Utilization of Geographic Information Systems (GIS) and Remote Sensing Imagery to Detect the Availability of Green Open Space in Palembang

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***Abstract*— Geographic Information System (GIS) is a computer-based information system, and is designed to process data that has spatial information. The high dynamics and activities of the city are developing rapidly, whether it is the physical city or inhabitants activities, such as in the city of Palembang. The existence of green open space in Palembang has decreased every year, while the land has been growing wider. The purpose of this study is to find the changing of availability of green open space using geographic information systems and satellite imagery and to know the green open space needed for the people of Palembang. The research method is a quantitative research method, using primary and secondary data. Primary data is obtained from observation and imagery data processing. Secondary data is obtained online (palembang in figures/BPS) and various reference references from previous research. Analysis is doing by digital imagery interpretation. Furthermore, the imagery classification process uses the supervised classification method. The results of the analysis show that the availability of green open space in Palembang in 2007 was 229.59 km^2, in 2017 it decreased to 123.83km^2. Meanwhile, the built up area has increased from 2007 to 2017 each of 107.55 km^2 and 223.95 km^2. Total area needed as a green open space based on oxygen demand by the people of Palembang is 23,839.12897 ha.**

Keywords- GIS, Remote Sensing, Green Open Space, Palembang.

I. INTRODUCTION

Information technology begins to enter various lines of human life (Abdillah, et al, 2007). Its development is so fast affecting its users to create various applications or software designed to help human tasks and make human life easier. Information technology is widely used in various disciplines, including geography. One of the technological developments in geography is the use of geographic information systems.

Geographic Information System (GIS) is a computer-based information system, and is designed to process data that has spatial information. This system captures, checks, integrates, manipulates, analyzes, and displays data spatially and reflects conditions on earth. According to UNDP (2007) generally GIS is a component consisting of hardware, software, geographic data, and human resources that work together effectively to enter, store, repair, update, manage, manipulate, integrate, analyze, and display data in a geographical information. The technology in GIS integrates general database operations, such as queries and statistical analysis, with unique visualization and analysis capabilities, and is presented in the form of maps. This ability distinguishes GIS from other information systems which makes it more useful for various groups to explain events, design strategies, and predict what will happen (Aini, 2007).

GIS was first introduced in Indonesia in 1972 with the name Data Banks for Development (Rais, (2005) in Ramadhan (2013)). The term geographic information system began after it was initiated by the General Assembly of the International Geographical Union in Ottawa-Canada in 1967. Next, the GIS was developed by Roger Tomlison, later called CGIS (Canadian GIS). At that time CGIS was used to store, analyze, and process data, collected to inventory land in Canada (CLI-Canadian Land Inventory), an initiative to determine the ability of land in rural Canada by mapping various information on land, agriculture, tourism, nature free, poultry and land use on a scale of 1: 250,000. Since then, geographic information systems have developed in several continents, especially in America, Europe, Australia and Asia. Like other countries, in Indonesia the development of GIS began with the government and the military. The development of GIS has become increasingly rapid since it is supported by quality resources in the academic community (universities).

Basically the geographic information system is the next step after the remote sensing process. The image obtained through remote sensing is basic data, then processed and presented by a geographic information system. The position of the data in remote sensing can be corrected using a geographic information system. Thus, integration between remote sensing image data and geographic information systems will produce optimal information as data in regional development.

One of the uses of GIS in regional development is detect changes in land use. Land use changes in urban areas usually occur every year. Regional development can be in the form of good spatial planning while still taking into account environmental conditions, but there are also developments that tend to damage the environment. To developing a city, must pay attention to land conditions and suitability in land use. Rapid development in urban areas is usually influenced by factors of economic growth and population growth (Budiman,

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2014). Economic and population growth, will increase the land need for the development of economic centers and settlements, ultimately encouraging changes in land use, especially the decline of green open spaces. According to Alphy in Sinuksmoyo (2013) the direction of land cover changing of green open space into built-up land tends to be irreversible, which is difficult to return to normal, even though it can return to the initial land cover, it needs a lot of energy to overcome it such as costs, time, and the possibility of emergence social and cultural conflict.

Based on the Minister of Public Works Regulation Number: 05/PRT/M/2008 concerning Guidelines for Provision and Utilization of Green Open Space (*Ruang Terbuka Hijau*/RTH) in Urban Areas, the percentage of urban areas used as green open space is at least 30% of the total urban area, consisting of 20% of public green open space and 10% private green space. Even though there are strict rules governing green open space, many cities in Indonesia tend not to care about fulfilling the above percentage requirements.

Palembang as the second largest city on the island of Sumatra after Medan, is one of the cities that experienced the fastest development of the region in Indonesia. The dynamics and urban activities of Palembang are high, triggering the rapid development of the city, both the physical development of the city and the activities of its inhabitants. Currently a lot of development is being carried out in Palembang which requires land clearing at the expense of green open space areas. Rapid regional development such as what happened in the city of Palembang, requires a comprehensive spatial arrangement as a guide in land use and implementation of development, so that urban life can be balanced.

Quoted from one of the online newspaper media pages, the Executive Director of the South Sumatra Indonesian Forum for the Environment (Wahana Lingkungan Hidup/ WALHI), Hairul Sobri, stated that the green open space in Palembang City until May 2018 was still lacking, currently WALHI continues to ask the city government to add it. Based on PP no. 23 of 1998 the area of Palembang city is 400.61 km^2. That is, the City of Palembang must provide an RTH covering an area of 120.19 km^2 consisting of an area of 80.12 km2 of public RTH and 40.07 km^2 of private RTH of the total area of Palembang.

By seeing the decreasing presence of green open space, it is necessary to conduct further studies on the direction of changes in the city. The temporal detection of changes in a region can be done using remote sensing imagery data. Detection of changes in land use is carried out to determine the availability of green open spaces in the city of Palembang. The data used in the study are data from Landsat imagery. The purpose of this study is to find changes in the availability of green open spaces and to find the need for green open space the city of Palembang.

II. THEORICAL REVIEW

2.1. Geographic Information System

According to Murai (1999) GIS as an information system that is used to enter, store, recall, process, analyze and produce geographic reference data or geospatial data, to support decision making in planning and managing land use, natural resources, environment, transportation, city facilities, and other public services. The GIS supporting components consist of five components that work in an integrated manner, namely hardware, software, data, people, and methods that can be described as follows:

1) Hardware. GIS hardware is physical devices from a part of a computer system that supports geographic analysis and mapping. GIS hardware has the ability to present images with high resolution and speed and supports database operations with large volumes of data quickly.
2) Software. Used for the process of storing, analyzing, visualizing data both spatial and non-spatial data. The software that must be in the GIS software component are: Tools for entering and manipulating GIS data, Data Base Management System (DBMS), Tools for analyzing data, and Tools for displaying data and analysis results.
3) Data. In principle there are two types of data to support GIS namely Spatial Data and attributes. Spatial data is a real picture of an area on the surface of the earth. Non-spatial data / attributes are data in the form of tables where the table contains information possessed by objects in spatial data.
4) Humans. Humans are the core element of GIS because humans are planners and users of GIS.
5) Method. The method used in GIS will be different for each problem.

Pic. 1. GIS Components

Source: www.google.com, 2018.

Basically the scope of GIS includes five processes:

1) Data Input. The data input process is used to input spatial data and non-spatial data. Spatial data usually is an analog map.
2) Data Manipulation. The data type required by a GIS section may need to be manipulated to fit the system used.
3) Data Management. After spatial data is entered, the next process is processing non-spatial data.
4) Query and Analysis. Query is a process of analysis that is done tabularly. Fundamentally, GIS can do two types of analysis, namely: Proximity analysis which is a geographic analysis based on the distance between

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layers; and Overlay analysis which is the process of integrating data from different layer layers.

5) Visualization. For some types of geographic operations, the best results are realized in maps or graphs. Maps are very effective for storing and delivering geographic information.

2.2. Green open space

Open space is an area with an environmentally sound component that can be interpreted as a landscape, hardscape, park or recreation space in the urban sphere. Based on the Minister of Public Works Regulation No: 05/PRT/M/2008 concerning Guidelines for Provision and Utilization of Green Open Space in Urban Areas, open spaces are spaces in a city or wider area both in the form of area/region and in the form of elongated areas/lanes where in more use open, basically without buildings. Open space consists of green open space (RTH) and non-green open space (RTNH).

Here is the differences between RTH and RTNH. Green open space is an elongated/lane and/or clustered area, whose use is more open, a place to grow plants, both those that grow plants naturally and intentionally planted. While non-green open spaces are open spaces in surface areas that are not included in the green space category, in the form of hardened land or water bodies.

According to its proportions green open space is divided into private green open spaces and public green open spaces. A private green open space is a green open space owned by a particular institution or an individual whose limited use is among others in the form of a garden or yard of a house/ building owned by a public/private planted with plants. Whereas the public green open space is a green open space owned and managed by the city/regency government which is used for the benefit of the general public. The role and function of Green Open Space was determined in the Ministry of Home Affairs Instruction No. 4 of 1988, which states that green open spaces whose population is dominated by reforestation either naturally or plant cultivation, in their use and function as an ongoing area of ecological function and supporting the life of urban areas.

Based on Minister of Public Works Regulation, the following are the purpose, functions and benefits of green open space in urban areas. The purpose of green open space:

- maintain the availability of land as a water catchment area;
- creating a planological aspect through a balancing between the natural evironment and built environment that is useful for the benefit of the community; and
- increasing urban environment harmony as a means of protecting the urban environment is that safe, comfortable, fresh, beautiful, and clean.

RTH has the following functions:

- The main function (intrinsic) is ecological: it guarantees the provision of green open space to become part of the air circulation system (city lungs); regulates the microclimate so that the air circulation system and water can naturally run smoothly; as shade; oxygen producer; rainwater absorbent; animal habitat provider; absorbing air, water and soil pollutants; and windbreak.
- Extrinsic functions, namely: social and cultural functions: describe the expression of local culture; communication media for inhabitant; recreation areas; and places and objects of education, research, and training in studying nature; economic functions: sources of products that can be sold, such as flowers, fruits, leaves, vegetables; and can be part of agricultural, plantation and forestry businesses and others; as well as an aesthetic function: increase comfort, beautify the environment both in terms of micro scale: home yard, residential environment, and macro: the city landscape as a whole; stimulate creativity and productivity of inhabitant; forming architectural beauty factors; and create a harmonious and balanced atmosphere between the built and unconscious areas.

The benefits of green open space based on its function are divided into:

- Direct benefits (in a fast term and tangible sense), forming beauty and comfort city (shade, fresh, cool) and getting materials for sale (wood, flowers, fruit); and
- Indirect benefits (long-term and intangible), namely effective air purifiers, maintenance of the continuity of groundwater supplies, preservation of environmental functions and all the contents of existing flora and fauna.

2.3. Palembang

Palembang is one of the metropolitan cities in Indonesia. Geographically, Palembang located between 2°52 'to 3°5' South Latitude and 104°37 'to 104°52' East Longitude with an average height of 8 meters above sea level. The city of Palembang is the capital of the Province of South Sumatra with the borders that are to the north, east and west with the Banyuasin Regency; while the south borders the Muara Enim and Ogan Ilir Regency. The natural condition of Palembang city is the tropical valley region, with an average temperature of most areas of Palembang City 21°-32°C, with rainfall of 22-428 mml per year. Based on geological conditions, the city of Palembang has various reliefs consist of soil in the form of alluvial layers and sandy loam. In the southern part of the city, the rock is in the form of translucent clay sand, the north is water-resistant clay sand, while the west is gravel clay, translucent clay sand to water-proof. In terms of hydrological conditions, the city of Palembang is split by the Musi River into two large parts called Seberang Ulu and Seberang Ilir. Palembang City has 108 tributaries. There are 4 large rivers that cross the city of Palembang. The Musi River is the largest river with an average width of 504 meters (the longest width is 1,350 meters located around Kemaro Island, and the shortest width of 250 meters is located around Musi II Bridge). The other three major rivers are the Komering River with an average width of 236 meters; the Ogan River with an average width of 211 meters, and the Keramasan River with an average width of 103 meters. The function of the river in the city of Palembang before was as a river transport to inland

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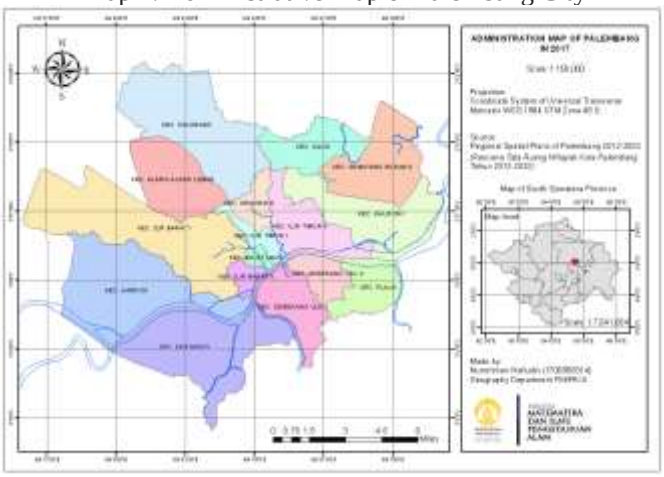
areas, but now many have experienced changes in functions, among others, as drainage and for flood control.

Map 1. Administrative Map of Palembang City



Source: Results of personal analysis, 2018.

Administratively, according to Regional Regulation of Palembang City number 19 year 2007 concerning extentsion of ward sandcity of Palembang Subdistrict Regulation No. 20 year 2007 on district expansion, the region of Palembang city administration to change the number of subdistricts and wards, where the current number of subdistricts in the city of Palembang into 16 subdistricts and 107 wards that were previously only 14 subdistricts and 103 wards. Two new subdistricts are Alang-alang lebar Subdistrict which is afraction of the Sukarami subdistrict and Sematang Borang subdistrict which is afraction of the Sako Subdistrict. While the four new villages are Talang jambe, which is afraction of Talang Betutu wards, Sukodadi, which is afraction of Alang-alang Lebar wards, Sako Baru which is fraction of Sako wards. And the last, Karya Mulya wards which is fraction of Sukamulya wards (Palembang Municipality in Figures, 2017).

III. RESEARCH METHODOLOGY

To see the changing in land use in the urban area of Palembang, the research method used is a quantitative research method using primary and secondary data. Primary data is obtained from observation and digital imagery interpretation. Digital imagery interpretation is done to collect data on land use area and to analyze the development of Palembang city. Secondary data are regional data in numbers obtained online.

Following is the procedure for analyzing research data based on Budiman (2014) with several changes:

1) Location determination. According to Bintarto, city is a network of human life systems with high population density, heterogeneous social strata, and materialistic patterns of life. Cities have different characteristics. Cities that have various characteristics can be classified. According to the classification of cities based on population, the population of Palembang in 2016 was 1,602,071 people (Palembang in Figures, 2017), Palembang was categorized as a Metropolitan city. When the population in a city is increasing, it is estimated that the area of green open space will decrease.
2) Determination of indicators to detect green open space changes through a pattern of urban development changes (Alonso, 1998). The pattern of urban development is focused on changes in vegetation and non-vegetation. Changes in green open space were detected through changes in area in the last 10 years.
3) Capture data. Data collection is done by downloading Landsat satellite imagery from the https://earthexplorer.usgs.gov/ page. Landsat imagery are imagery produced from several spectrums with different wavelengths. There are many applications that can be applied from Landsat data, including for land cover mapping, land use mapping, land mapping, geological mapping, mapping of sea surface temperature and others. The imagery used to determine the change in the green open space of Palembang city is Landsat 5 imagery and Landsat 8 imagery.
4) Data storage. The next process is the extraction and collecting of imagery data in accordance with the desired region and year. In this study, the Landsat imagery used was in 2007 Landsat 5 imagery and Landsat 8 imagery in 2017. This time series data was used to view land use changes over the past 10 years in the city of Palembang.
5) Query. Data selection is done by searching for high quality images with low cloud coverage (<10%) in accordance with USGS standards. The purpose of selecting an image with cloud cover below 10% is so that not too much information is lost and the imagery presented is close to the actual land cover condition.
6) Processing (analysis). The analysis is done by doing geometric correction (georeferencing) so that the imagery is in the actual position based on the WGS 84 Datum with the universal transverse mercator (UTM) coordinate system. Palembang is in path 124 and row 062, and in zone 48 S. The GIS tool used in this research is Arcgis 10.3. After the file is collected, the next step is to clip the imagery based on the city administration boundary according to the map of the Palembang city spatial plan in 2012-2032. The next step is to composite the imagery band pieces with a combination for Landsat Image 1-6 red combination: green: blue is a 2: 3: 1 band, for landsat imagery 7 red: green: blue combination is 5: 4: 3 band, and for Landsat imagery 8 red: green: blue combination is 6: 5: 4 band. This study uses Landsat 5 and Landsat 8 imagery. The results of this combination will produce landsat imagery according to the actual situation, this composite is called the true color combination. After that, the process of classifying landsat imagery is carried out, the classification process uses the supervised classification method. Supervised classification is a classification whose analysis has a number of pixels representing each desired class or category (Jaya, 2007).

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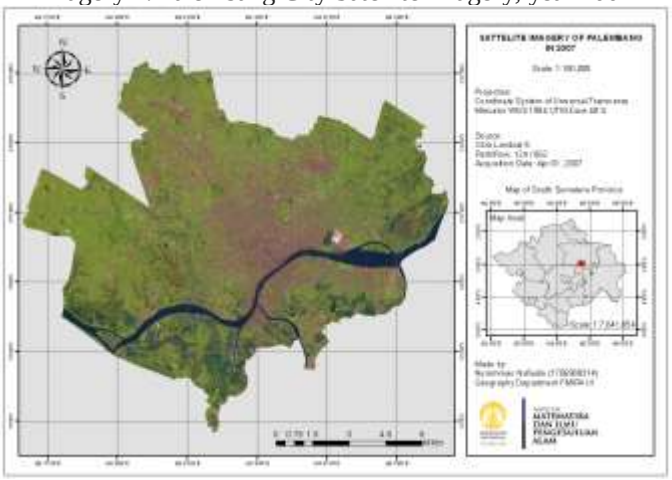
7) Appearance (display). From the analysis, it was found that landcover in Palembang with 6 landcover types, namely 1) trees, 2) agricultural land, bush, grass and rice fields 3) urban land (housing and trade), 4) industrial land, 5) open land and 6) water bodies (river, reservoir/ situ (lake)). Trees, agricultural land, shrubs, grass and rice fields are categorized as green open space. Urban land (housing and trade), industrial land, and open land are included in the non-green open space category, while rivers, reservoirs/situ, and swamps are categorized as water bodies.
8) Layout. From the results of the green open space change display process can be seen based on visuality (pattern of change) and quantity (change in green space area).

IV. RESULTS AND DISCUSSION

4.1. Availability of Palembang City Green Open Space in 2007

The imagery used to determine the availability of green open space in 2007 is Landsat 5 imagery. Landsat 5 is a low-Earth orbit satellite launched on March 1, 1984 to collect the earth's surface imagery. A continuation of the Landsat Program, Landsat 5 is jointly managed by the US Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA). Data from Landsat 5 is collected and distributed from the USGS center for Earth Resources Observation and Science (EROS). Landsat 5 is equipped with multispectral scanner (MSS) and Thematic Mapper (TM) equipment. MSS is an optical sensor that designed to observe solar radiation, which is reflected from the surface of the earth in four different spectral channels/bands, using a combination of optical systems and sensors. TM more sophisticated version of the observation equipment used in MSS, which observes the earth's surface in seven spectral bands that range from visible light to the thermal infrared region.

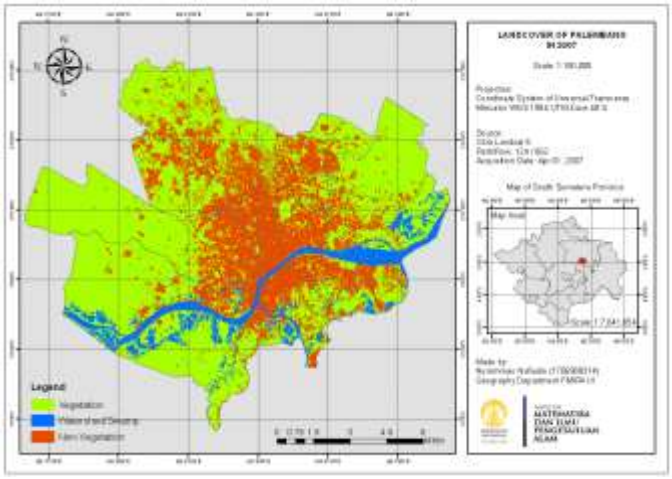
Imagery 1. Palembang City Satellite Imagery, year 2007



Source: results of personal analysis, 2018.

The research area was based on the administrative limits of Palembang city according to the administrative borders in the Palembang city spatial plan 2012-2032. The total area of Palembang city including the Musi river body and its tributaries is 366.80 km^2. As explained in the procedure of research analysis, to find out the availability of green open space in the city of Palembang, this is done by combining the imagery band, to continue imagery classification using a supervised classification technique to produce land cover class data. Supervised imagery analysis is the process of selecting the desired category of information or class and then selecting the training area that represents each category (Lillesand and Kiefer, 1990). The following is the Palembang city land cover map in 2007.

Map 2. Palembang City Land Cover Map, year 2007.



Source: results of personal analysis, 2018.

From the maps above, we can calculate the area of every land cover in Palembang city. The details of the area is in table below.

Table 1. Land Cover of Palembang City 2007 in the form of Percentage

No.	Landcover	Area (km^2)	Percentage (%)
1	Vegetation	229.59	62.59
2	Watershed	29.66	8.09
3	Non-Vegetation	107.55	29.32
Total		366.81	100.00

Source: results of personal analysis, 2018.

The results of the availability of green open spaces analysis indicate the availability of green open space in each sub-district in the city of Palembang in 2007. The total area of green open space in the city of Palembang is 229.59 km^2. It means that, at that time the existence of green open spaces still dominated in most parts of Palembang city. The vegetation cover is still dominated by vegetation with an area of 62.59% of the total area of Palembang. In 2007 the construction had not been carried out too massive. Meanwhile, the area of built land in 2007 reached 107.55 km^2 or 29.32% of the total area of Palembang city. City life that is still quite comfortable for humans to live in various life activities.

The existence of vegetation in urban areas has various functions, including as soil conservation through prevention of

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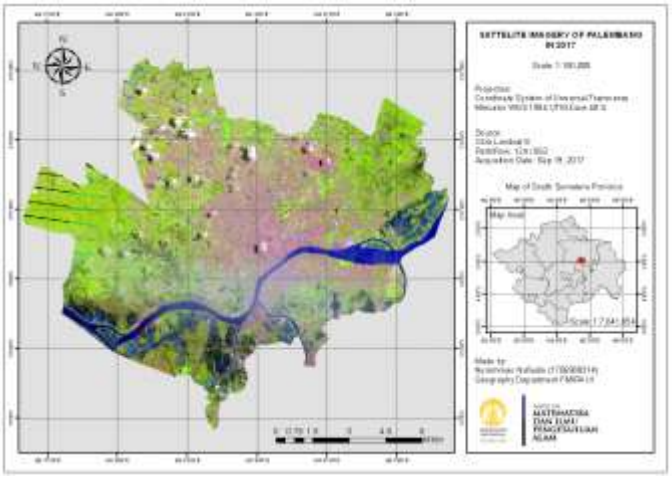
erosion caused by rainfall, maintaining high air temperature fluctuations, filtering pollutant and aerosol materials, reducing noise, air filters through fixation of carbon dioxide (CO_2), increasing the availability of air fresh which is rich in oxygen (O_2), increases biodiversity, and prevents intrusion of seawater into land due to groundwater (Sabarudin, 2012).

4.2. Availability of Palembang City's Open Green Space Changes in 2017

The imagery used is Landsat 8 satellite imagery. Compared to previous versions, Landsat 8 has several advantages especially related to the specifications of the bands that are owned or the length of the spectrum of electromagnetic waves captured. As is well known, the color of objects in the imagery is composed of 3 basic colors, namely red, green and blue (RGB). With the increasing number of bands as RGB composite composers, the colors of objects become more varied. This Landsat 8 imagery is used to help calculate the amount of green space availability in Palembang City. The classification process is carried out by using a supervised classification technique to produce land cover data.

Imagery 2. Palembang City Satellite Image, year 2017



Source: results of personal analysis, 2018.

Based on the analysis of Landsat 8 imagery data regarding the availability of green open space, the imagery can show the availability of green open space in Palembang in 2017 in each sub-district in Palembang. The following is the percentage of land cover in Palembang in 2017 which experienced a rapid change compared to 2007.

Table 2. Land Cover of Palembang City 2017 in Percentage

No.	Landcover	Area (km^2)	Percentage (%)
1	Vegetation	123.83	33.76
2	Watershed	19.02	5.19
3	Non-Vegetation	223.95	61.06
Total		366.81	100.00

Source: Results of personal analysis, 2018.

Total area of green open space in 2017 reaches 123.83 km^2, while in 2007 the area of green space is 229.59 km^2. When compared with the availability of green open space in 2007, in 2017 the area of green open space decreased by 105.76 km^2. Meanwhile, the development of the city of Palembang over the past ten years has experienced rapid growth. A lot of green open land is transformed into built-up land. Economic growth and increasing population contributed to the transfer of land functions. The increase in various economic activities in the city of Palembang such as the tourism economy, trade and services, as well as the construction of various other important facilities became an attraction for the people around Palembang to live in Palembang (Sagala, 2013). Meanwhile, based on the 2016 population projection, the total population of Palembang City was 1,602,071 inhabitants, consisting of 802,990 inhabitants of men and 799,081 women, compared to the projected population in 2015, the population of Palembang experienced a growth of 1.36 percent (Palembang in Figures, 2017). The more population the need for settlements will be more and more, so that a lot of green open space will change into residential areas. One of the developments that was intensively carried out in Palembang was the Jakabaring area development.

The Jakabaring Sport City area is a new development area and was originally a swamp that was reclaimed to become a sports area housing. Intense development around the swamp area has caused various problems. The area that was originally an area with a lot of water was piled up to be used as a building on it. As a result, the original residential areas of the residents who have lived for a long time around the Jababaring area often exposed flooding during the rainy season.

Table 3. Land Cover of Palembang City 2017.

No.	Subdistrict	Area (km^2)			RTH Percentage (%)
		Vegetation	Watershed	Non-Vegetation	
1	Alang-alang Lebar	23.87	0.00	18.93	55.77
2	Bukit Kecil	0.00	1.84	18.52	0.00
3	Gandus	24.87	1.99	19.03	54.20
4	Ilir Barat I	22.93	0.00	18.92	54.78
5	Ilir Barat II	0.01	1.84	18.52	0.06
6	Ilir Timur I	0.02	1.84	18.52	0.11
7	Ilir Timur II	1.15	1.84	0.32	34.72
8	Kalidoni	12.75	1.88	18.90	38.02
9	Kemuning	0.11	0.00	18.52	0.58
10	Kertapati	5.92	2.06	3.40	52.02
11	Plaju	0.82	1.93	4.37	11.46
12	Sako	12.21	0.00	18.75	39.43
13	Seberang Ulu I	0.31	1.86	4.36	4.75
14	Seberang Ulu II	0.30	1.91	4.36	4.54
15	S. Borang	10.74	0.00	19.23	35.84
16	Sukarami	7.82	0.00	19.31	28.82
Total		123.83	19.02	223.95	33.76

Source: Results of personal analysis, 2018.

The results of the analysis show that the area of land built-up in the city of Palembang in 2017 has more than

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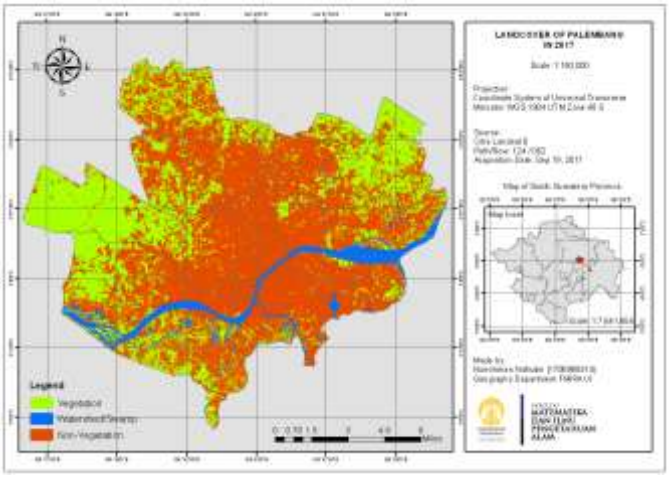
doubled. The increase in land area was built-up during ten years period from 2007-2017 to an area of 223.95 km^2. Based on the processed table data from the imagery above, it can be seen that many sub-districts in Palembang do not have the availability of green open space in accordance with the standards set out in Undang-Undang No. 26 of 2007 concerning spatial planning, which is a minimum of 30%. Sub-districts in Palembang City that must increase the availability of green open spaces, namely Bukit Kecil, Ilir Barat II, Ilir Timur I, Kemuning, Plaju, Seberang Ulu I, Seberang Ulu II, and Sematang Borang subdistricts.

Map 3. Palembang City Land Cover Map 2017



Source: Results of personal analysis, 2018.

4.3. Green Open Space Needs in Palembang City Based on Oxygen Needs

Oxygen is the most vital basic need in human life. In the body, oxygen plays an important role in cell metabolic processes. Lack of oxygen will have a significant impact on the body, one of which is death. One of the functions of urban green open space is the ecological function of producing oxygen. Through physiological processes, plants evapotrans-piration and photosynthesis. Through this physiological process, plants can neutralize carbon dioxide (CO_2), produce oxygen (O_2), and increase moisture content that can cooling down the surrounding air during the day. Analysis of green open space needs based on the amount of oxygen demand is the process to determining the area of green open space based on the number of population, the number of livestock, and the number of motorized vehicles in each sub-district in Palembang city.

To calculate the area of RTH based on oxygen requirements, here is the formula:

$$Lt = \frac{Pt + Kt + Tt}{(54)(0.9375)(2)} m\text{^}2$$

Information:

Lt is the area of green space in year t (m^2)
Pt is the amount of oxygen needed for the population in year t
Kt is the amount of oxygen needed for motorized vehicles in year t
Tt is the amount of oxygen needed for livestock in year t
54 is a constant which shows that 1 m2 of land area produces 54 grams of dry weight of plants per day
0.9375 is a constant that shows that 1 gram of plant dr weight is equivalent to 0.9375 grams of oxygen
2 is the number of seasons in Indonesia

(Minister of Public Works Regulation No: 05/PRT/M/2008).

A green open space full of trees as a lung in the city is an oxygen producer that has not been replaced by its function. The role of trees that cannot be replaced by others is related to the supply of oxygen to human life. According to Wisesa (1988) in Muis (2005), every one hectare of green open space is estimated to be able to produce 0.6 tons of oxygen for 1500 residents to be able to breathe freely.

The oxygen requirement per population is in accordance with the standard of green open space per person in the Guidelines for Provision and Utilization of Green Open Space in Urban Areas in the Minister of Public Works Regulation is 840 grams/day. To find the total oxygen consumption is multiplying the the number of population each sub-districk and human oxygen consumption.

Table 4. RTH Needs of Palembang City Based on Population Oxygen Needs

No.	Subdistrict	Population Number (soul)	Human Oxygen Consumption/ day (gram/day)	Oxygen Consumption (gram/day)
1	Alang-alang Lebar	106602	840	89545680
2	Bukit Kecil	44567		37436280
3	Gandus	62994		52914960
4	Ilir Barat I	137231		115274040
5	Ilir Barat II	66891		56188440
6	Ilir Timur I	72391		60808440
7	Ilir Timur II	167491		140692440
8	Kalidoni	112495		94495800
9	Kemuning	86161		72375240
10	Kertapati	85853		72116520
11	Plaju	83008		69726720
12	Sako	92329		77556360
13	Seberang Ulu I	179160		150494400
14	Seberang Ulu II	100575		84483000
15	S. Borang	37945		31873800
16	Sukarami	166378		139757520
Jumlah		1602071	840	1345739640

Source: results of personal analysis, 2018.

Based on the data above, can be known that with a population of 1,602,071 people and with the calculation of human oxygen demand per day of 840 grams/day, the total oxygen demand of the entire population of Palembang city is 1,345,739,640 grams/day. Logically, the more population there

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will be more oxygen. The following are the details of the subdistrict with the largest and smallest population based on data from Palembang in figures 2017. Seberang Ulu I Subdistrict as a sub-district located in the upper city of Palembang requires the most oxygen with a total requirement of 150,494,400 gram/day, while the smallest subdistrict that needs oxygen is Sematang Borang subdistrict with oxygen demand of 31,873,800 grams/day.

To determine oxygen requirements based on motorized vehicles, the needs vary. This depends on the fuel used and the minimum power (PS) of each motor vehicle. The following are oxygen requirements based on the type of motorized vehicle per day which is loaded in grams/day.

Table 5. Need for Motorized Oxygen Vehicles

No.	Classification	Minimal Power (PS)	Fuel Needs (kg / PS)	Oxygen Requirement Per 1 Liter BB (kg)	Oxygen Needs Per Day (kg/day)	Oxygen Needs Per Day (kg/day)
1	Motorcycle	1	0.21	2.77	0.5817	581.7
2	Passenger Vehicles	20	0.21	2.77	11.6340	11634.0
3	Truck Vehicles	50	0.21	2.77	29.0850	29085.0
4	Bus Vehicles	100	0.16	2.86	45.7600	45760.0

Source: Minister of Public Works Regulation No: 05/PRT/M/2008.

Table 6. RTH Needs of Palembang City Based on Number of Motorized Vehicles

No.	Transportation type	Number of vehicles	Oxygen demand per vehicle (gram/day)	The vehicle is assumed to be used for 5 hours/day	Total oxygen requirement per day (gram/day)
1	Motorcycle	922756	581.7	5	2683835826
2	Car	67374	29085	5	9797863950
3	Bus	3859	45760	5	882939200
4	Passenger Vehicles	162055	11634	5	9426739350
Total		1156044	87060.7	20	22791378326

Source: results of personal analysis, 2018.

Based on the data above, can be known that with the total transportation type is 1.156.044, and the vehicles is assumed to be used for 5 hours/day (Nirmalasari, 2013), the total oxygen demand for motorized vehicles in Palembang is as much as 22,791,378,326 grams/day.

The type of motorized vehicle that needs the most oxygen to keep the engine alive is a car with a total oxygen requirement of 9797863950 grams / day. The number of cars counted in this study includes private cars that are often used by the people of Palembang. the need for public awareness to be wiser in driving using passenger vehicles. in addition to reducing congestion, the use of public transportation can also help so that urban air quality is still fresh and contains a lot of oxygen.

In addition to calculating oxygen requirements for motorized vehicles, it is necessary to calculate oxygen requirements based on the number of livestock. the need for the number of livestock of each animal has different needs. The following is the details of the explanation presented in table form.

Table 7. Oxygen Needs for Livestock

No.	Types of livestock	Oxygen Needs (kg/day)	Oxygen Needs (gram/day)
1	Cow	1.70	0.00170
2	Buffalo	1.70	0.00170
3	Horse	2.86	0.00286
4	Pig	1.24	0.00124
5	Goat	0.31	0.00031
6	Sheep	0.31	0.00031
7	Poultry (Chicken, Birds, Manila Duck, etc.)	0.17	0.00017

(Sumber: Nirmalasari, 2013).

Based on the above provisions, the following is a calculation to find out the total oxygen demand for livestock:

Table 8. Total Animal Oxygen Needs

No.	Types of livestock	Total	Animal Oxygen Needs (grams/day)	Total Oxygen Needs (grams/day)
1	Cow	7993	0.0017	13.5881
2	Buffalo	24	0.0017	0.0408
3	Horse	0	0.00286	0
4	Goat	21024	0.00031	6.51744
5	Sheep	559	0.00031	0.17329
6	Pig	682	0.00124	0.84568
7	Poultry	5076204	0.00017	862.95468
Jumlah		5106486	0.00829	884.12

Source: Results of personal analysis, 2018.

From the table above, the total oxygen demand for livestock in Palembang is 118,30464 grams / day.

To get the area of green space based on oxygen requirements, can be calculated by the method of Gerakis (1974), which is modified in Wisesa (1988), as follows:

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$$Lt = \frac{Pt + Kt + Tt}{(54)(0.9375)(2)} m\text{^}2$$

$$Lt = \frac{1345739640 + 2279137832\,6 + 884.12}{(54)(0.9375)(2)} m\text{^}2$$

$$Lt = \frac{2413711885\,0}{101.25} m\text{^}2$$

Lt = 238391297.3 m^2

Lt = 23.839,12973 ha.

Based on the results of data analysis, the total area needed as RTH based on oxygen demand is 23.839,12973 ha. The government needs to maintain and provide green open space in the form of urban forests, city parks or other forms of green open space with the total area mentioned above to meet the oxygen demand for residents, livestock, and motorized vehicles, so that balance and regularity in life can still run with healthy, comfortable and sustainable.

V. CONCLUSION

The development of information technology began to penetrate various fields of life. It cannot be denied that information technology can improve work effectiveness and efficiency in human life. GIS as an information system is used to enter, store, recall, process, analyze and produce geographical reference data or geospatial data, to support decision making in the planning and management of land use, natural resources, environment, transportation, city facilities and public services others. Through the use of geographic information systems and processing of remote sensing image data, the development of a city can be monitored on a continuum basis. Based on the data analysis, the availability of green space in the city of Palembang is always reduced every year, while the area of land constructed has more than doubled in the period of 10 years from 2007-2017. Meanwhile, the area of built land has experienced a rapid increase in the last 10 years. Based on data on RTH requirements based on oxygen requirements, the government needs to pay attention to the existence of the number of motorized vehicles on the road. In addition to motorized vehicles, the government also needs to control population growth. The more number of vehicles and population, the more oxygen demand.

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REFERENCES

Achsan, Andi Chairul. 2015. Analisis Kesesuaian Lokasi Pengembangan Ruang Terbuka Hijau Publik di Kecamatan Palu Timur dan Palu Barat. Palu: Program Studi Perencanaan Wilayah Dan Kota, Fakultas Teknik, Universitas Tadulako. E-Jurnal Arsitektur Lansekap ISSN: 2442-5508 Vol. 1, No. 2, Oktober 2015

Aini, Anisah. 2007. Definition of Geographic Information Systems and their Applications. Yogyakarta: STMIK AMIKOM Yogyakarta.

Aronoff, 1989. Geographic Information System: A Management Perspective. Canada: WDL Publishing.

BPS Palembang City. 2017. City of Palembang in Figures. Palembang: BPS Palembang City.

Budiman, Ariev. et al. 2014. Detection of Changes in Green Open Space in 5 Major Cities in Java Island (Case Study: DKI Jakarta, Bandung City, Semarang City, Jogjakarta City, and Surabaya City).

Budiharjo, Eko. 1993. Kota Berwawasan Lingkungan. Bandung: Alumni.

Dwihatmojo, Roswidyatmoko. 2013. Ruang Terbuka Hijau yang Semakin Terpinggirkan. Staf Pusat Tata dan Ruang Atlas BIG

Erwin Hardika Putra. 2012. Green Space Analysis Based On Oxygen Demands Using the EO-1 ALI (Earth Observer-1 Advanced Land Imager) in Manado City. Info BPK Manado (2)1:41-54.

Ferry Adriono. 2013. Dynamic Of Green Open Space And Temperature Humidity Index In Malang City. International Journal Of Engineering And Science (2) 3:26-32.

Gallion, Arthur B., & Eisner, Simon. (1996). Introduction to City Design: Urban Design and Planning. Jakarta: Erlangga.

Hoffimann, Elaine, et al. 2018. Development of a smartphone app to evaluate the quality of public open space for physical activity. An instrument for health reserachers and urban planners. Landsacap and Urban Planning 177 (2018) 191-195 on Elsevier.

Harsono, Eddy. 2011. Isu Dan Permasalahan Reklamasi Rawa Jakabaring Palembang. Disampaikan pada acara Seminar Sehari di Fakultas Teknik Sipil Universitas Bina Darma Palembang, 18 Nopember 2011.

Joga, Nirwono., dan Pradana, Ryan. 2011. RTH 30%! Resolusi (Kota) Hijau. Jakarta: Gramedia Pustaka Utama.

L. A. Abdillah, et al. 2007. The effect of compensation and information technology on the performance of lecturers (KIDO) remains at Bina Darma University. Palembang: MATRIK Scientific Journal, vol. 9, pp. 1-20, April 2007.

Lee, Bo Kyeong, et al. 2014. Design guidelines for the dashilar, Beijing open green space redevelopment project. Urban forestry & Urban Greening 12 (2014) 385-396.

Ludang, Yetrie. 2017. Keragaman Hayati Ruang Terbuka Hijau Berbasis Pengetahuan Ulayat di Kota Palangkaraya. Tangerang: An1mage.

Minister of Public Works Regulation Number 5 of 2008 concerning Guidelines for Provision and Use of Green Open Space in Urban Areas. Jakarta: Directorate General of Spatial Planning Ministry of Public Works.

Ramadhan, Muhammad Isa. 2013. Geographic Information System (Gis) in Education "Problems of Application Geographic Information Systems (GIS) in Secondary

ISBN 978-602-53524-0-9

Schools and Higher Education. Bandung: Graduated School, Indonesian University of Education.

Sinuksmoyo, Bagas. 2016. (Thesis) Determining the Location of Development of Green Open Space Based on Surface Temperature Distribution in West Jakarta Municipality. Bogor: Department of Forest Resource Conservation and Ecotourism Faculty of Forestry, Bogor Agricultural University.

Wicaksosno, Rizqi Agung., Zulharnen. 2017. Utilization of High Resolution Remote Sensing Images and Geographic Information Systems (Sig) To Determine Priority Locations for Green Open Space Development (RTH) in Surakarta City. Yogyakarta: Faculty of Geography, Gadjah Mada University Yogyakarta. Jurnal Bumi Indonesia Volume 6, Number 3, Year 2017.

Xue, Fei, et al. 2017. Green open space inn high-dense Asian cities: site configurations, microlimates and users' perceptions. Sustainable Cities and Society 34 (2017) 114-125.

https://elshinta.com/news/146675/2018/05/30/ruang-terbuka-hijau-di-palembang-dinilai-masih-kurang (Accessed October 23, 2017, 14.23 WIB).

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NURROHMAN NAFIUDIN, was born in Air Putih Ulu on February 2, 1993. The author is the fourth of four children, the couple of Mr. Jalalludin and Mrs. Siti Aminah. The level of education began to be started from TK Aisiyah Bustanul Athfal, graduating in 1999. The first basic education was passed at Air Putih Ulu 2 Public Elementary School, and graduated in 2005. Then completed his High School in Sekayu State MTs, graduating in 2008. The education level above was tracked at Sekayu 2 State High School, graduating in 2011. Furthermore, in 2011 author became students of Geography Education (FKIP) at the Palembang PGRI University and graduated in 2015. After graduation, the author had several times worked on teaching work, including as an Integrated Social Studies teacher, character building teacher, scout coach, PMR coach, and had been a Deputy Head of Student Affairs at one of the private schools in Palembang. At present the author is a student of Master of Geography (FMIPA) at the University of Indonesia since 2017.

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