

# Analysis of land use changes for green open space (gos) in tebingtinggi city

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**Submission date:** 19-Apr-2021 02:20PM (UTC+0700)

**Submission ID:** 1563374316

**File name:** Lubis\_et\_al\_2021.pdf (931.2K)

**Word count:** 3648

**Character count:** 19597

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To cite this article: Darwin Parlaungan Lubis *et al* 2021 *J. Phys.: Conf. Ser.* **1811** 012024

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## Analysis of land use changes for green open space (gos) in tebingtinggi city

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**Abstract.** This study aimed to 1) Analyze land use change that has occurred in each sub-district in Tebing Tinggi City for 6 years (2014 - 2020), 2) Analyze the factors influencing the dynamics of changes in the use of green open space into a built-up area in the Tebing Tinggi City. The method used in this research was a survey method. The research design was performed in 3 stages; (1) Literature study, (2) Data collection, (3) Discussing the processed data. The results showed that 1) Tebing Tinggi City had experienced very dynamic land use change. The biggest land use change was the built-up area, including a residential area, which increased by 370.95 hectares, the industrial area increased by 14.8 hectares, and the service area increased by 7.5 hectares. Meanwhile, vegetated land, such as rice fields decreased to 137,7 Ha. The mixed plantation land area decreased to 255.54 Ha. 2) The factors influencing land use change indicate that residential land has a significant effect on changes in GOS with a p-level value of less than 0.05 and is positive. It shows that each addition of residential land in a sub-district reduced the area GOS change to the built-up area of 0.016 Ha.

### 1. Introduction

The existence of GOS in urban areas is mostly ignored because it is considered not to provide direct economic benefits and consequently the area of GOS is decreasing. The decrease of GOS is due to the growing need for land due to the increasing community welfare and population growth [1]. The ever-increasing population growth over time will give implications for the high pressure on land use so that it requires special attention, particularly regarding providing space for settlements, public and social facilities, and public spaces in urban areas [2].

Tebing Tinggi City has an area of 38.44 Km<sup>2</sup> with 5 districts and has a population of 164,581 in 2019 [3]. It is recognized that the residents of Tebing Tinggi City have very basic needs for a healthy air environment, groundwater availability, and space to serve social interaction. Therefore, space usually called GOS is required to accommodate it, which also acts as a city public space. The rapid change of land use in Tebing Tinggi City has displaced GOS with the built-up space without optimum control, thus marginalizing the concept of a green city as a system of intact urban ecology.

It is hard to find alternatives to the management of GOS in Tebing Tinggi City because no specific research has been conducted, explaining the characteristics or patterns and carrying capacity of GOS and its implications. Accordingly, the pragmatic efforts to solve various urban environmental issues that are carried out continuously by practitioners often run into deadlocks. Therefore, it is necessary to research the availability of GOS and the provision of GOS needs in Tebing Tinggi City.



Tebing Tinggi City has an intense commitment to become an environmentally friendly green city, as characterized by the existence of a proportional green area. The difficulty to find alternatives to GOS management in urban areas [4] is caused by no specific research that explains the characteristics or patterns and carrying capacity of GOS and its implications [5], particularly the GOS development model. As a consequence, the pragmatic efforts to solve various urban environmental issues that are carried out continuously by practitioners often run into deadlocks. [6]

Thus far, research on urban areas has been focused on the framework of urban economic improvement and urban design studies [7]. Meanwhile, studies on environmental problems and GOS provision and its implications have not received much attention [8]. Therefore, a number of studies must continue to be conducted to develop GOS development models in Indonesia [9]. Hence, pragmatic attempts in solving urban problems in Indonesia are not merely trapped using western theories which are not necessarily suitable for the Indonesian context [10-12].

This research aimed to formulate the main ideas and priority scale to develop a sustainable green city management approach. The main objective is essentially the generation of several supporting objectives as follows: (1). Analyzing land use change that occurred in each sub-district in Tebing Tinggi City for 6 years (2014 - 2020) (2). Analyzing the factors influencing the dynamics of changes in the use of green open space into built-up spaces in Tebing Tinggi City.

## 2. Material and Methods

### 2.1. Place and time of research

The study was conducted in Tebing Tinggi City, North Sumatra Province. This city represents a high rate of population growth, similar to other cities in the North Sumatra Province [3]. This population growth triggers a rapidly high rate of land use change in urban areas into housing or settlement, trade, services, and industry [13]. The research was conducted in 4 months beginning from June 2020 - October 2020. which consisted of three stages, including the stages of data collection and data classification, analysis, and synthesis as well as concepts and planning. In general, this research consists of 6 activities, including the stages of preparation, data collection, analysis, interpretation of results, field checks, and research organization.

### 2.2. Data Analysis Technique

The data analysis techniques used in the study were as follows:

1. Identification of changes in GOS land use into the built-up area was performed by working stages, including classifying GOS and constructed land using spatial analysis. The spatial analysis included geometric correction processes performed using Arc-Gis software on the prepared maps. The classification process was continued following the completion of the correction and digitization process to obtain a map of land use change and GOS distribution
2. Analysis of the factors influencing the dynamics of changes in the use of GOS into the built-up area using multiple regression analysis, which is then processed using SPSS Statistics 17.0 software.

### 2.3. Research Tools and Data

The tools used in this study was a set of computers and their equipment that was useful for processing and analyzing data.

The tools used included:

- Laboratory tools: computer hardware with GIS software (ArcGIS), SPSS Statistics 17.0 software, Global Positioning System (GPS), compass, and other supporting tools to determine the coordinates of ground control points that are beneficial for determining training areas of the vegetated areas.
- Ikonos satellite imagery of 2014 and 2020

- Earth Visual Map of Indonesia from the Geospatial Information Agency (BIG)

The data used were secondary and primary. Primary data was obtained through in-depth interviews with stakeholders regarding the direction of policy priorities. Secondary data included data of population, urban utility facilities/built-up area, vegetated land, and other processed data.

### 3. Results and Discussion

#### 3.1. Land Use change in Tebing Tinggi City in 2014-2020

The results of research using the ikonos satellite imagery (Lillesland, T. M., & Kiefer, R. W. 1979) shows that Tebing Tinggi City experienced very dynamic land use change from 2014 – 2020 (Figure 1 and Figure 2). The land use that experiences the biggest change was the built-up area, such as residential land increased by 370.95 hectares, industrial land increased by 14.8 hectares, and service area increased by 7.5 hectares. Meanwhile, vegetated land (GOS) such as rice fields decreased 137,7 Ha, mixed plantation area decreased by 255.54 Ha. The dynamics of land use change in Tebing Tinggi City in 2014 - 2020 are shown in Figure 3.

The built-up area in Tebing Tinggi City tends to increase from 1738.85 Ha (2014) to 2132.1 Ha (2020), as indicated by an increase in population and the development of the economic structure. The conversion of GOS land to developed land is difficult to ignore because of this trend. Several cases show that land use changes result in a change in the surrounding land and its function progressively in a short time.

The spread and change of GOS into the built-up area is due to two factors. First, relevant to the development of residential and industrial areas, the accessibility of these locations is becoming increasingly conducive to housing and industrial development. This finally encourages increased demand for land by investors or land speculators, and thus, land prices in the vicinity increase. Second, the increased land prices can eventually stimulate other residents around them to sell their land. The perpetrators of the land purchase are commonly not local residents, resulting in the formation of land change, which is vulnerable to the process of land conversion in general [14-15].

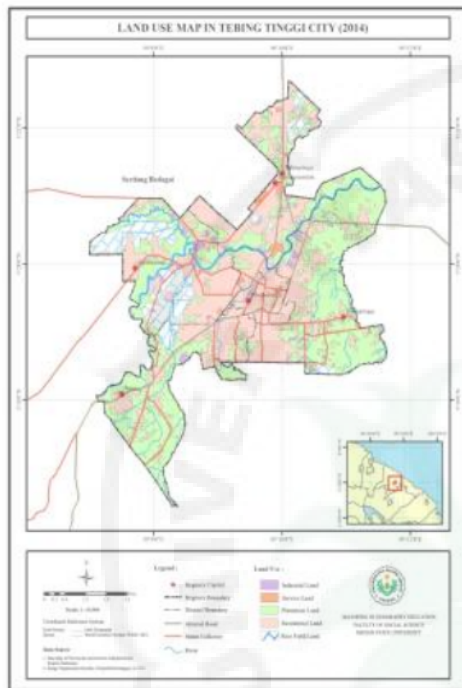


Figure 1. Land use Map in Tebing Tinggi City 2014

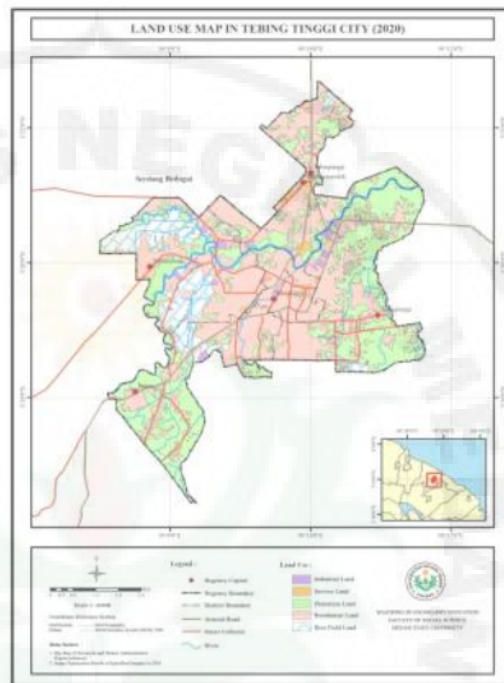


Figure 2. Land use Map in Tebing Tinggi City 2020



Figure 3. The Dynamics of Land Use Change in Tebing Tinggi City 2014 - 2020 (Ha)

The process of GOS land change into the built-up area is also caused by external and internal factors. External factors are due to the dynamics of urban, demographic, and economic growth. Internal factors are due to the socio-economic conditions of farmer households, policy factors,

including aspects of regulations issued by central and local governments related to changes in the function of agricultural land.

3.2. Factors Affecting the Dynamics of the Change of the Use of GOS into Building Areas in Tebing Tinggi City

GOS change to the built-up area in Tebing Tinggi City is thought to be caused by several factors. Multiple regression analysis is one approach to estimate the factors influencing the occurrence of these changes. In using this analytical model, several variables are thought to influence GOS change. These variables include the industrial land area (2014 - 2020 in units of Ha), residential land area (2014 - 2020, in units of Ha), service land area in 2014 - 2020, in units of Ha).

The results of the analysis show that of the 3 (three) estimating variables, 1 (one) variable that has a significant effect on the objective variable ( $\alpha \leq 0.05$ ), which is the number of settlements, and expressed in the form of an equation. As follows:

$$Y = 9182,213 - 0,004 X_1 - 0.16 X_2 - 0.24 X_3$$

In which :

- Y = GOS land area (2014 – 2020 in units of Ha)
- X<sub>1</sub> = Industrial land area (2014 – 2020, in units of Ha)
- X<sub>2</sub> = Residential land area (2014 – 2020, in units of Ha)
- X<sub>3</sub> = Service land area (2014 – 2020, in units of Ha)

Table 1. Regression Analysis Data

Model Summary <sup>b</sup>									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.945 <sup>a</sup>	.894	.848	149.4777	.894	19.629	3	7	.001
ANOVA <sup>a</sup>									
Model		Sum of Squares	df	Mean Square	F	Sig.			
1	Regression	1315765.013	3	438588.338	19.629	.001 <sup>a</sup>			
	Residual	156405.169	7	22343.596					
	Total	1472170.182	10						
Coefficients <sup>a</sup>									
Model		Unstandardized Coefficients		Standardized Coefficients		t	Sig.		
		B	Std. Error	Beta					
1	(Constant)	9182.213	5768.289			1.592	.155		
	Industry	-.004	.004	.469		.870	.613		
	Residence	-.016	.006	-1.392		-2.609	.035		
	Service	-.024	.561	-.006		-.042	.968		

The R square value of 0.89 (Table 1) shows that about 89 percent of these variables can explain the influence level on the change in GOS into built-up areas, while the rest or 0.11 percent is influenced by other variables (industry and services). The variable that has a significant effect on the change of GOS into built-up areas is residential land which has a p-level of less than 0.05. The magnitude of the influence of residential land can be seen from the magnitude of the regression coefficient. The coefficient value as marked negative indicates that the factor has a unidirectional effect which reduces the change in GOS to the built-up area.

In more detail, the factors influencing the changes in the GOS area in Tebing Tinggi City are residential land. The results of the regression analysis show that the number of settlements has a significant effect on changes in GOS with a p-level value of less than 0.05 and is positive. It shows that each additional residential area in a sub-district will increase the change of the GOS area into the built-up area of 0.016 Ha.

The high level of settlement density will give an impact on increasing space requirements, particularly the need for other supporting facilities and infrastructure. This increase cannot be followed by the availability of land which is essentially fixed so that the conversion process of GOS into built-up areas is considered the easiest alternative to meet these demands.

The 52.50 percent land use pattern of Tebing Tinggi City is utilized for built-up areas such as housing and settlements. Construction conditions and housing and settlement facilities in Tebing Tinggi City include:

- The settlement distribution pattern remains tends towards the city center and has not indicated an even distribution to parts of the city area.
- The low provision of appropriate housing, particularly for low-income people.
- Some residential areas are not well ordered. These issues include the inadequate efforts to revitalize historic buildings or environments and the low number of illegal and legal residential areas.
- High land prices and untreated vertical housing developments such as apartments, condos, or flats.
- Low housing infrastructure and facilities. The availability of infrastructure and facilities for the housing environment becomes one of the elements in improving the comfort and aesthetics of the urban community.

The increasing trend of population growth, along with a high demand for developed land for housing, has complex spatial consequences for urban life. The population will continue to increase because in normal conditions (without natural disaster), population growth follows an exponential curve [16]. This situation has led to an imbalance in the proportion of protected and cultivated areas due to neglect and marginalization of GOS management.

The Government of Tebing Tinggi City has not maximally monitored the city's GOS, and therefore, the remaining open land is always utilized for the building construction. The real consequences are increasing air temperature and the malfunctioning of the city's lungs as well as human lungs, which will also suffer the consequences [17]. In principle, development in urban areas is managed to realize a livable city. The intention of a sustainable city has a green agenda not to be ruined into a bad and unhealthy city. City governance that can realize a sustainable city is described by Yunus [17] as good governance practice.

To create a comfortable, productive, and sustainable urban space, it is important to consider the existence of GOS in Tebing Tinggi City. A Green City is a city that is environmentally friendly by utilizing water and energy resources effectively and efficiently, minimizing waste, implementing an integrated transportation system, ensuring environmental health, synergizing natural and artificial environments, according to urban planning and design that supports the principles of sustainable development.

A green city is built by continuously cultivating all city assets including humans, the built environment, natural resources, the environment, and the quality of urban infrastructure. Green City is also adapting and mitigates climate change. The development of a green city indicates the development of urban people who take the initiative and cooperate in making changes and joint movements. The development of a green city in Tebing Tinggi City requires joint action of all elements of city stakeholders. Green city development also needs fundamental change/innovation and massive initiatives (from practice to values). As a form of implementation of a green city, it is necessary to plan and design an environmentally friendly city that is intended for the general public, with an emphasis on quality, social, and cultural activities and green space within.



The Green City Development Program has been initiated by the Ministry of Public Works c.q. The Directorate General of Spatial Planning [18] becomes one of the concrete measures taken by the central government together with the provincial and city/district governments in meeting the provisions of the UUPR, particularly regarding the fulfillment of urban GOS, and addressing the challenges of climate change in Indonesia. The Green City Development Program (P2KH) is an innovative program for the realization of urban GOS in Indonesia [19].

#### 4. Conclusions

The results of research using the ikonos satellite imagery indicate that the Tebing Tinggi City has experienced very dynamic land use change from 2014 to 2020. The biggest land use change was the built-up area, such as residential area, which increased by 370.95 hectares, the industrial area increased by 14.8 hectares, and service areas increased by 7.5 hectares. Meanwhile, vegetated land (GOS), such as rice fields decreased to 137,7 Ha and the mixed plantation area decreased to 255.54 Ha.

The factors affecting the dynamics changes in the use of GOS into the built-up area using linear regression analysis produce the model  $Y = 9182,213 - 0,004 X_1 - 0,16 X_2 - 0,24 X_3$  with a correlation coefficient of  $R = 0.94$  and a coefficient of determination of  $R^2 = 89\%$  with a p-level less than 0.05 and positive. It indicates that each additional residential area in a sub-district will increase the area of the GOS change to the built-up area of 0.016 Ha. The increase in the number of settlements directly has a chain effect on the population, resulting in high GOS conversion pressure for cities with economic development as a derivative factor. The consequence of economic growth in the region requires the need for developed land to increase.

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#### Acknowledgment

The author would like to thank you to the Universitas Negeri Medan for for funding in this research by Basic Research Grant 2020 (Contract number 48/UN33.8/PL-PNBP /2020).

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