

## **Original Research Article**

# **Assessment and Planning Green Open Spaces of Kisaran Timur for Sustainable Urban Development**

### **Abstract**

The provision of Green Open Space (GOS) in Kisaran Timur Subdistrict remains below national standards, with only 81.46 hectares recorded in 2023, representing a modest increase from 71.58 hectares in 2013. However, this growth is overshadowed by the expansion of built-up areas, which increased by 141.50 hectares during the same period. This study evaluates the current state of GOS, calculates the subdistrict's GOS requirements based on area and population projections, and identifies optimal locations for future development. The findings reveal that Kisaran Timur requires a minimum of 522.64 hectares of GOS, equivalent to 20% of the total area, as mandated by Law No. 26 of 2007. By 2043, the projected population of 122,421 will necessitate 244,842 m<sup>2</sup> of public GOS, yet only two villages—Selawan and Siumbut Baru—currently meet these requirements. Spatial analysis using GIS identifies Mutiara Village as the most suitable location for subdistrict park development, offering the largest vacant land and highest serviceable population. The study emphasizes the urgent need for strategic planning and collaborative management to address GOS deficits, ensure equitable distribution, and promote ecological and social balance in urban areas. The results provide a valuable framework for policymakers to enhance urban sustainability through targeted GOS development.

**Keywords:** Green Open Space, urban planning, sustainable development, spatial analysis, Kisaran Timur Subdistrict.

### **I. Introduction**

Urban areas play a strategic role in supporting economic, social, and cultural activities. Effective and sustainable spatial planning is essential to maintaining the quality of life for urban residents (FAO, 2020). One critical aspect of spatial planning is the provision of Green Open Spaces (GOS), which serve as water catchment areas, microclimate regulators, carbon dioxide absorbers, and public recreational spaces (Forest Service Publications, 2003; Ministry of Agriculture, 2023). However, rapid urbanization and insufficient planning frequently threaten the existence and effectiveness of GOS (Hakim & Utomo, 2004).

The provision of GOS in Indonesia is governed by Law Number 26 of 2007 on Spatial Planning, which mandates a minimum allocation of 30% of the total urban area, comprising 20% public GOS and 10% private GOS. Despite these regulations, many regions, including Asahan Regency, struggle to meet these standards. For instance, while the Regional Spatial Plan (RTRW) of Asahan Regency for 2013–2033 plans a 30% GOS allocation, specific locations remain undetermined, and the lack of a Detailed Spatial Plan (RDTR) further exacerbates the situation (Dinas PUPR Kabupaten Humbang Hasundutan, 2023; Bappenas, 2021).

Kisaran Timur Subdistrict, part of the capital of Asahan Regency, faces significant challenges from rapid population growth and urban development. Between 2013 and 2023, the population increased from 70,415 to 85,596, with density rising from 1,809 people/km<sup>2</sup> to 2,837.33 people/km<sup>2</sup> (BPS, 2023).

This growth drives extensive residential and infrastructure development, often at the expense of GOS (Nasution & Siregar, 2023). Furthermore, Kisaran Timur lags behind Kisaran Barat, which has more developed public green spaces, such as urban forests and squares (Ministry of Environment and Forestry, 2022).

Spatial planning challenges in Kisaran City also stem from plantation land dominance, disaster risks, and deviations from regional planning predictions. Addressing these issues requires prioritizing decentralization, creating growth centers, and improving infrastructure to support sustainable urban development (Abdul et al., 2024). Similar to other regions, the transition from agricultural to non-agricultural land introduces socio-economic challenges such as job displacement and reduced social interaction, underscoring the need for balanced growth through sustainable land management and alternative agricultural development (Eko Suharizki et al., 2024).

Urban GOS not only ensures ecological balance but also contributes to community welfare. Studies highlight the significant role of sustainable practices, such as oil palm cultivation, in rural development, despite challenges like labor management and environmental concerns. This underscores the importance of governance structures and holistic approaches to land use management (Arga et al., 2024). These findings align with urban GOS planning, where the integration of ecological, social, and economic factors is critical.

Community empowerment strategies, such as "one house one jumantik," demonstrate the potential for localized programs to improve urban environments. However, limited resources and infrastructure often hinder the success of these initiatives, as seen in Pekanbaru City (Arga Abdi RafiudDarajat Lubis et al., 2024). Similarly, the success of ecotourism initiatives, such as those in Sei Nagalawan Village, shows that creative economic solutions can strengthen community welfare and ensure long-term benefits, provided technological and governmental support are improved (Anisah, 2024).

Research emphasizes the importance of data-driven approaches to GOS planning. Tinambunan (2006) identified insufficient green space in Pekanbaru City, while Siregar (2016) stressed the need for analysis based on population and oxygen demand. Moreover, integrating advanced tools such as satellite imagery and Geographic Information Systems (GIS) can yield accurate evaluations of GOS adequacy and distribution (Gulo, 2008; Siska, 2023). The development of sustainable food systems and agribusiness, as observed in Medan City and LintongNihuta, further demonstrates the intersection of land use, economic resilience, and regional growth (Muliadi et al., 2024; Lubis, S. N., 2023).

This study aims to analyze the GOS needs in Kisaran Timur Subdistrict comprehensively by evaluating the balance between built-up land and GOS, projecting GOS requirements based on population growth, and identifying optimal locations for GOS development. By addressing these challenges, this research contributes to sustainable spatial policies that align with ecological and socio-economic goals, reflecting broader efforts to enhance urban resilience and community welfare (Satia Negara Lubis & Arga Abdi RafiudDarajat Lubis, 2024).

## **II. Research Methodology**

### **2.1 Research Type**

This study employs a descriptive approach using qualitative methods. The objective is to analyze the demand and availability of Green Open Space (Ruang Terbuka Hijau, RTH) in the Kisaran Timur Subdistrict based on collected data. Qualitative methods allow for the extraction of descriptive narratives

from various sources to gain a comprehensive understanding of the phenomenon (Bodgan& Taylor in Barowi& Suwandi, 2009).

## 2.2 Study Area

The research was conducted in Kisaran Timur Subdistrict, Asahan Regency. This area was selected due to rapid residential development, which poses a potential threat to ecological balance by reducing green open spaces. Kisaran Timur is among the regions with the highest population growth in Asahan Regency.

## 2.3 Data Types and Sources

The study utilized secondary data obtained from:

1. Relevant government agencies, such as the Environmental Agency and the Public Works and Spatial Planning Agency of Asahan Regency.
2. Official government websites, including the Central Bureau of Statistics (BPS) and other online platforms.

The collected data includes:

- Land cover data (shapefiles) for 2013 and 2023.
- Population data from 2000 to 2023.
- Administrative boundary and land-use data.

## 2.4 Data Collection Methods

Data collection was carried out through two main methods:

1. Requests for data from relevant government institutions:
  - Public green space location data from the Environmental Agency.
  - Land cover shapefiles from the Public Works and Spatial Planning Agency of Asahan Regency.
2. Downloading data from official sources:
  - Population data from the BPS website.

To verify the accuracy of the secondary data, ground checks were conducted, including capturing GPS coordinates, direct observations, and documenting the condition of existing green spaces.

## 2.5 Data Analysis

Data analysis was conducted using a combination of QGIS and Microsoft Excel, with the following steps:

### 2.5.1 Land Cover Analysis

- **Map cropping:** The study area was delineated based on the administrative boundaries of Kisaran Timur Subdistrict.
- **Ground verification:** Field observations were conducted to validate the interpreted map data.

- **Land cover classification:** Data were categorized into green open spaces, built-up areas, and other potential land uses using QGIS.

**2.5.2 Analysis of RTH Needs Based on Area** The ideal green open space requirement was calculated using the formula:

$$\text{RTH Requirement (Ha)} = \text{Area (Ha)} \times 20\%$$

This analysis estimates the ideal RTH area based on the subdistrict's total area.

**2.5.3 Analysis of RTH Needs Based on Population** The required RTH was calculated as follows:

$$\text{RTH}_{pi} = P_i \times K$$

Where:

- $P_i$ : Population in area  $i$ .
- $K$ : RTH requirement per capita (as per the Ministry of Public Works Regulation No. 05/PRT/M/2008).

This calculation assesses the adequacy or deficit of green spaces based on population standards.

**2.5.4 Green Space Location Analysis** The optimal location for green spaces was determined using two variables:

1. **Land availability:** Identification of potential areas using grids, excluding unsuitable zones.
2. **Population served:** Calculation of the number of residents within the service radius based on population density.

The results from these analyses were combined to generate an optimal green space location map.

## 2.6 Operational Definitions of Variables

1. **General Spatial Plan of Kisaran City:** A framework for optimal and efficient spatial utilization over a specified period.
2. **Green Open Space Development:** Changes in the extent and distribution of RTH in Kisaran Timur Subdistrict.
3. **RTH Requirements:** The ideal RTH area based on land size and population parameters.

This structured methodology ensures a thorough assessment of the green space needs and availability in Kisaran Timur, contributing to sustainable urban planning efforts.

## III. Results and Discussion

### 3.1 General Overview of Kisaran Timur Subdistrict

Kisaran Timur Subdistrict is part of the capital of Asahan Regency, with a total area of 3,892 hectares (38.92 km<sup>2</sup>). This area is bordered by Rawang PancaArga Subdistrict in the north, Air Joman Subdistrict in the east, Sei Dadap Subdistrict in the south, and Kisaran Barat Subdistrict in the west. This subdistrict consists of 12 villages, with the largest village being Karang Anyer (5.97 km<sup>2</sup>) and the smallest being Kisaran Timur (0.51 km<sup>2</sup>). The distribution of the area of each village is presented in Table 1.

**Table 1. Area of Villages in Kisaran Timur Subdistrict**

No.	Urban Village	Area (km <sup>2</sup> )	Percentage (%)
1	Sentang	4,14	10,64
2	Kedai Ledang	3,10	7,94
3	Kisaran Naga	2,19	5,63
4	Teladan	0,70	1,80
5	Kisaran Timur	0,51	1,31
6	Selawan	2,78	7,14
7	Mutiara	2,00	5,14
8	Siumbut Baru	2,70	6,94
9	Siumbut-umbut	2,90	7,45
10	Karang Anyer	5,97	15,34
11	Gambir Baru	5,97	15,34
12	Lestari	5,96	15,31
<b>Total</b>		<b>38,92</b>	<b>100,00</b>

Source :BPS Kisaran Timur Subdistrict, 2024

### 3.2 Availability of Green Open Space in Kisaran Timur Subdistrict

The availability of public Green Open Space (GOS) in Kisaran Timur Subdistrict is still very minimal compared to the standard requirements. According to data from the Environmental Agency of Asahan Regency, GOS managed by the government is predominantly concentrated in Kisaran Barat Subdistrict, while Kisaran Timur Subdistrict only has several GOS locations, such as Taman Mantri Madjizat, Taman Sentang, and Stadion Mutiara. A detailed comparison of built-up land and GOS area between 2013 and 2023 is presented in Table 2.

**Table 2.** Comparison of Built-up Land and GOS Areas in 2013 and 2023

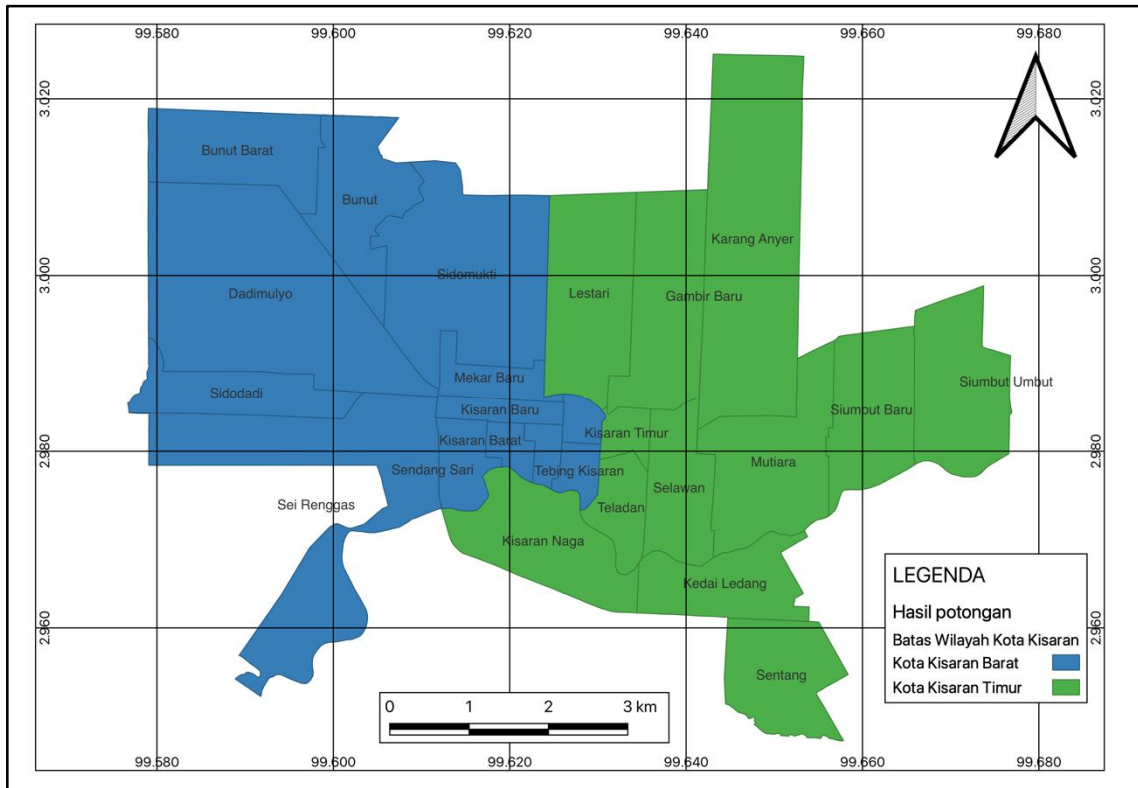
No	Urban Village	Build-up Land Area (Ha)			GOS Area (Ha)		
		2013	2023	difference	2013	2023	Difference
1	Sentang	15,34	21,10	5,76	-	0,90	0,90
2	Kedai Ledang	10,44	28,72	18,28	12,16	12,31	0,15
3	Kisaran Naga	21,80	44,56	22,76	19,22	19,37	0,15
4	Teladan	16,75	22,27	5,52	9,56	12,35	2,79
5	Kisaran Timur	8,32	9,88	1,56	-	0,01	0,01
6	Selawan	23,08	31,11	8,03	10,62	11,71	1,09
7	Mutiara	15,61	36,56	20,95	8,18	8,57	0,38
8	Siumbut Baru	7,46	26,92	19,47	4,79	9,13	4,34
9	Siumbut-umbut	10,98	24,95	13,97	5,31	5,31	0,00
10	Karang Anyer	7,97	13,38	5,41	-	-	0,00
11	Gambir Baru	12,05	21,10	9,04	-	0,07	0,07
12	Lestari	14,65	25,39	10,74	1,74	1,74	0,00
<b>TOTAL</b>		<b>164,44</b>	<b>305,94</b>	<b>141,50</b>	<b>71,58</b>	<b>81,46</b>	<b>9,88</b>

### 3.3 Land Cover Analysis

#### 3.3.1 Map Cropping

The analysis began with cropping maps using shapefile data from 2013 and 2023 for land cover and administrative boundary data from the Geospatial Information Agency (BIG). After the cropping and standardization process, the total area of Kisaran Timur City was determined to be 26,132,225.28 m<sup>2</sup>.

**Figure 1.** Cropped Map of Kisaran Timur City



### 3.3.2 Ground Check

Ground checks were conducted to verify map analysis results with field conditions. Documentation of several GOS areas such as Taman Mantri Madjizat, Taman Sentang, and Stadion Mutiara is included in the following images.

**Figure 2.** Green Open Space: Taman Mantri Madjizat in Kisaran Timur Village



**Figure 3.** Green Open Space Taman Sentang in Kisaran Naga Village



**Figure 4.** Green Open Space: Stadion Mutiara in Selawan Village



### 3.3.3 Land Cover Classification

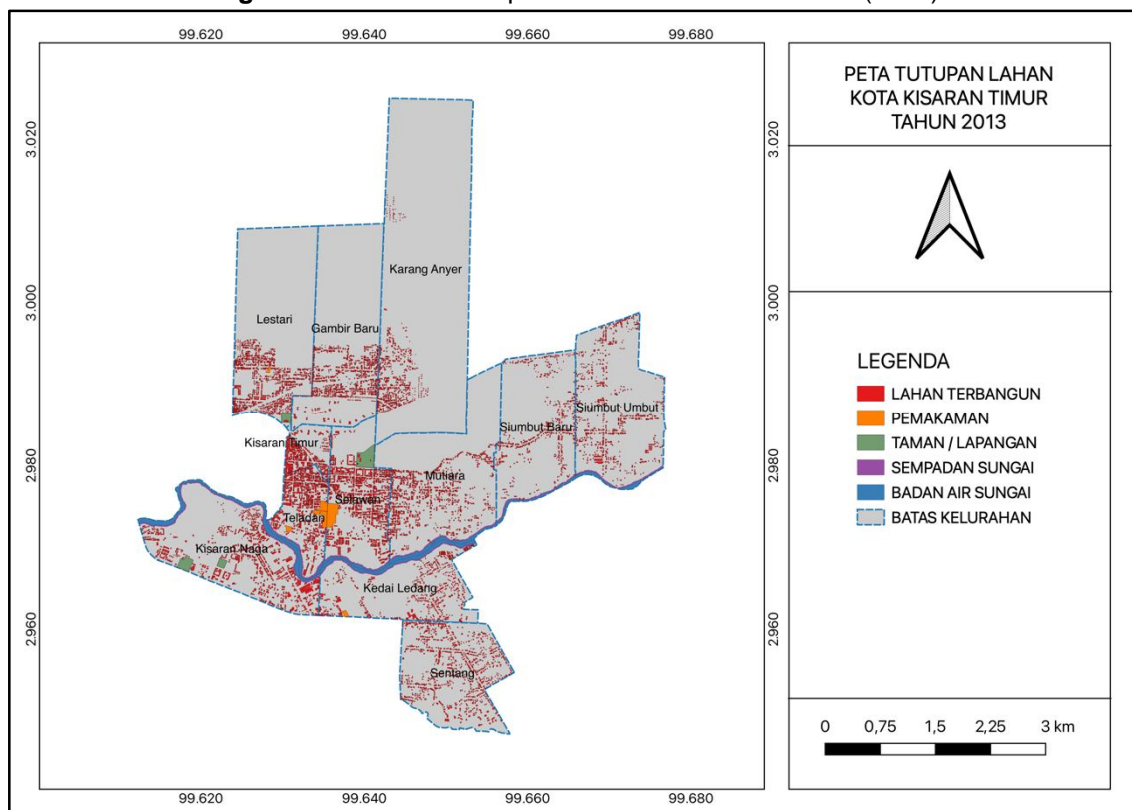
Based on land cover classification, in 2013, Kisaran Timur Subdistrict had 71.58 hectares of GOS, which increased to 81.46 hectares in 2023. However, this growth in GOS was not proportional to the increase in built-up land, which reached 141.50 hectares. Detailed information can be seen in Tables 3 and 4, and Figures 5 and 6.

Table 3. GOS Distribution in Kisaran Timur Subdistrict (2013)

No	Village	Built-up Land Area (Ha)	GOS Area by Type (m <sup>2</sup> )				Total GOS Area (Ha)
			Park	Public Cemetery	River Body	Riverbank	
1	Sentang	15,34					-
2	Kedai Ledang	10,44		4.788,50	78.925,10	37.842,53	12,16
3	Kisaran Naga	21,80	620,57		130.360,31	61.252,30	19,22
4	Teladan	16,75		35.468,69	37.560,60	22.544,12	9,56
5	Kisaran Timur	8,32					-
6	Selawan	23,08	26.922,13	39.436,33	23.250,46	16.585,64	10,62
7	Mutiara	15,61			54.457,19	27.378,00	8,18
8	Siumbut Baru	7,46			25.638,99	22.286,96	4,79

9	Siumbut-umbut	10,98			30.817,18	22.263,15	5,31
10	Karang Anyer	7,97					-
11	Gambir Baru	12,05					-
12	Lestari	14,65	14.481,48	2.917,38			1,74
<b>TOTAL</b>		<b>164,44</b>	<b>42.024,18</b>	<b>82.610,90</b>	<b>381.009,82</b>	<b>210.152,70</b>	<b>71,58</b>

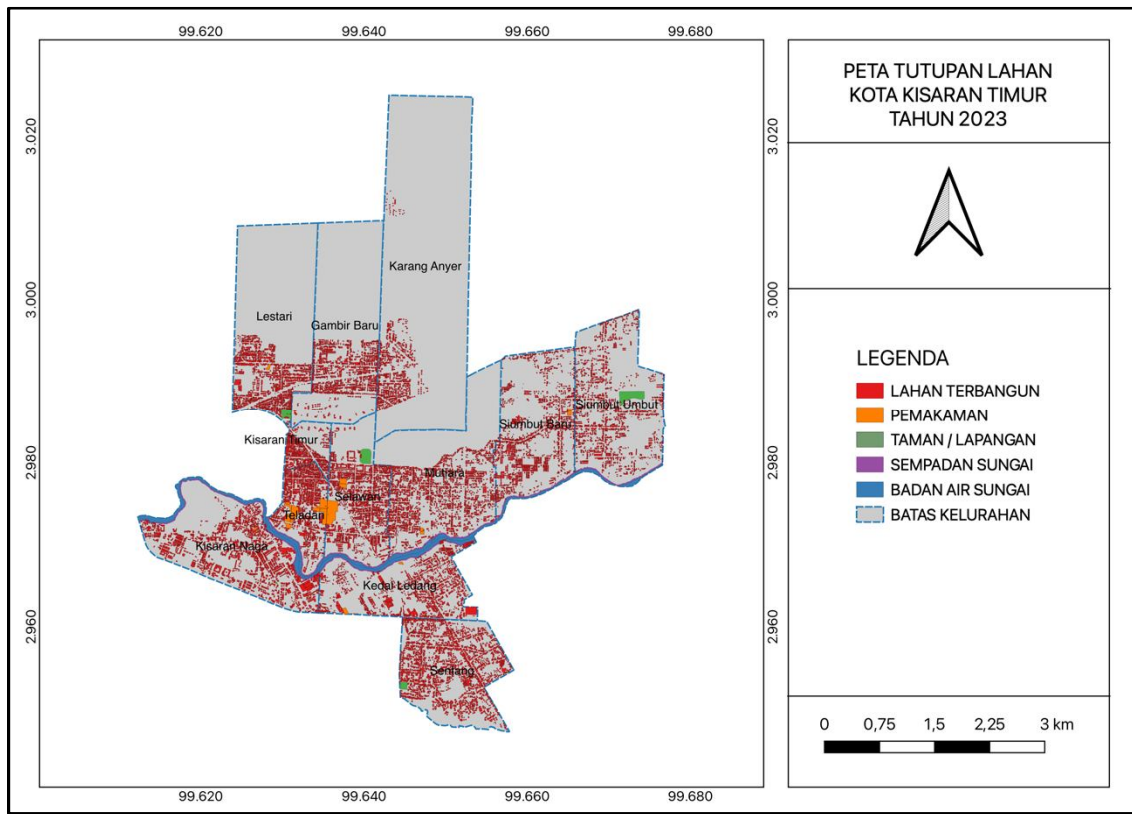
**Figure 5.** Land Cover Map of Kisaran Timur Subdistrict (2013)



**Table 4.** GOS Distribution in Kisaran Timur Subdistrict (2023)

No	Village	Built-up Land Area (Ha)	GOS Area by Type (m <sup>2</sup> )				Total GOS Area (Ha)
			Park	Public Cemetery	River Body	Riverbank	
1	Sentang	21,10	8.986,92				0,90
2	Kedai Ledang	28,72		6.301,32	78.925,10	37.842,53	12,31
3	Kisaran Naga	44,56	620,57	1.490,28	130.360,31	61.252,30	19,37
4	Teladan	22,27		63.394,48	37.560,60	22.544,12	12,35
5	Kisaran Timur	9,88	83,91				0,01
6	Selawan	31,11	26.922,13	50.347,32	23.250,46	16.585,64	11,71
7	Mutiara	36,56		3.826,64	54.457,19	27.378,00	8,57
8	Siumbut Baru	26,92	38.874,33	4.508,16	25.638,99	22.286,96	9,13
9	Siumbut-umbut	24,95			30.817,18	22.263,15	5,31
10	Karang Anyer	13,38					-
11	Gambir Baru	21,10	660,86				0,07
12	Lestari	25,39	14.481,48	2.917,38			1,74
<b>TOTAL</b>		<b>305,94</b>	<b>90.630,20</b>	<b>132.785,58</b>	<b>381.009,82</b>	<b>210.152,70</b>	<b>81,46</b>

**Figure 6.** Land Cover Map of Kisaran Timur Subdistrict (2023)



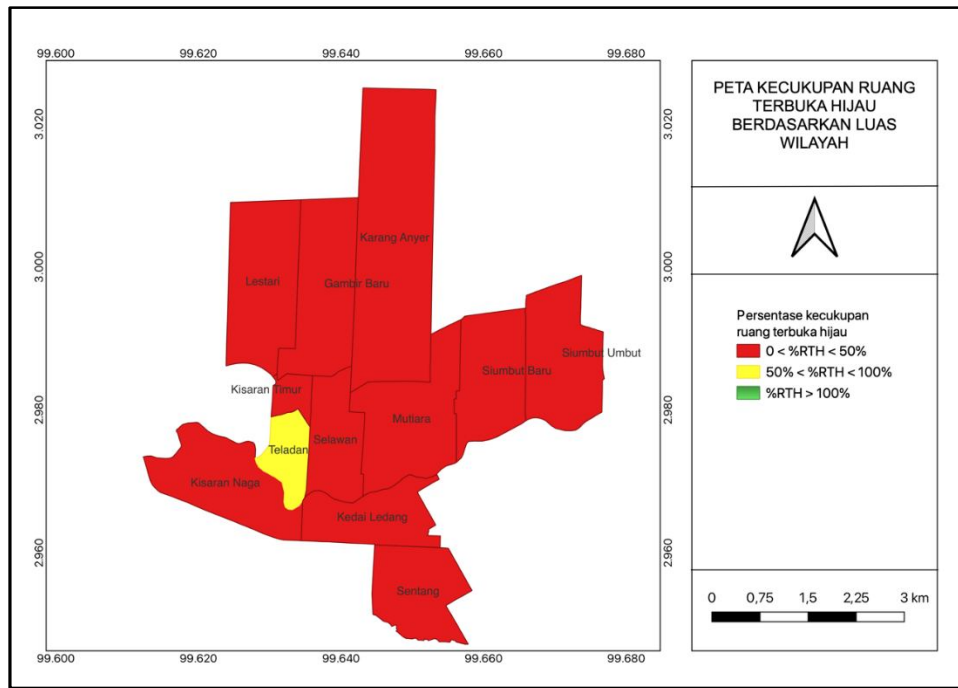
### 3.4 Analysis of Public GOS Needs Based on Area

According to regulations, the minimum public Green Open Space (GOS) requirement is 20% of the total area. For Kisaran Timur Subdistrict, this translates to **522.64 hectares**. However, current GOS fulfills only **15.59%** of this requirement, leaving a significant deficit. Detailed results are presented in **Table 5**, while the analysis is visualized in **Figure 7**.

**Table 5.** Public GOS Needs Based on Area in Kisaran Timur Subdistrict

No	Urban Village	Area (Ha)	Required GOS Area (Ha)	Current GOS Area (Ha)	Deficit (Ha)	Current GOS (%)	Notes
1	Sentang	181,26	36,25	0,90	-35,35	2,48	insufficient
2	Kedai Ledang	166,28	33,26	12,31	-20,95	37,01	insufficient
3	Kisaran Naga	233,37	46,67	19,37	-27,30	41,50	insufficient
4	Teladan	80,37	16,07	12,35	-3,72	76,83	insufficient
5	Kisaran Timur	37,05	7,41	0,01	-7,40	0,11	insufficient
6	Selawan	148,18	29,64	11,71	-17,93	39,51	insufficient
7	Mutiara	267,49	53,50	8,57	-44,93	16,01	insufficient
8	Siumbut Baru	202,79	40,56	9,13	-31,43	22,51	insufficient
9	Siumbut-umbut	233,46	46,69	5,31	-41,38	11,37	insufficient
10	Karang Anyer	539,33	107,87	0,00	-107,87	0,00	insufficient
11	Gambir Baru	253,52	50,70	0,07	-50,64	0,13	insufficient
12	Lestari	270,10	54,02	1,74	-52,28	3,22	insufficient

**Figure 7.** Results of Public GOS Needs Analysis Based on Area



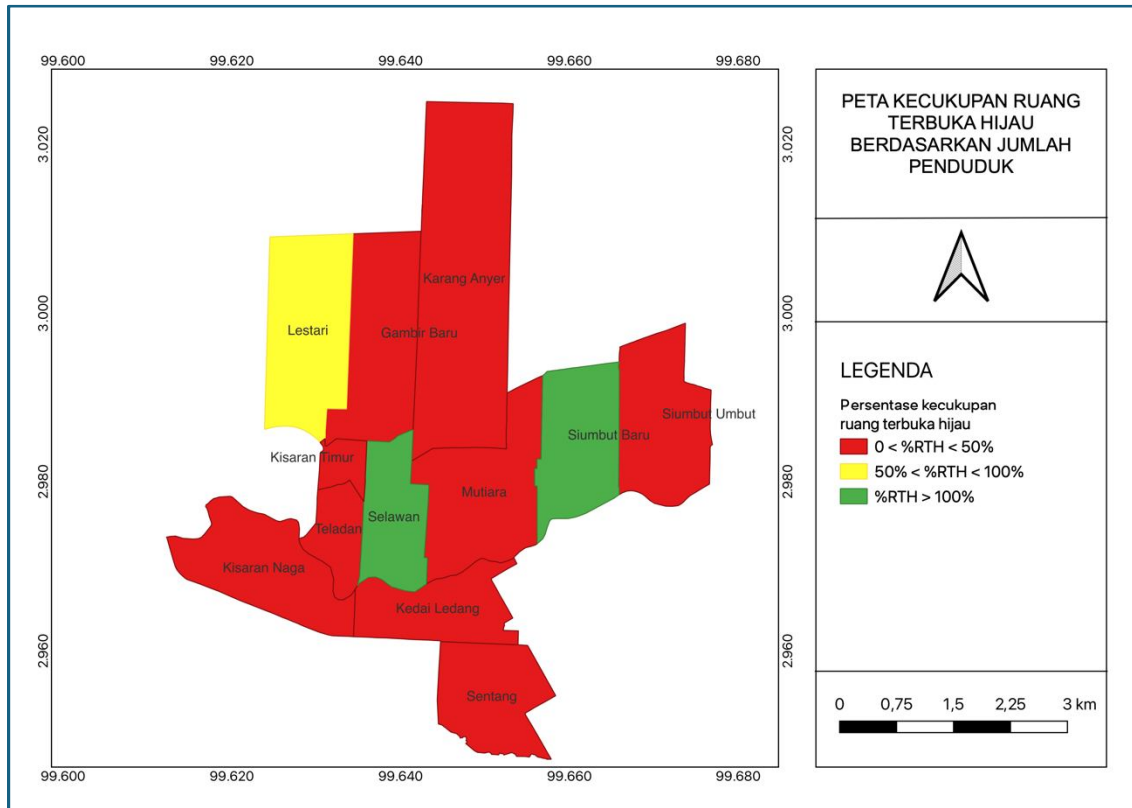
### 3.5 Analysis of Public GOS Needs Based on Population

The analysis of GOS needs based on population projections for 2043 reveals a significant deficit. With an estimated population of **122,421**, the required GOS for public spaces is **244,842 m<sup>2</sup>**, based on the standard of **0.2 m<sup>2</sup> per person for subdistrict parks**. Currently, only two villages—**Selawan** and **Siumbang Baru**—meet this requirement. Detailed results are presented in **Table 6**, while the analysis is visualized in **Figure 8**.

**Table 6.** Analysis of Minimal Public GOS Needs Based on Population

No	Urban Village	Required GOS (m <sup>2</sup> )	Current GOS (m <sup>2</sup> )	Deficit (m <sup>2</sup> )	Current GOS (%)	Notes
1	Sentang	28.616	8.986,92	-19.629,08	31,41	Insufficient
2	Kedai Ledang	15.774	0,00	-15.774,00	0,00	Insufficient
3	Kisaran Naga	17.752	620,57	-17.131,43	3,50	Insufficient
4	Teladan	13.094	0,00	-13.094,00	0,00	Insufficient
5	Kisaran Timur	6.056	83,91	-5.972,09	1,39	Insufficient
6	Selawan	21.186	26.922,13	5.736,13	127,08	Sufficient
7	Mutiara	39.834	0,00	-39.834,00	0,00	Insufficient
8	Siumbang Baru	29.864	38.874,33	9.010,33	130,17	Sufficient
9	Siumbang-umbut	31.352	0,00	-31.352,00	0,00	Insufficient
10	Karang Anyer	10.880	0,00	-10.880,00	0,00	Insufficient
11	Gambir Baru	13.562	660,86	-12.901,14	4,87	Insufficient
12	Lestari	16.872	14.481,48	-2.390,52	85,83	Insufficient
		244.842	90.630,20	-154.211,80		Insufficient

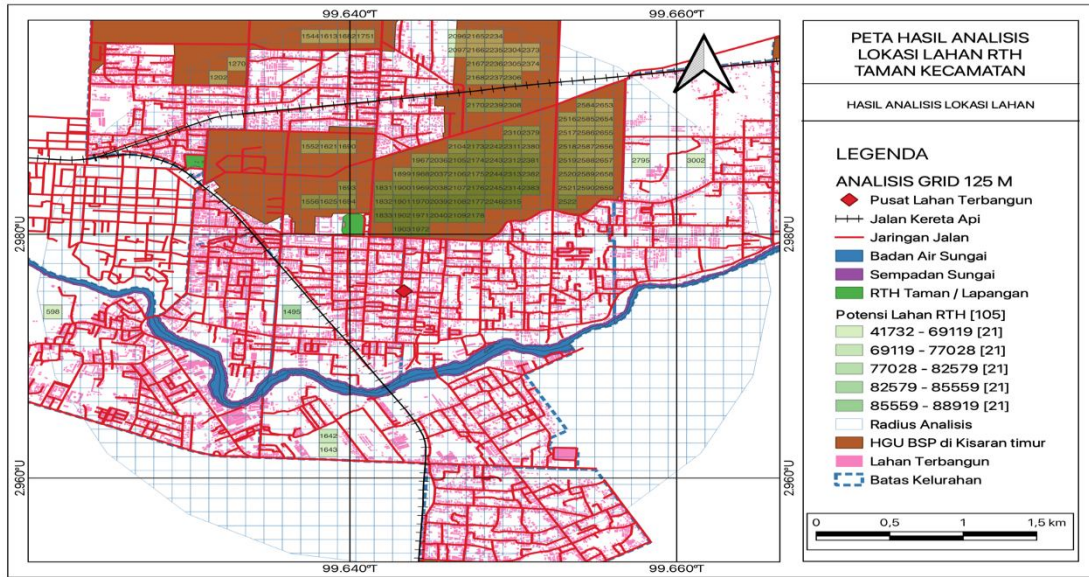
**Figure 8.**Results of Minimal Public GOS Needs Analysis Based on Population



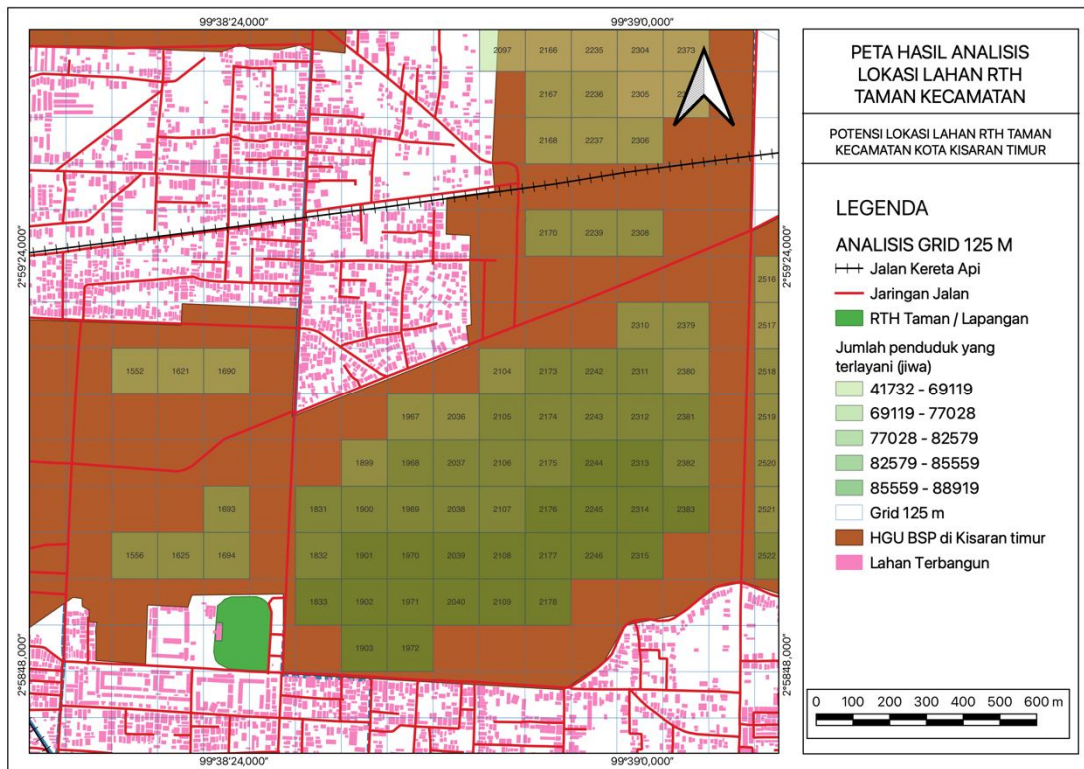
### 3.6 Analysis of Potential Locations for GOS Development

The analysis of potential GOS locations used a **125 x 125-meter grid** based on a **2,500-meter service radius**. After the elimination process, **105 grids** were identified as potential locations for GOS development. Among the identified areas, **Mutiara Village** emerged as the most suitable, with the highest potential population served within the service radius. The results are visualized in **Figures 9-10**.

**Figure 9.** Map of Potential GOS Locations in Kisaran Timur Subdistrict



**Figure 10.** Optimal Locations for GOS Development in Kisaran Timur Subdistrict



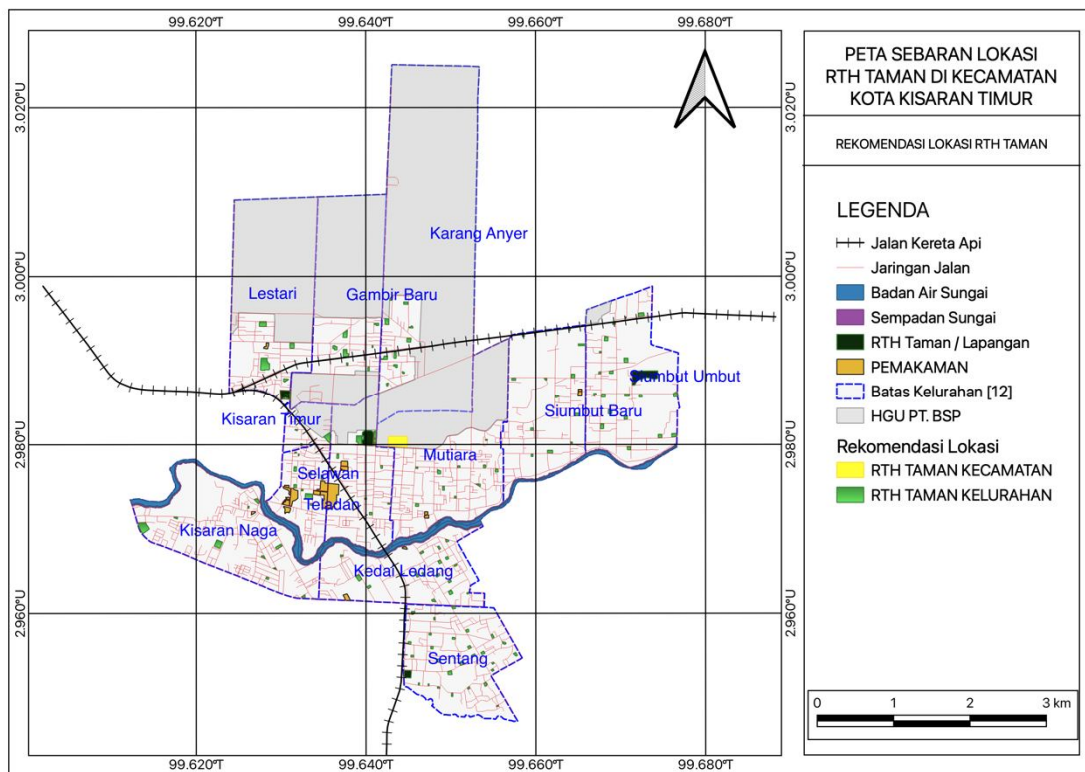
### 3.7 Recommendations for Village-Level GOS Planning

Based on the analysis, the total recommended GOS area is **354,599.98 m<sup>2</sup>**, spread across **135 locations** in Kisaran Timur Subdistrict. This additional GOS would enable all villages to meet the minimum GOS requirements. A breakdown of the proposed GOS expansions is detailed in **Table 7**, and the spatial distribution is shown in **Figure 11**.

**Table 7.** Proposed GOS for Villages to Meet Requirements.

NO	Urban Village	GOS Area (m <sup>2</sup> )			Required GOS (m <sup>2</sup> )	Notes
		Existing GOS	Planned GOS	TOTAL GOS		
1	Sentang	8.986,92	26.850,74	35.837,66	28.616	Sufficient
2	Kedai Ledang	0,00	20.325,52	20.325,52	15.774	Sufficient
3	Kisaran Naga	620,57	28.718,19	29.338,76	17.752	Sufficient
4	Teladan	0,00	13.343,29	13.343,29	13.094	Sufficient
5	Kisaran Timur	83,91	6.860,66	6.944,57	6.056	Sufficient
6	Selawan	26.922,13	15.876,87	42.799,00	21.186	Sufficient
7	Mutiara	0,00	43.644,80	43.644,80	39.834	Sufficient
8	Siumbut Baru	38.874,33	14.981,68	53.856,01	29.864	Sufficient
9	Siumbut-umbut	0,00	34.191,58	34.191,58	31.352	Sufficient
10	Karang Anyer	0,00	17.433,04	17.433,04	10.880	Sufficient
11	Gambir Baru	660,86	14.918,83	15.579,69	13.562	Sufficient
12	Lestari	14.481,48	26.824,58	41.306,06	16.872	Sufficient
JUMLAH		90.630,20	263.969,78	354.599,98	244.842	Sufficient

**Figure 11.** Recommended GOS Locations in Kisaran Timur Subdistrict



## 4.8 Discussion

Kisaran Timur Subdistrict experienced an increase in Green Open Space (GOS) from **71.58 hectares in 2013** to **81.46 hectares in 2023**. However, this 9.88-hectare increase over a decade is considered insufficient to meet the ideal requirement of 20% of the total area. This highlights a significant gap between the current conditions and the GOS standards outlined in regulatory provisions.

The GOS deficit in Kisaran Timur Subdistrict is further evidenced by population growth and its impact on public space needs. With the population projected to reach **88,919 by 2043**, the required public GOS for parks is estimated at **244,842 m<sup>2</sup>**. Based on the standards outlined in **Regulation of the Ministry of Public Works No. 05/PRT/M/2008**, each individual requires at least **0.3 m<sup>2</sup> for village parks** and **0.2 m<sup>2</sup> for subdistrict parks**. This underscores the need for accelerated GOS development to balance population growth and address socio-ecological needs.

The concentration of GOS in Kisaran Barat Subdistrict poses a challenge for Kisaran Timur. Most GOS facilities, such as **Hutan Kota** and **Alun-Alun Kota**, are located in Kisaran Barat, while Kisaran Timur has only a few small-scale GOS, such as **Taman Sentang** and **Stadion Mutiara**. This imbalance in distribution creates inequities in public access to green spaces and environmental quality.

From an ecological perspective, the lack of adequate GOS in Kisaran Timur Subdistrict has the potential to negatively impact local environmental quality. The limited green areas reduce water absorption capacity, increase flood risks, and exacerbate air pollution. Additionally, sufficient green spaces are critical for mitigating urban heat islands, improving air quality, and supporting urban environmental sustainability.

Spatial analysis identified **Mutiara Village** as the most promising area for GOS development. The village has sufficient vacant land and a high potential population to serve. Using spatial analysis with GIS, approximately **135 potential locations** for GOS development were identified in Kisaran Timur Subdistrict, reflecting significant opportunities to meet future green space needs.

The designation of new GOS locations requires a strategic approach that integrates land availability and population needs. This study recommends the development of subdistrict parks with a **minimum area of 15,000 m<sup>2</sup>** as a priority solution. These parks can function not only as water absorption areas but also as venues for social and recreational activities. With a service radius of **2,500 meters**, these parks are expected to reach a larger population in the surrounding areas.

Effective GOS planning must also consider sustainability aspects. Beyond meeting ecological needs, GOS can provide social and economic benefits, such as enhancing urban aesthetics, reducing community stress, and supporting local economic activities through tourism. Thus, GOS is not only a critical element of urban spatial planning but also an integral part of sustainable urban development.

The development of GOS in Kisaran Timur Subdistrict requires collaboration among the government, community, and private sectors. The government must ensure supportive regulations for land acquisition for GOS, while the community and private sectors can contribute to greening efforts and maintaining green areas. These efforts demand a long-term commitment to creating a healthier and more comfortable living environment for residents.

The importance of spatial planning policies oriented toward ecological and social needs cannot be overstated. With rapid population growth and extensive land conversion, providing sufficient GOS in Kisaran Timur Subdistrict is an urgent priority. The sustainability of the region depends not only on physical infrastructure development but also on balancing human needs with environmental preservation.

Through appropriate planning measures, Kisaran Timur Subdistrict has significant potential to enhance its environmental quality through adequate GOS development. This study provides an empirical foundation for local governments to develop more targeted policies toward realizing environmentally friendly and sustainable urban development.

#### IV. Conclusion and Recommendations

Kisaran Timur Subdistrict faces significant challenges in providing Green Open Space (GOS) in accordance with national standards. In 2023, the total GOS in the subdistrict was recorded at **81.46 hectares**, an increase from **71.58 hectares** in 2013. However, this growth is disproportionate to the expansion of built-up areas, which reached **141.50 hectares** over the same period. Based on the needs analysis, the subdistrict requires at least **522.64 hectares** of public GOS, equivalent to **20% of the total area**, as mandated by **Law No. 26 of 2007**. This shortfall means that most villages, including those with high population densities, fail to meet the ideal public GOS requirements.

Additionally, with the projected population in 2043 expected to reach **122,421 residents**, the calculated public GOS requirement is **244,842 m<sup>2</sup>**. However, only two villages—**Selawan** and **Siumbut Baru**—currently meet these needs. The uneven distribution of GOS exacerbates the limited public access to the ecological, social, and aesthetic benefits of green spaces.

This study also identified **Mutiara Village** as the optimal location for subdistrict park development, offering the largest land potential and the highest number of residents that can be served. Overall, the findings emphasize the critical need for more targeted planning and management of GOS to achieve ecological and social balance in urban areas.

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## **Legal Regulations**

Undang-Undang Nomor 26 Tahun 2007 tentang Penataan Ruang.

Undang-Undang Nomor 6 Tahun 2023 tentang Penetapan Peraturan Pemerintah Pengganti Undang-Undang Nomor 2 Tahun 2022 Tentang Cipta Kerja Menjadi Undang-Undang.

Peraturan Menteri Pekerjaan Umum Nomor 05/PRT/M/2008 tentang Penyediaan dan Pemanfaatan Ruang Terbuka Hijau di Kawasan Perkotaan.

Peraturan Menteri Agraria dan Tata Ruang/Kepala Badan Pertanahan Nasional Republik Indonesia Nomor 14 Tahun 2022 tentang Penyediaan dan Pemanfaatan Ruang Terbuka Hijau.

UNDER PEER REVIEW