law No. 26 of 2007, which mandates that at least 20% of urban land be allocated to public green open spaces.

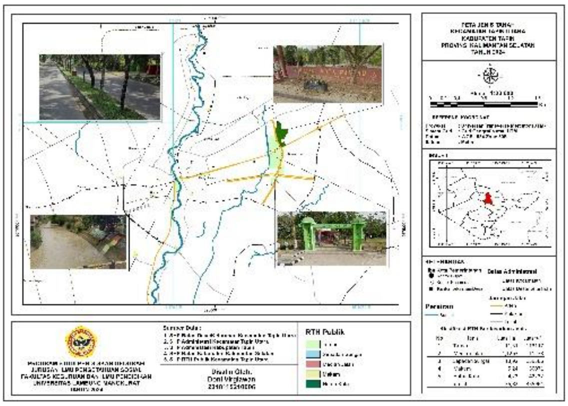

Figure 2. Map of Green Open Space Distribution in North Tapin District
Source: Data Analysis Results, 2024

Table 7 summarizes the areas of public green open spaces by type, totaling 35.82 ha, distributed as follows: parks (11.31 ha), road medians (1.13 ha), riverbank buffers (13.92 ha), cemeteries (5.24 ha), and urban forests (4.22 ha). This represents approximately 5.48% of the total district area, which is significantly less than the legal minimum.

Table 7. Population Density and Distribution

No	*Type*	*Area (Ha)*	*Area (m²)*
1	*Park*	*11.31*	*113,117*
2	*Road Median*	*1,126.30*	*11,238*
3	*Riverbank Buffer*	*13.92*	*139,306*
4	*Cemetery*	*5.24*	*50,071*
5	*Urban Forest*	*4.22*	*42,232*
	Total	*35.82*	*355,964*

Source: Data Analysis Results, 2024

Results of Field Ground Check

This section presents the validation results of green open spaces (GOS) in the North Tapin Subdistrict, aimed at verifying the accuracy of digitized spatial data through field measurements. Table 8 summarizes the measured areas of various GOS types alongside their mapped extents, with a suitability level indicating the degree of correspondence between the field and GIS data. The suitability levels ranged from 27.5% (notably low for Muslimin Kupang Cemetery) to 99%, with an overall average suitability of 86.7%. Variability in suitability highlights areas where spatial data may require refinement or where land-use changes have occurred.

Table 8. Results of Field Ground Check

No	*GOS Classification*	*Toponym*	*Area Result*	*Area Result*	*Suitability Level (%)*
1	*Park*	*Rantau Baru GOS*	*4.49*	*4.12*	*91.6*
2	*Park*	*Tapin Regent Office Park*	*0.49*	*0.42*	*85.1*
3	*Park*	*Taman Maunjun Fishing Park*	*2.90*	*2.56*	*88.1*
4	*Park*	*Playground*	*0.37*	*0.41*	*90.2*
5	*Park*	*Harapan Park*	*0.41*	*0.40*	*98.8*
6	*Park*	*Rantau GOS*	*1.07*	*1.08*	*99.0*
7	*Park*	*Dulang Roundabout*	*0.07*	*0.06*	*85.7*
8	*Park*	*Adipura Roundabout*	*0.09*	*0.07*	*80.5*
9	*Park*	*Tapin Pendopo Parking Lot*	*0.65*	*0.71*	*91.9*

10	*Park*	*30 November Tennis Field GOS*	*0.08*	*0.07*	*91.1*
11	*Cemetery*	*Unnamed Cemetery 1*	*0.22*	*0.19*	*86.6*
12	*Cemetery*	*Muslimin Almahya Cemetery*	*0.36*	*0.37*	*94.5*
13	*Cemetery*	*Muslimin Sugirama Cemetery*	*0.12*	*0.11*	*87.5*
14	*Cemetery*	*Darussalam Cangkring Cemetery*	*0.15*	*0.13*	*87.0*
15	*Cemetery*	*Muslimin Banua Halae Cemetery 3*	*0.12*	*0.11*	*90.3*
16	*Cemetery*	*Muslimin Banua Halae Cemetery 2*	*0.11*	*0.13*	*88.4*
17	*Cemetery*	*Muslimin Banua Halae Cemetery 1*	*0.34*	*0.11*	*93.8*
18	*Cemetery*	*Muslimin Banua Haur Kuning Cemetery*	*0.18*	*0.33*	*97.3*
19	*Cemetery*	*Assyarif Sheikh Muhdhar Cemetery*	*0.21*	*0.16*	*86.6*
20	*Cemetery*	*Al Falah Cemetery*	*0.04*	*0.18*	*85.9*
21	*Cemetery*	*Muslimin Keramat Village Cemetery*	*0.06*	*0.04*	*92.7*
22	*Cemetery*	*Muslimin Cemetery 2*	*0.13*	*0.05*	*78.3*
23	*Cemetery*	*Unnamed Cemetery*	*0.23*	*0.12*	*89.1*
24	*Cemetery*	*Muslimin Cemetery 2*	*0.07*	*0.20*	*87.0*
25	*Cemetery*	*Tasam Panyi Cemetery*	*0.05*	*0.06*	*83.8*
26	*Cemetery*	*Muslim Rantau Cemetery*	*0.08*	*0.04*	*85.1*
27	*Cemetery*	*Muslimin Abdullah Cemetery*	*0.04*	*0.04*	*94.7*
28	*Cemetery*	*Muslimin Kupang Cemetery*	*0.02*	*0.08*	*27.5*
29	*Cemetery*	*Muslimin Nurul Hidayah Cemetery*	*0.34*	*0.36*	*95.5*
30	*Cemetery*	*Unnamed Cemetery*	*0.01*	*0.01*	*71.4*
31	*Urban Forest*	*Tapin Urban Forest*	*4.20*	*3.70*	*88.1*
32	*Park*	*Lapangan Parkir Pasar Hanyar*	*0.50*	*0.61*	*80.3*
	Average	*Hanyar Market Parking Lot*			*86.7*

Source: Data Analysis Results, 2024

Green Open Space Needs in North Tapin Subdistrict

1. Identification of Green Open Space Needs Based on Area

Based on the North Tapin Subdistrict's total land area of approximately 3,265 hectares, the mandated public green open space requirement, according to Law No. 26 of 2007, is 20% or 653 hectares. However, the existing green open space currently covers only 35.82 hectares, resulting in a substantial deficit of 617.18 hectares. This indicates that public green open space availability accounts for only 5.48% of the total land area, which is significantly below the legal standards (Sutrisno et al., 2020) (Table 9 and Figure 3).

Table 9. Comparison of Green Open Space Needs Based on Land Area

Area of North Tapin Subdistrict (ha)	*Public Green Open Space Needs Based on Area (ha)*	*Existing Green Open Space (ha)*	*Green Open Space Deficit (ha)*
3,265	*653*	*35.82*	*(-) 617.18*

Source: Data Analysis Results, 2024

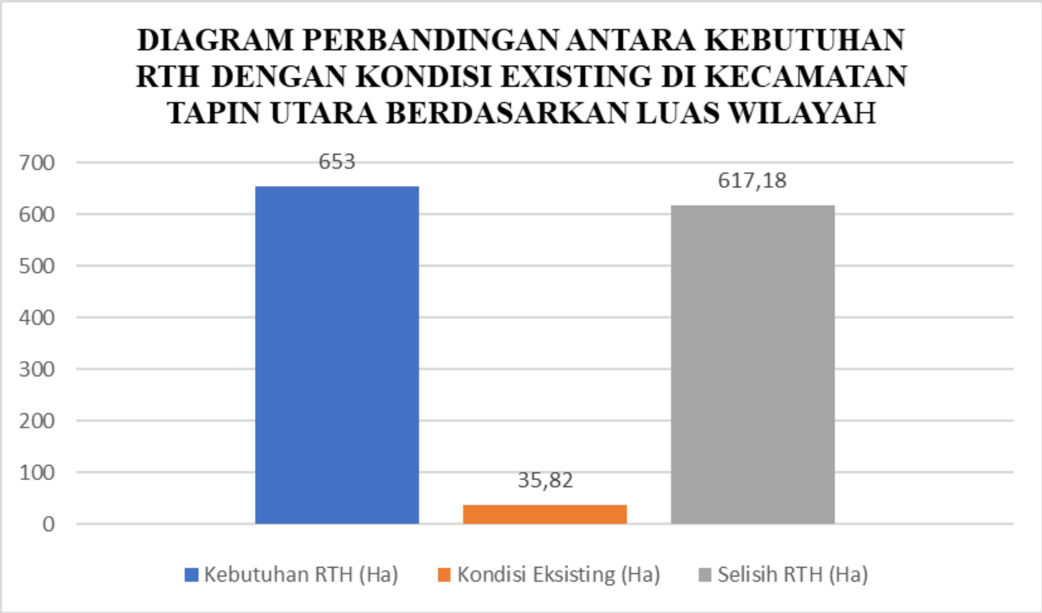

Figure 3. Comparison Between Green Open Space Needs and Existing Conditions in North Tapin Subdistrict Based on Area (hectares)

2. Identification of Green Open Space Needs Based on Population

As of 2023, the population of the North Tapin Subdistrict was 25, 754. Applying the per-capita green open space standard of 20 m² per person, the population-based GOS requirement is 51.51 hectares. Given the existing 35.82 hectares of public GOS, there remains a shortfall of approximately 15.69 hectares (Table 10 and Figure 4). This deficit reflects the challenge of meeting population-driven demands for green spaces, which are essential for urban environmental quality and residents' well-being (Arellano & Roca, 2022; Ramamurthy et al., 2025).

Table 10. Comparison of Green Open Space Needs Based on population

Area of North Tapin Subdistrict (ha)	*Public Green Open Space Needs Based on Area (ha)*	*Existing Green Open Space (ha)*	*Green Open Space Deficit (ha)*
25,754	*51.508*	*35.82*	*(-) 15,680*

Source: Data Analysis Results, 2024

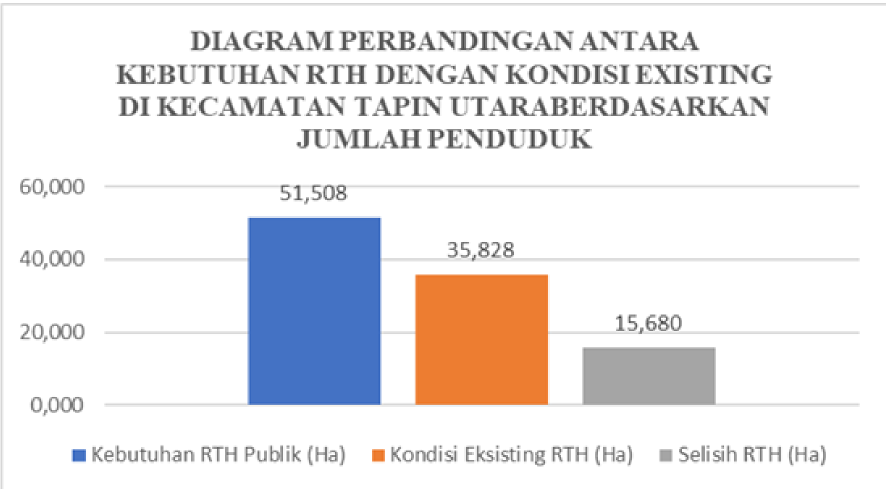

Figure 4. Comparison Between Green Open Space Needs and Existing Conditions in North Tapin Subdistrict Based on Population (hectares)

3. Projection of Green Open Space Needs in 2044

Population projections estimate that by 2044, the North Tapin Subdistrict will house approximately 36,079 residents. Correspondingly, the green open space requirement is projected to increase to 72.16 ha based on the same per-capita standard. Comparing this to the current GOS availability reveals an anticipated deficit of 36.34 ha if no additional green space is developed (Table 11 and Figure 5). These projections underscore the urgent need for strategic urban planning interventions to expand and preserve public green spaces to sustain environmental and social health (Rojas-Rueda, 2021; Vilcins et al., 2024; Willis & Crabtree, 2011).

Table 11. Projection of Public Green Open Space Needs, Existing Conditions, and Deficit in North Tapin Subdistrict Based on Area and Population (2024–2044)

Area	*Population*	*Public GOS Need*	*Existing GOS*	*GOS Deficit*
	2044	*2044*	*2024*	*(ha)*
3,265	*36,079*	*72,158*	*35.82*	*(-) 36,338*

Source: Data Analysis Results, 2024

Conclusion

Based on the land area of North Tapin Subdistrict, the mandated green open space requirement, as stipulated by Law Number 26 of 2007 on Spatial Planning, is approximately 653 ha. This requirement significantly exceeds the currently available green open space of only 35.82 hectares. Consequently, green open spaces currently constitute only 5.48% of the total land area in the North Tapin Subdistrict, which is substantially below the legal minimum. This shortfall has important implications for environmental quality, urban livability and ecosystem services within the district.

`The green open space requirement calculated based on the population size of 25,754 individuals is 72.16 hectares, applying the standard of 20 m² per capita. However, the existing green open space area remains only 35.82 ha. Therefore, a deficit of approximately 15.68 hectares exists, representing around 44% of the required green open space needed to meet the current population demands. With an annual population growth rate of 1.7%, the projected population for 2044 is estimated at 36,079 individuals, calculated using the compound growth formula. Correspondingly, the projected green open space demand for 2044 is estimated to be 72.16 hectares, reflecting the increased spatial requirements necessary to accommodate population growth and maintain sustainable urban environments.

Recommendations

The Department of Public Works and Spatial Planning (DPUPR) at both the provincial and regency levels should collaborate closely to expand green open spaces in accordance with the criteria set forth in Law Number 26 of 2007. Such collaboration may include joint planning efforts, coordinated funding allocation, and policy synchronization to ensure the effective development and management of green spaces. Efforts to increase green open spaces should prioritize the optimization of existing land resources through targeted greening programs along transportation corridors, as well as the establishment of urban forests, parks, and community green spaces, such as Ruang Publik Terpadu Ramah Anak (RPTRA), to promote equitable spatial distribution. Clear criteria for site selection and community accessibility should guide such initiatives.

Additionally, the conversion of unproductive or underutilized land into green open spaces should be systematically implemented. Identifying suitable land parcels and addressing potential legal or socioeconomic barriers will be critical for successful expansion. Local governments must also strengthen their capacity to conserve, manage, and maintain accessible green open spaces to ensure their long-term sustainability, ecological functionality, and aesthetic value. This includes developing comprehensive maintenance frameworks, allocating sufficient budgets, and building technical expertise to support these functions. Moreover, community engagement should be actively encouraged to foster local stewardship to maintain cleanliness and enhance the aesthetic quality of green open spaces. Strategies such as awareness campaigns, volunteer programs, and partnerships between governmental agencies and community organizations can maximize social benefits and ensure that these green spaces effectively serve the population.

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