

# Green Open Space Analysis with Utilization Remote Sensing and Geographical Information System in Banda Aceh City

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**Abstract** Banda Aceh City, the capital of Aceh Province, has experienced both urban development and an increase in population. The increase in the physical development of the city in the form of the construction of residential areas, transportation facilities, trade, industry, and other services has resulted in an increase in the transfer of land from open space to built-up space, which in turn has an impact on reducing green open space (RTH). The purpose of this research is to determine whether the city of Banda Aceh has fulfilled the status of a city with sufficient green open space of 30% of the total area of Banda Aceh city if studied through remote sensing. This study aimed to analyze the green open spaces of Banda Aceh City based on remote sensing and Geographic Information Systems. The scope of this research is the entire district of Banda Aceh City. The proportion of Banda Aceh City that must be made into an open green area is a minimum of 1,840.89 ha (30%) with the provisions of 20% public green open space and 10% private green open space. Data processing methods and techniques use Spatial analysis with exploratory methods. Based on the results of data analysis through remote sensing. This study concludes that Banda Aceh City's green open space is currently 2,461.57 ha (41.11%), with the distribution of public green open space of 878.24 ha (14.31%) and private green open space of 1,583.32 ha (25.80%). It cannot be said that it meets the criteria for the number of green open spaces because the number of private green open spaces is greater than the number of public green open spaces.

**Keywords:** Green Open Space; Remote Sensing; Geographic Information System

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## 1. Introduction

Banda Aceh City as the capital city of Aceh Province has experienced rapid development both in terms of city development and an increase in population. The rapid development of physical facilities and infrastructure in the form of developing residential areas, transportation facilities,

construction, trade, office centers, culinary tourism, industry and household activities in Banda Aceh City and its surroundings has had an impact on the accumulation of various types of pollutants in the urban environment, including in air. Besides that, the physical development of the city has triggered a decrease in the quantity of green belt vegetation cover, city parks, and other green areas that function as shade, noise reduction, microclimate regulator, carbon dioxide absorber and oxygen producer, this is what causes a reduction in green open space in Banda Aceh city.

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Cities and urban areas are centers of settlements and population activities has administrative area boundaries regulated in a statutory regulation to show the character and characteristics of urban life. Considering that the development of a city is always followed by an urbanization process, thus the city and Urban areas are always dynamic in terms of structure, shape, face, and appearance city. Urban development is also the result of urban conflict resolution occur, and reflects the development of the civilization of city residents and managers (Chafid et al., 2004). One of the conflicts that has recently increased in the region urban areas is an environmental problem, so integration is needed environmental planning into urban spatial planning (Budihardjo, 2005). Spatial planning and the environment have a very broad meaning because of the city A good one is a spatial unit that is planned based on needs components of the arrangement of space, to create an atmosphere of comfort and health for its citizens. From this concept, it can be understood that spatial planning is a concept of thought or idea in all aspects of activity within an area (Tarigan, 2010).

Based on Republic of Indonesia Law No. 26 of 2007 concerning Spatial Planning which requires a minimum green open space of 30% of the area of urban areas which is divided into public green open space of at least 20% and private green open space of at least 10%, as an alternative effort to minimize the impact of environmental damage by optimizing the ecological functions of Green Open Spaces in Urban Areas. The minimum green open space standard required by the City of Banda Aceh based on an area of 6,136 ha, must provide 1,840.7 ha or 30% green open space, 1,227.2 ha or 20% public open space and 613.6 ha or 10%

private green open space. Based on data obtained by public green open spaces in Banda Aceh City, which existed in 2019, only 13% were available.

The decrease in the quantity and quality of green open space has resulted in a decrease in the quality of the urban environment such as high air pollution, and decreased community productivity due to stress due to the limited public space available for social interaction. In this case, far-reaching thinking is needed and a re-orientation of the city's development vision is needed that takes the environment and sustainable development into account. Spatial utilization strategies for cultivation areas and protected areas need to be carried out creatively, so that the conversion of productive land or green areas into non-green and non-productive areas can be controlled to increase the sense of comfort for residents living areas.

One of the technologies that can be used to obtain information on the distribution and extent of green open space in Banda Aceh City is to use remote sensing technology and geographic information systems. Remote sensing technology is a technology that can be utilized. Remote sensing is a science or technology to obtain information or natural phenomena through the analysis of data obtained from recordings of the object, area or phenomenon being studied. The recording or collection of remote sensing data is carried out using sensors installed on aircraft or satellites (Lillesand et al., 2004)

Remote sensing, often abbreviated as senses, is the science and art of obtaining information about an object, area or phenomenon through the analysis of data obtained with a tool without direct contact with the object, area or phenomenon being studied (Lillesand et al., 2015). So, it can be

concluded that remote sensing is a science that is used to obtain information about an object, area, or phenomenon through analysis of data obtained with a tool without direct contact with the object, area or phenomenon being studied.

Remote sensing basically utilizes electromagnetic waves to obtain information from an object, material, and phenomenon without direct contact with the object (Lillesand et al., 2015). Each object has a response in absorbing, reflecting, or emitting certain electromagnetic wavelengths, so that each object can be distinguished based on its spectral response. When viewed in terms of spectral resolution, the greater number of bands or channels a satellite image has, the more object information can be identified. Likewise with the spatial resolution, the greater the spatial resolution of an image, the more detailed object information is received.

Geographic Information System is defined as an information system that is used to enter, store, process, analyze, and generate geographically referenced data or geospatial data, to support decision makers in planning and managing land use, natural resources, environment, transportation, urban facilities, and other public services (Shellito, 2018). Geographic Information System (GIS) is an organized system where GIS could manage, store, process, manipulate, analyze, and display data where the data used in GIS is data that is spatially related to the earth's surface. Gunn stated that the application of GIS has broad capabilities in mapping and analysis processes so that the technology is often used in landscape planning processes. One of the advantages of using GIS can increase time efficiency and accuracy (accuracy).

GIS is a very strong computer technology system, both in dealing with spatial and non-spatial database problems. This system reallocates geographic locations with descriptive information so that users can easily create maps and then analyze the information in various ways (Kumar et al., 2023).

Ministerial Regulation Number 1 of 2007 concerning Green Open Spatial Planning are spaces in cities or wider areas, both in the form of areas/areas and in the form of areas extending paths where in their use they are more open in nature and basically without buildings. Green open space is part of the open spaces in an urban area filled with plants, plants, and vegetation to support the direct or indirect benefits generated by green open space in the city, namely security, comfort, welfare and beauty of the area. urban areas (Dewi et al., 2018). Green open space is concluded as a form of land use in an area designated for greening parks. Apart from being an environmental facility, it also functions to protect certain habitats or agricultural cultivation and also to improve the quality of the atmosphere and support the preservation of water and soil as seen on Table 1.

Based on RI Law Number 26 of 2007 Spatial Planning in Chapter VI concerning Implementation of Spatial Planning Part One Paragraph 5 concerning Spatial Planning for City Areas article 29 paragraphs 2 and 3.

Based on the ownership status of RTH, it is classified into: (1) public green open space is a green open space whose provision and maintenance is the responsibility of the district/city government (UU Number 26 of 2007 concerning Spatial Planning), and (2) private or non-public green open spaces, namely GOS whose provision and maintenance are the responsibility of the private sector,

individuals, communities which are controlled through space utilization permits by the district/city government

(UU Number 26 of 2007 concerning Spatial Planning).

Table 1. Classification of green open space based on ownership

Type	GOS Public	GOS Private
GOS Yard		
a. Home Yard		V
b. Pages of homes, offices, shops, and places of business		V
c. Rooftop Garden		V
GOS City Parks and Forests		
a. RT Park		V
b. RW Park		V
c. Village Park		V
d. District Park		V
e. City Park	V	
f. City Forest	V	
g. Green belt	V	
GOS Green Line Road		
a. Street islands and road medians	V	
b. Pedestrian path	V	
c. The space under the flyover	V	
GOS Specific Functions		
a. GOS railroad border	V	
b. The green line of the high-voltage power grid	V	
c. GOS river border	V	
d. GOS beach border	V	
e. GOS protection of frozen water sources/springs	V	
f. Burial	V	

Source: (P2KH Kota Banda Aceh, 2012)

The purpose of this research is to find out the Green Open Space (GOS) of Banda Aceh City from the standard determined 30% of the area of the city by dividing 20% Public Open Space and 10% Private Green Open Space, this research was studied using the Remote Sensing (PJ) application and the Geographic Information (GIS). The benefits of this research are expected to be able to provide input as information about the need for green open space in making development policy decisions and managing green open spaces in the city of Banda Aceh.

Many previous studies have focused on remote sensing regarding green open spaces in urban areas, but what distinguishes this research from previous research is that previous research only studied green open spaces for the public, but in this study not only examined the area of public green open spaces but also examine the area of private green open space, so that the total area of green open space in the city of Banda Aceh can be known.

## 2. Methods

Data processing methods and techniques use Spatial analysis with exploratory methods. The remote sensing method is carried out with visual interpretation to obtain data about the distribution of green open spaces in the city of Banda Aceh, this has several advantages, including relatively fast data, reliable validity, and relatively affordable technology so it is very good for dynamic urban studies. which needs to be monitored or monitored and is part of a spatial-based geographic phenomenon and is expected to be able to examine problems related to the location of the distribution of green open spaces in the city of Banda Aceh.

The time of this research was approximately 6 months and the implementation was carried out in the administrative area of Banda Aceh City consisting of 9 sub-districts namely Baiturrahman District, Banda Raya District, Jaya Baru District, Kuta Alam District, Kuta Raja District, Lueng Bata District, Meuraxa District, Syiah Kuala, and Ulee Kareng District.

### Data collection technique

#### Documentation Techniques

The documentation technique in this study was used to obtain secondary data regarding the general condition of the research area in the form of: land use, map of the location of the research area, as well as other documentation data needed in this study. The data sources examined are in Table 2.

#### Data Processing and Analysis Techniques

At the data analysis stage, to obtain research results in the form of green open space distribution maps, the analysis used was Google Earth image analysis, using remote sensing applications and geographic information

systems. In the data processing stage, literature is needed in determining the limits of the need for Green Open Space itself, a formula is needed to calculate the percentage of green open space, the following formula is used:

$$\begin{aligned} \text{GOS Public} &= \frac{\text{an area}}{100} \times 20 \\ \text{GOS Private} &= \frac{\text{an area}}{100} \times 10 \\ \text{Total GOS} &= \frac{\text{an area}}{100} \times 30 \end{aligned}$$

(Jayanti, et al, 2015)

To calculate the condition of adequacy of green open space:

Adequacy GOS public:

existing GOS public – Adequacy GOS

Adequacy GOS private:

eksisting GOS private – Adequacy

GOS private

Table 2. Research Data Sources

No	Data	Source
1	Graphical/Spatial Data	Google Earth/SASPlanet
2	Vector Data	Open Street Map
3	Attribute Data	BPS
4	Map of the Spatial Plan for the City of Banda Aceh	Bappeda
5	Map of Distribution of Existing GOS in Banda Aceh City 2021	Dinas PU Banda Aceh
6	Banda Aceh City Administration Map	Bappeda

Source: Analisis 2021

#### Research data

The materials used in the research are:

- 1) Spatial data in the form of Google Earth imagery of Banda Aceh City 2020.
- 2) Vector data, namely vector data that describes geography in the form of a collection of points that can be connected to form lines and polygons
- 3) City Spatial Plan (RTRWK) Map of Banda Aceh City

- 4) Distribution Map of GOS Eksisting Banda Aceh city 2021
- 5) Administrative Map of Banda Aceh City
- 6) Attribute data, namely the physical condition of the field (geographical location, area area, soil type, slope, hydrology, and population density).

Overlay is the process of merging data from several different layers. Overlay is simply referred to as a visual operation that requires more than one layer to be physically

combined. overlay is considered very good for spatial studies, such as studying green open spaces in the city of Banda Aceh. Some of the data that is overlaid is vector data for the City of Banda Aceh format (shp), administrative maps of the City of Banda Aceh, maps of the RTRW for the City of Banda Aceh, Google Earth 2021 images. Imagery from Google Earth is used to see the existing condition of the city of Banda Aceh. The process of combining the data can be seen in Figure 1.

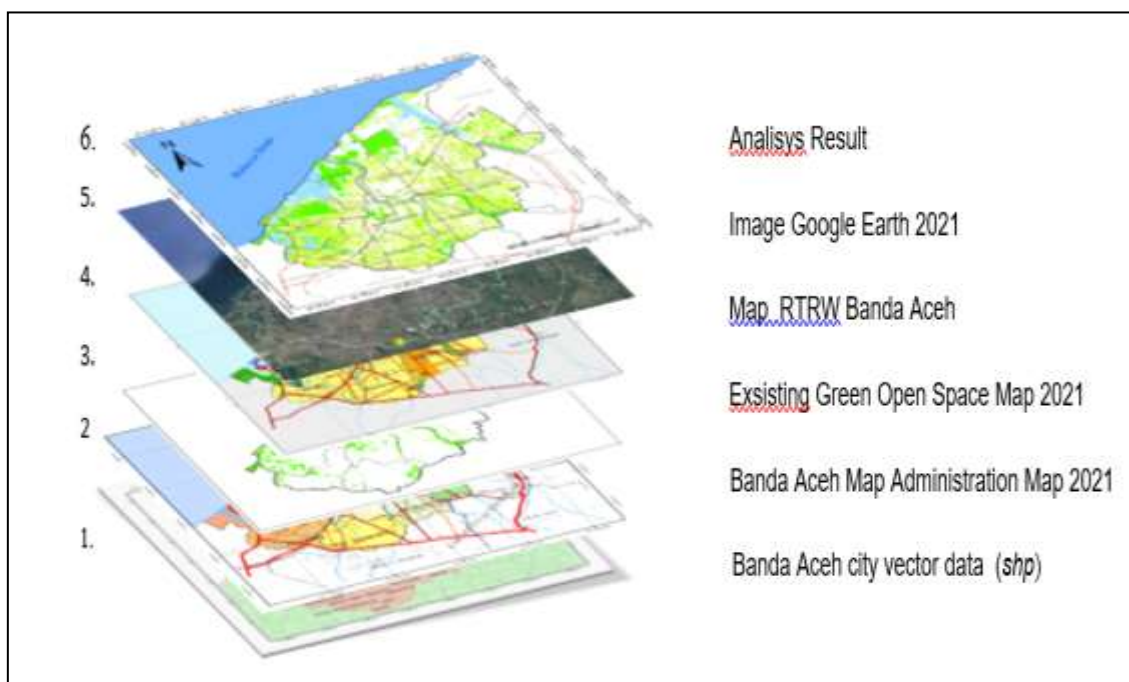


Figure 1. Overlay Data Map GOS Banda Aceh City

### 3. Results and Discussions Needs GOS Based on City Area

Based on the area stipulated by law, the City of Banda Aceh with an area of 61.36 km<sup>2</sup> or 6,136 ha, must provide green open space with an area of 1,840.8 ha, consisting of public green

open space with an area of 1,227.2 ha and private green open space with an area of 613.6 ha. The distribution of open space for the city of Banda Aceh for each sub-district can be seen in Table 3.

Table 3 The need for green open space in Banda Aceh City based on the area

No	Subdistrict	An Area (ha)	Needs GOS		Total Needs GOS (ha)
			Public (ha)	Private (ha)	
1	Syiah Kuala	1486,21	297,242	148,621	445,863
2	Meuraxa	892,44	178,488	89,244	267,732
3	Kuta Raja	354,33	70,866	35,433	106,299
4	Jaya Baru	461,22	92,244	46,122	138,366
5	Banda Raya	517,74	103,548	51,774	155,322
6	Baiturrahman	408,87	81,774	40,887	122,661
7	Lueng Bata	445,62	89,124	44,562	133,686
8	Ulee Kareng	508,82	101,764	50,882	152,646
9	Kuta Alam	1061,05	212,21	106,105	318,315
<b>Total</b>		<b>6136,31</b>	<b>1227,26</b>	<b>613,63</b>	<b>1840,89</b>

Source: Analisis Data 2021

#### Needs GOS Public dan GOS Private Banda Aceh City

From the results of remote sensing data analysis using the Arcgis 10.3 software, the total area of the current (existing) Green Open Space in Banda Aceh City is 2,461.57 ha or 41.11% of the city area. This area has fulfilled the provisions that must be provided for in Law Number 26 of 2007 concerning Spatial Planning and Minister of Public Works Regulation NO.05/PRT/M/2008 concerning Guidelines for the Provision and

Utilization of Green Open Spaces in Urban Areas, but the percentages are reversed. The existing public green open space area of 878.24 ha or 14.31% still lacks 5.30% of the stipulated minimum area, on the other hand the availability of existing private green open space, which is 1,583.32 ha or 25.80%, has exceeded the minimum area that has been set, namely 10% of the total area although the distribution is uneven. The need and adequacy of Public and Private Green Open Space are shown in Table 4.

Table 4 Needs GOS Public dan GOS Private Banda Aceh City

No		Needs GOS (ha)		Eksisting GOS (ha)		Needs (ha)	
		Public	Private	Public	Private	Public	Private
1	Syiah Kuala	297,242	148,621	129,163	281,797	-168,079	133,176
2	Meuraxa	178,488	89,244	219,801	205,723	41,313	116,479
3	Kuta Raja	70,866	35,433	129,107	44,294	58,241	8,861
4	Jaya Baru	92,244	46,122	34,972	190,886	-57,272	144,764
5	Banda Raya	103,548	51,774	35	222,207	-68,548	170,433
6	Baiturrahman	81,774	40,887	57,2	89,756	-24,574	48,869
7	Lueng Bata	89,124	44,562	34,541	149,677	-54,583	105,115
8	Ulee Kareng	101,764	50,882	38,029	236,44	-63,735	185,558
9	Kuta Alam	212,21	106,105	200,435	162,543	11,775	56,438
<b>Total</b>		<b>1.227,26</b>	<b>613,63</b>	<b>878,248</b>	<b>1.583,323</b>	<b>-325,462</b>	<b>969,693</b>
<b>Presentase</b>		<b>20%</b>	<b>10%</b>	<b>14,31%</b>	<b>25,80%</b>	<b>-5,30%</b>	<b>15,80%</b>

Source: Data Analysis 2021

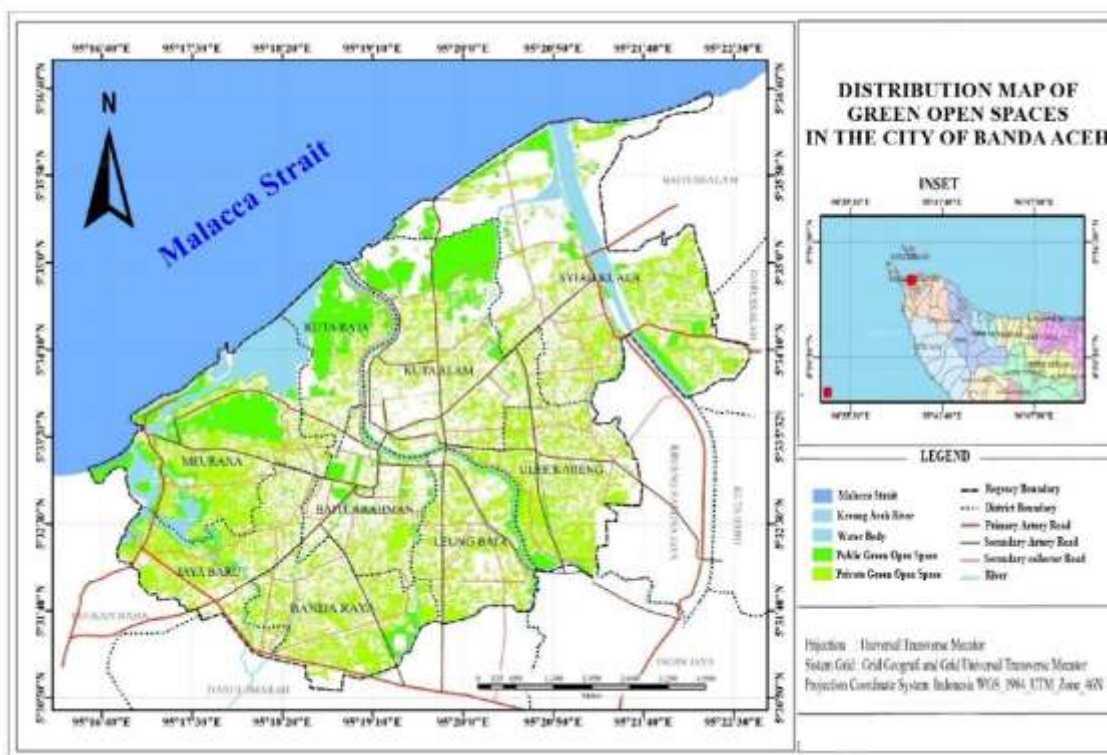


Figure 2. Distribution Map of Green Open Space Overlay in Banda Aceh City

Based on the results of the study, it can be concluded that the lack of public green space in all sub-districts in Banda Aceh City is due to the not yet optimal greening program, especially the addition of city parks, urban forests, urban green lanes, in addition to their uneven distribution. To meet the minimum needs of public green open space, this can be achieved by maintaining the existing green open space and increasing the area of public green open space by turning urban agricultural open space/ponds into city parks and urban forests or establishing special areas such as water catchment areas, mangrove forests into nature tourism parks or protected forests.

### Conclusion

Based on the results of data analysis through remote sensing, the distribution of green open space in Banda Aceh City is currently still

uneven. This is because there are still many abandoned plantation areas, ponds and vacant land. The condition of green open space that must be achieved by the city government is 1,840.89 ha or 30% of the total area of the city, while the currently distributed green open space is 2,461.57 ha or 41.11%, which has exceeded the provisions but the uneven distribution causes the government to work hard. in meeting the target of 30% green land according to the Constitution. The currently available public green open space is 878.24 ha or 14.31%, there is still a shortage of 325.46 ha or 5.30%. The available private green open space is 1,583.323 ha or 25.80%, so that the condition of private green open space has exceeded the established adequacy standard. From the results of the study, the authors provide the following suggestions. The Banda Aceh city government is expected to be able



to increase the existence of green open space to create Banda Aceh City as a city center with healthy and clean environmental qualities. The government is also expected to carry out greening programs such as planting trees that involve the community so that they are aware of the importance of going green for the city. The government is expected to be able to embrace youth and the community in realizing equal distribution of green open space in the city of Banda Aceh. The government is expected to expand green open space on land and land in accordance with the stipulated land price standard. The community is expected to carry out activities that support increasing green open space in the form of reforestation such as suggesting that the yard of the house be planted with trees, making green lanes along the roadside, planting trees along river banks, planting trees in open/vacant land.

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