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Analysis of the Need for Green Open Space Based on Oxygen Requirement in Medan City

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ABSTRACT
Medan City is a Metropolitan City with a high population growth rate, in line with the growth rate of regional development. These problems spur the occurrence of land use change. The need for land for residential locations, transportation infrastructure facilities and others will impact the reduced availability of green open space as an oxygen producer in the city of Medan. This study aims to examine the distribution of green open space, estimate the need and adequacy of green open space, and develop directions for developing green open space. This research was conducted from January to completion, using the method of interpretation and analysis of spatial data from quick bird images taken from the SAS Planet application, and calculations were carried out using the Gerarchic formula to determine oxygen demand. The results showed that the area of green open space in Medan City was 86.27 km2 (33%), and non-vegetated/non-green open space was 178.83 km2 or equivalent to (67%) of the Medan City area of 265.10 km^2. The oxygen plants produce in green open spaces is 4,367,418.75 kg/day. Meanwhile, the oxygen demand in Medan City is 5,150,425.98 kg/day, and when converted into green open space, it is 101.74 km2. Directions for the development of green open spaces can be carried out in several ways, namely managing green spaces, synergizing the natural and artificial environment, implementing a low-cost transportation system, empowering population policy strategies, utilizing water and energy resources, maintaining environmental health based on city planning those favours development principles sustainable

INTRODUCTION

Urban areas have a relatively high level of regional development accompanied by high population growth. This growth is in line with the development of infrastructure, education, technology, and the strengthening of the economic system in urban areas (Nurhanifah 2021). (Zhang et al., 2020) explained that the increase in population in urban areas makes ecosystems in these areas more vulnerable. The population growth rate in urban areas in China reached 5.33% in 2020. This affects green infrastructure in urban areas. The occurrence of exploration of urban spaces to meet the demand for housing and urban infrastructure to support the economy.

The development of urban areas is caused by several factors, one of which is an increase in the population and activities in it.

(Anguluri and Narayanan, 2017) Argues that more than 50% of the global population currently lives in urban areas; this situation disrupts ecological systems that impact the environmental conditions in urban areas. Senik and Uzun (2022) argue that the relationship between urbanization and population growth spurred the gradual need for urban housing. It will consider rebuilding the urban environment to provide healthy and sustainable conditions. (Dianovita and Siwi, 2019) argue that the increase in population yearly will impact the need for built-up land. This causes the conversion of land functions from open land to built land, such as settlements, industrial locations, and other infrastructure facilities. These conditions will force development at every corner in urban areas to meet the population's needs and other activities (Irham, Elvitriana et al., 2017).

The rate of population growth influences changes in regional spatial planning. The balance of the population growth rate coupled with the development of a large area (Nurhanifah 2021). This is not only happening in urban areas in Indonesia but has also become a global problem in all cities worldwide. This will lead to increased air pollution and land conversion from an environmental perspective. The impact of this problem is the availability of green open space. Developments in urban areas force the reduction of green spaces to meet needs in every aspect. (Chen et al., 2021) argued that the presence of green open space provides many benefits. The benefits of green open spaces can affect environmental factors, such as absorbing pollutants from the air, absorbing noise from the environment, creating micro-climates and others.

Furthermore, green open spaces provide various activities for the surrounding residents, such as recreational activities, sports, and social contacts. And then, the presence of green open space includes health benefits for the surrounding residents. For example, the city of Berlin has an excellent green infrastructure, which is proven by the achievement of green infrastructure in managing the ecological environment, improving environmental quality, and promoting the population's health.

Development and economic growth concentrated in urban areas spurred the conversion of land functions from open spaces to built-up areas. This will indirectly lead to decreased environmental quality (Zainudin 2019). (Libriyanto et al., 2022) argues that the development of a place will change the function and purpose of the land use of an area. This will harm the environment and the potential of the existing land. (Untajana et al., 2019) The impact of development in urban areas causes reduced vegetation in green open spaces to supply oxygen. Another impact is a decrease in air quality and environmental pollution. The reduction of green open space will be a threat to urban areas. This will provide the potential for a shortage of clean water, the danger of flooding, a decrease in air quality and limited land (Aryaguna et al., 2022).

(Arsandrie and Widayanti, 2018) Argues that green open space is part of urban space with functions and roles such as regulating microclimate, supplying oxygen, reducing air pollution, maintaining ecosystem balance, and creating health, environmental cleanliness, beauty and comfort. Andryani (2020) stated that green open space in urban areas has many functions, including as an oxygen producer, water absorber and aesthetics. Oxygen in green open spaces is available naturally through the vegetation that grows in them.

Vegetation, as the main element of green open space, produces oxygen needed for various life activities in urban areas. Humans and animals will then consume oxygen produced by plants and vegetation in green open spaces. It can be used in the combustion process of motorized vehicle engines and industrial machinery (Pradipta et al., 2018). The oxygen produced in plants can be consumed by the community and used for other activities. Oxygen gas produced by plants is processed through photosynthesis which supplies energy through sunlight; carbon and water are absorbed in the soil through the roots. Furthermore, the process produces glucose and oxygen (Nasyith et al., 2020).

Medan City is a Metropolitan City and the third largest city in Indonesia, with a population of 2,264,145 people (BPS 2021). Medan City is divided into 21 sub-districts and 151 urban villages with a total area of 265.10 Km2. Identifying the location and distribution of Green Open Space can be done by utilizing remote sensing technology, namely a geographic information system that utilizes the image of the city of Medan. Geographic information systems are used to organize and utilize geographic data, and this system is widely known as a spatial analysis technique in various fields such as forest management, urban planning, civil engineering, settlement management, business, and environmental studies. (Sari and Kushardono, 2019) stated that the use of remote sensing technology is constructive so that planning for developing green open spaces can be carried out more quickly, especially in analyzing the determination of green available space requirements based on oxygen demand. Based on this background, the authors need to research investigating the need for green open space based on oxygen demand in the city of Medan to improve the quality of the living environment to support the fulfilment of the oxygen needs of the population in the city of Medan.

RESEARCH METHODS

This research was conducted in Medan City, located between the coordinates of $2^{0}27'$ to $2^{0}44'$ North Latitude and $98^{0}35'$ to $98^{0}44'$ East Longitude. Medan City is directly adjacent to Deli Serdang Regency in the North, South, West and East (Figure 1).

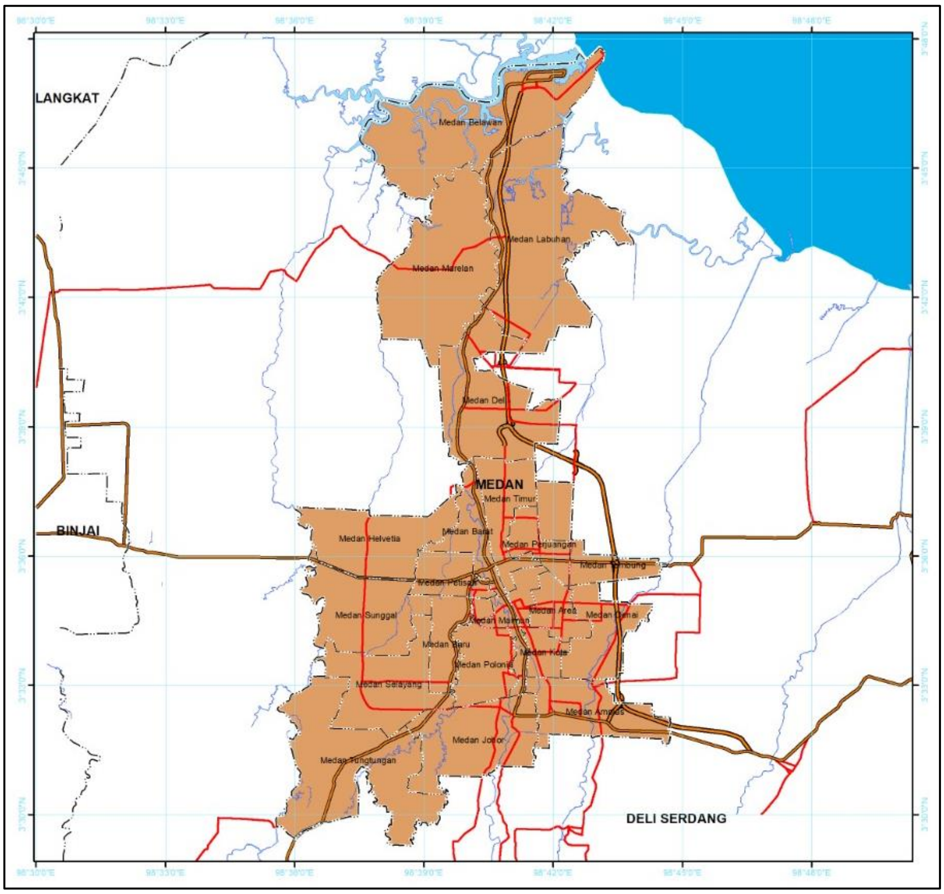


Figure 1. Research Location Map

The tools and materials needed in this research are computers used to analyze data and writing, printers used to print results and reports, GIS software version 10.5 used to analyze spatial data, google earth pro version 7.3.4 and quick bird images used to view the land cover display, the SAS planet application is used to download high-resolution photos, GPS is used to determine the location of research samples and digital cameras are used for documentation during field surveys. The collection technique was obtained from literature study, documentation, and observation. The data in this study are divided into two types: primary and secondary.

Table 1. Data Collection Techniques

Data	Data Type	Information
Primer	The duration of operating a motorized vehicle	Interview
	Coordinate point of land cover sample	Field survey
Sekunder	Population data	BPS
	Data on the number of motorized vehicles	Samsat
	Industry number data	BPS
	Image of Medan City	SAS Planet
	Medan city administration map	Ina geospatial
	RBI map 1:50,000 scale 2017	BIG

In this study, interpretation and data analysis were carried out. The image used in this study is a quick bird image taken from the SAS planet application. Quickbird imagery is used as input data to analyze the type of land cover and the area of green open space in Medan City.

Image interpretation is carried out visually with on-screen digitization, which includes activities to recognize the characteristics of objects based on interpretation elements and then limit groups that have the same features and separate them from others. Image interpretation is carried out on a scale of 1:25,000 to 1:5,000, depending on the appearance of objects in the image. Furthermore, the idea is digitized to determine the distribution of green open space and then identify the area of green open space.

Furthermore, the image analysis data is tested for accuracy utilizing field survey activities at several sample points. The reinterpretation stage is used to re-analyze the results by improving the previous interpretation results by correcting the results of field checks. (Ratnaningtyas and Hadi, 2013) Put forward the calculation of the accuracy test based on the short method, namely by determining the sample on the map resulting from the interpretation and then comparing it with the reality in the field.

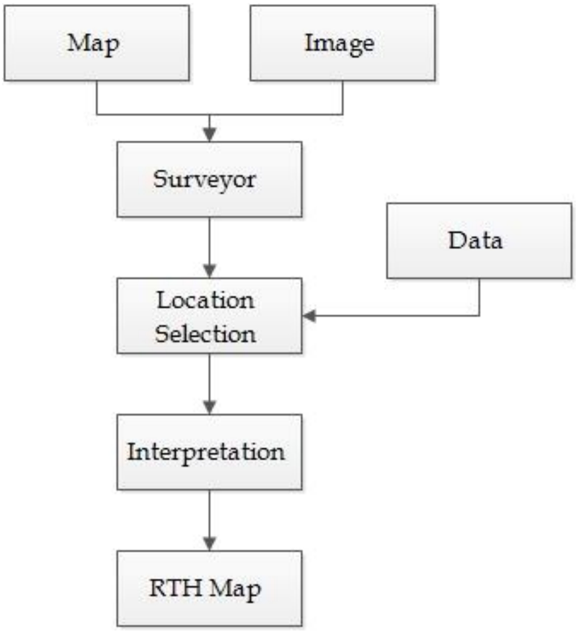


Figure 2. Analysis Flowchart

The data on the area of green open space obtained is then calculated using the oxygen demand approach with the Gerarkis formula, using the oxygen demand parameters by residents, motor vehicles, and industry that have been modified by (Nasyith et al., 2020) the following formula:

$$Lt = \frac{(pt + Kt + It)}{(54 \times 0{,}9375)} m^2$$

Information:

Lt	=	Area of green open space in year t (m^2)
Pt	=	Total Oxygen Needs per day in year t (g/day)
Kt	=	The total oxygen demand of motorized vehicles per day in year t (g/day)
It	=	Total Industrial Oxygen Demand in year t (g/day)
54	=	Constant, 1 m^2 of the land area produces 54 grams of plant dry weight per day (g/day/m^2)
0,9375	=	The constant 1 gram dry weight of plants is equivalent to oxygen production of 0.9375 grams (g/day)

The assumptions used in this study are as follows:

1. Oxygen users are only humans, motor vehicles, and industry.
2. The need for oxygen per day for each person is considered the same.
3. The number of vehicles entering and leaving the research area is considered the same every day, and each type uses the same oxygen level. The duration of operation on every motorized vehicle is taken from interviews with motorized vehicle users.
4. The need for oxygen by each large and small industrial machine is considered the same. Large industrial machines operate 24 hours a day, and small industrial machines work eight hours a day.
5. Oxygen supply from outside the area is neglected and produced only by plants that supply oxygen at the same level every 1 m^2.

RESULTS AND DISCUSSION

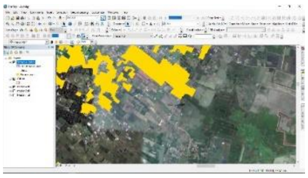
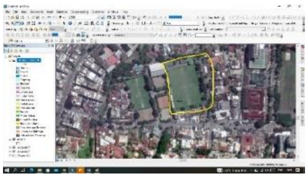
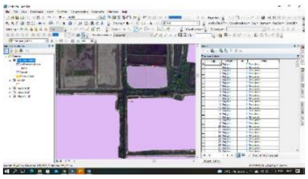
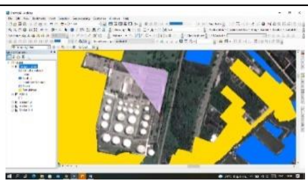
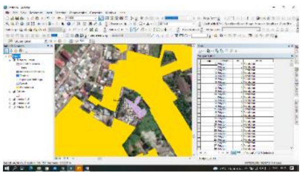
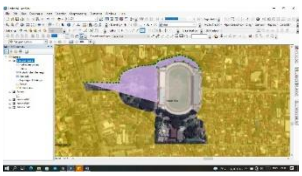
Image Interpretation and Analysis

The image used in this study is a quick bird image downloaded from the SAS Planet application. The image of the city of Medan is downloaded into three parts with a zoom scale of 20 on each download. The data analysis was carried out by analyzing the availability of green open space by taking images juxtaposed with secondary data from the RBI map at a scale of 1:50,000 in 2017 to assist in the image interpretation process.

The interpretation to obtain the land cover type refers to the Indonesian National Standard on land cover classes in interpreting high and medium-resolution images. Object recognition is based on interpretation elements such as pattern, colour, size, site and association. The image interpretation technique is carried out using a scale of 1:25,000 – 1:5,000, depending on the object and appearance in the image. No significant cloud coverage can interfere with the interpretation process at the interpretation stage. In addition, good image quality and knowledge of the research area can facilitate the interpretation process (Karteris et al., 2016).

Table 2. Land Cover Appearance from Image Interpretation

Land Cover	Image Appearance	Information
Settlement		The appearance of settlements is recognized by considering the shape, association, pattern and size, bright hues, dark red, dark brown or light brown. The arrangement of the settlements is on the side of significant and minor roads.

Land Cover	Image Appearance	Information
Ricefield		The appearance of the rice fields in Citra has a smooth texture and a checkerboard pattern
Soccer field		The appearance of the Sports Field (Football Field) is seen from the shape and size, and the football field has a rectangular shape with the width of the area having a length that is less than the length of the field
Mangrove		Mangroves can be identified by their dark hue and rough texture. It is located in brackish waters, such as the edge of river mouths and coastal edges
Pond		We can distinguish the pond in the image by looking at the dark pattern and hue because the pond is filled with water
Industry		Industry can be identified in buildings consisting of single elongated buildings with irregular patterns, bright hues of bright white with substantial building sizes.
Burial		Cemeteries are recognizable in the form of a greyish-white colour (like scars), irregular patterns, rough texture, and small buildings with few trees.
City Park		Gardens can be recognized by their dark green hue, rough texture, broad size and no precise shape
Shrubs		Shrubs can be identified by the dark colour, no pattern, size and shape that is not clear and irregular. Usually found in vacant land with varied vegetation

Source: Data Analysis (2022).

The results of image interpretation in the form of land cover data have a measurable accuracy. Test the accuracy of the image interpretation results by comparing the object that has been interpreted with the actual situation in the field. Taking a sample point in the test of the accuracy of the image interpretation results on land use is based on the difficulty in recognizing the interpreted object. The accuracy of image interpretation is 90%, while the error is 10%. There are 81 sample points of field data according to the type obtained in the interpretation results. At the same time, nine field data objects do not match the types accepted in the interpretation results. Furthermore, reinterpretation is carried out by improving the previous outcomes with the results obtained during the field check.

The image's interpretation accuracy has met the requirements set by the USGS (United States Geology Survey). According to the USGS, the minimum accuracy in interpretation for identifying land use or land cover categories is at least 85% (Ratnaningtyas and Hadi 2013). The interpretation and field survey data are then combined according to the classification of green open space units and non-green open space units. The data produces data on the distribution of green open space, which is used in calculating the area of green open space.

Availability of green open space

(Vazquez et al., 2021) He explained that green infrastructure is an implementation tool to connect urban areas with the environment. The Commission in Europe is directing development towards designing a green area strategy as a planning tool. This is an active effort based on the principle of sustainability in the future.

Medan City is a metropolitan city experiencing rapid development as part of the corridor of national economic growth. Economic progress and an increase in population have led to the rise in the population's need for land for settlements, industry, transportation facilities, financial centres, etc.

According to the detailed spatial plan and zoning regulations for Medan City 2010-2030, it is explained that green space is an elongated or clustered zone whose use is open, where plants grow both naturally and intentionally. The development of urban areas in line with the increase in the economy and population growth causes a mismatch in the planned RTRW. Urban green space is an essential component of the urban ecosystem system that provides environmental and social services to improve the city's quality of life. One of the main focuses in urban area development is optimizing the benefits of green spaces in balancing environmental quality (Nastiti and Giyarsih 2019).

The results obtained in image analysis and field surveys show the availability of green open space in Medan City, which is classified into two types, namely vegetated land/green open space of 86.26 km2 or equivalent to 33% and non-vegetated land/non-RTH. of 178.84 km2 or equivalent to 67% of the total area of Medan City of 265.10 km2. The scope of green open space and built-up land in Medan City is presented in Table 3.

Table 3. Area of Green Open Space and Built-up Land in Medan City

Subdistrict	RTH Area (Km^2)	Non-RTH Area (Km^2)	An Area (Km^2)	RTH Area (%)
Barat	0,71	4,62	5,33	13
Timur	0,33	7,43	7,76	4
Amplas	3,43	7,76	11,19	31
Area	0,23	5,29	5,52	4
Baru	1,38	4,46	5,84	24
Belawan	10,91	15,34	26,25	42
Deli	6,57	14,27	20,84	32
Denai	1,27	7,78	9,05	14
Helvetia	2,56	10,61	13,16	19
Johor	4,97	9,61	14,58	34

Kota	0,27	5,00	5,27	5
Labuhan	18,58	18,10	36,67	51
Maimun	0,45	2,53	2,98	15
Marelan	8,90	14,92	23,82	37
Perjuangan	0,12	3,97	4,09	3
Petisah	0,38	6,44	6,82	6
Polonia	4,30	4,71	9,01	48
Selayang	4,24	8,58	12,81	33
Sunggal	4,30	11,15	15,44	28
Tembung	0,48	7,52	7,99	6
Tuntungan	11,89	8,80	20,68	57
Total	86,27	178,83	265,10	33

Source: Data Analysis (2022).

Hutapea (2018) stated that implementing an open space policy in the city of Medan has complex problems, such as uneven distribution and land conversion into built-up areas. Land cover classification is divided into two types, namely vegetated land and non-vegetated land. Details of the allocation of the kinds of green open space in the City of Medan based on the interpretation of the image of the City of Medan in 2021 can be seen in Table 4 and 5.

Table 4. Land Use for Green Open Space

No	Type of RTH	Large (Km²)
1	Sports field	0,24
2	Burial	1,72
3	Plantation	21,82
4	Ricefield	14,22
5	Shrubs	6,73
6	Park	1,36
7	Moor/Field	14,73
8	Swamp Forest Land	17,92
9	Green Line Road	0,52
10	River Border	3,74
11	City Forest	1,01
12	Service Land	2,24
	Total	86,26

Source: Data Analysis (2022).

Table 5. Land Use for Non-Green Open Space

No	Non-RTH Type	Large (Km²)
1	Settlement	151,76
2	Industry	2,95
3	Dock	2,62
4	Airport	0,35
5	Lake	0,36
6	pond	0,63
7	River	6,88
8	pond	13,34
	Total	178,84

Source: Data Analysis (2022).

(Lubis, 2016) his research stated that the city of Medan experienced a dynamic land use change from 2003. The land use change that experienced the most significant change was built-up land, such as industrial land, service land and residential land, which was increasing. Meanwhile, green open spaces, such as swamp forests: mangroves, mixed gardens, rice fields and other available land, decreased.

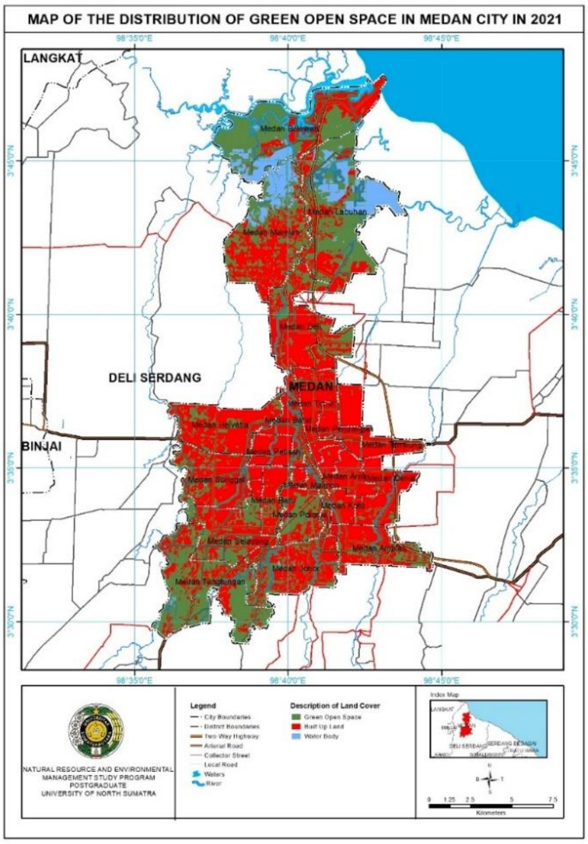


Figure 2. Map of Green Open Space Distribution in Medan City

Population Oxygen Needs

Based on data from the Medan City Statistical Center in 2021, the population of Medan City is 2,435,252 people. The oxygen demand of the population is calculated based on the estimate that the oxygen demand for each population is 0.864 kg/day/person, with the assumption that the oxygen demand for each population is considered the same (Sinambela, 2020). After calculating, thus the oxygen demand for residents in the city of Medan is 2,104,057.73 kg/day.

Motor Vehicle Oxygen Needs

Motor vehicles are consumers that consume oxygen in large enough quantities. The working process of motorized vehicles is ignition, burning fuel using oxygen. (Rahman et al., 2018) Suggested that to find out the oxygen demand for each type of motorized vehicle, it can be calculated based on four categories, with the formula:

a. Passenger Car
$$\frac{0,21}{PS.jam} x\ 20\ PS\ \frac{2,77}{1\ kg} = 11,63 kg/hour$$
b. Veban Car
$$\frac{0,16}{PS.jam} x\ 50\ PS\ \frac{2,86}{One\ kg} = 22,88\ kg/hour$$
c. Bus Car
$$\frac{0,16}{PS.jam} x\ 100\ PS\ \frac{2,77}{One\ kg} = 44,32\ kg/hour$$
d. Motorcycle
$$\frac{0,21}{PS.jam} x\ 1\ PS\ \frac{2,77}{1\ kg} = 0,58\ kg/hour$$

Motorized vehicles operate on the road for different amounts of time. The duration of operation of motorized vehicles is taken from an average of 20 (twenty) samples of vehicle users of each type who have been interviewed. The results obtained are:
a. Passenger cars operate 3 hours/day
b. Load car operates 3 hours/day
c. Bus cars operate 3 hours/day
d. Motorcycles operate 3 hours/day

The number of motorized vehicles in the city of Medan is 275,375 vehicles. After calculating, thus the total oxygen demand for motorized vehicles is 2,496,363.21 kg/day.

Industrial Oxygen Demand

Putrajaya (2017) stated the oxygen demand for industry using the equation from Wisesa that each sector's diesel engine requires oxygen of 66.17 kg/hour, assuming the oxygen demand by each large industrial machine and each small industrial machine is considered the same. The estimated usage time is that large industrial machines operate for 24 hours, and small industrial machines operate for 8 hours.

The number of small industries is 631 units, and large enterprises are 136 units. After calculating, thus the oxygen demand for industrial machines is 550.005.04 kg/day.

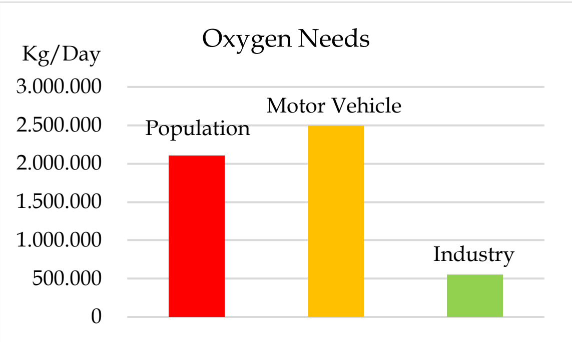


Figure 3. Diagram of Oxygen Demand for Each Parameter

Oxygen Production in Medan City

In this study, the reference used to determine oxygen production is to calculate the area of green open space in the city of Medan with the assumption that an area of 1 m2 of green open space can produce 50.625 g of oxygen per day (Purba et al., 2018). The data on the location of green open space that has been obtained from the visual interpretation process using Arcgis software is calculated with the ability to produce oxygen so that it is accepted that the total green open space available in the city of Medan is 86.26 km2, which means that the oxygen that the city of Medan can produce is 4,308 187.50 kg.

Green Open Space Needs Basing on Oxygen Demand

They are determining the need for green open space in the city of Medan based on the Gerarchist formula approach, where the need for green open space is based on the oxygen demand in an area. Oxygen demand is obtained from calculating the requirements of the population, industry, and motor vehicles.

After calculating the oxygen demand for each oxygen demand parameter, it can thus be calculated the need for green open space based on the oxygen demand in the city of Medan as follows:

$$Lt = \frac{(pt + Kt + It)}{(54 \times 0{,}9375)} m$$

$$Lt = \frac{(2.104.057{,}73 + 2.496.363{,}21 + 550.005{,}04)\ kg/day}{(54 \times 0{,}9375)\ gram/day} m^2$$

$$Lt = \frac{5.150.425{,}98\ kg/day}{50{,}625\ g/day} m^2$$

Lt = 101.736.809,44 m^2

Lt = 101,74 km^2

From the results of calculations using the Gerarkis method, it is known that the level of oxygen consumption based on population, motor vehicles and industry in Medan City is 5,150,425.98 kg/day. Meanwhile, if it is converted into an area of green open space that must be met, it is 101.74 km2. The need for green open space based on oxygen demand in Medan City is presented in Table 6.

Table 6. Green Open Space Needs Basing on Oxygen Demand

No	Subdistrict	Needs RTH (m^2)	Needs RTH (Km^2)
1	Tuntungan	5.035.831,62	5,04
2	Johor	6.475.918,30	6,48
3	Amplas	6.441.521,46	6,44
4	Denai	5.243.878,95	5,24
5	Area	4.271.682,09	4,27
6	Kota	3.928.994,65	3,93
7	Maimun	2.001.973,02	2,00
8	Polonia	2.696.653,83	2,70
9	Baru	2.278.333,59	2,28
10	Selayang	5.580.528,87	5,58
11	Sunggal	6.055.282,41	6,06
12	Helvetia	6.201.799,70	6,20
13	Petisah	3.432.988,76	3,43
14	Barat	3.273.123,12	3,27
15	Timur	4.501.042,96	4,50
16	Perjuangan	3.357.081,72	3,36
17	Tembung	5.014.257,70	5,01
18	Deli	6.947.394,25	6,95
19	Labuhan	6.076.898,37	6,08
20	Marelan	7.001.992,89	7,00
21	Belawan	5.919.631,17	5,92
	Total	101.736.809,44	101,74

Source: Data Analysis (2022).

Recommended Green Open Space Direction

Two factors cause the change of green open space into built-up land. First, in line with the development of residential and industrial areas, the accessibility of the location becomes more conducive to housing and industrial development, which in turn encourages increased demand for land by investors or land speculators so that the price of land in the vicinity increases. Second, the rise in land prices can further stimulate other nearby residents to sell land. Land purchasers are usually not residents, thus forming gantai grounds, which are generally vulnerable to land conversion (Ardiansah and Oktapani 2019).

(Senik and Uzun 2022) Argues that green open space is considered a landscape subsystem that focuses on urban character and the level of urbanization. It is necessary to set standards for green open spaces that guarantee the development of equitable urban areas and urban spaces that are sensitive to disasters. This standard is categorized into 2, namely, the standard for recreation and natural disasters. Thus, green open space is directed based on qualitative, quantitative, connectivity and site selection criteria with a holistic and multi-dimensional approach that is developed based on ecological, recreational and disaster requirements.

(Vazquez et al., 2021) He argued that the UN 2030 plan focuses on developing sustainable urban areas. To achieve this, it is necessary to create urban areas based on social, economic, and environmental principles. Green infrastructure has a vital role to play in meeting these goals.

The Medan City Government has two priority strategies in managing urban green open spaces: 1) Following the vision of the City of Medan to protect the existence of green open spaces with partnership programs with private parties; 2) Optimizing existing green open spaces by restoring green open spaces that have changed functions and increasing the number of city parks in various appropriate places. Some of the government's efforts are pretty supported by the community. Still, some other efforts sometimes also encounter obstacles, especially in efforts to restore green open spaces that have changed functions (Lubis 2016).

The direction of green open space development is carried out to meet the maximum green open space requirement that is still possible based on land cover conditions and RUTR in each sub-district. The distribution of green open space needs to be based on location. It is used to see the total need for green open space in the Medan City area in the form of open space dominated by greenery (vegetation). The state of green open space is adjusted to the availability of existing land, but it accommodates people's preferences as much as possible. If the availability of land in a sub-district is insufficient, then the fulfilment of needs is obtained from subsidies from other sub-districts.

The Medan City Government must be active in building new green open spaces such as urban forests to achieve the mandate of applicable regulations and maintain existing green open spaces, both public and private. The development of green open space can be done by empowering office areas, housing, industrial areas, schools, universities and sports fields to become vegetated areas (Hasanah and Naibaho 2021).

In conditions of limited land area, a solution is needed in making green open spaces, namely by carrying out a green available space strategy in the form of a roof garden. A roof garden is an alternative for growing vegetation in residential areas filled with buildings.

It is adding green open space to the city forest. Currently, Medan City has seven urban forests spread over several sub-districts. The amount is still minimal compared to the area of Medan City, and it is necessary to add urban forest to meet the essential needs. Government Regulation No. 63 of 2002 states that the location of the urban forest is at least 10% of the city's total area. City Forest in Medan City currently has an area of 101.04 hectares or about 4% of the scope of Medan City.

Addition of green open space for city parks. A city park green open space is a park that is intended to serve residents of one city or part of the city area by performing a minimum of 120,000 residents with a minimum standard of 0.3 m2 per city resident, with a minimum garden area of 0.2 – 1.2 m2. The green open space of city parks in Medan City should be built in regions with less than 30 per cent of green open space.

They are empowering existing green open spaces. Empowerment can be done by diversifying plant species and adding to the types of plants that occupy certain stratums, thereby increasing the amount of vegetation. Green open spaces such as parks with lots of trees do not guarantee that more oxygen will be produced if the selection of tree species is not correct. The characteristics of trees with broad crowns, leaves and stacks make more oxygen (Simangunsong and Fitri 2021).

Planting trees at 5x5 increases the conversion of green open spaces. With a population of 2,435,252 people, at least every 3-4 people can plant a tree to achieve the optimal area of green open space based on oxygen demand in Medan City.

CONCLUSION

Based on the results and discussion obtained, it can be concluded that the results of calculations using the Gerarkis formula, the need for green open space based on oxygen demand for residents, motor vehicles and industry in Medan City is 101.74 km2 or 38% of the area. In contrast, the oxygen consumption level in Medan is 5,150,425.98 kg/day. Compared to the size of green open space and oxygen production currently available, the Medan City Government must convert at least ± 15 km2 of the area into green open space to meet current oxygen needs. Directions for the development of green open spaces in the city of Medan can be carried out in several ways, several ways of managing green spaces, synergizing the natural and artificial environment, implementing a public transportation system, empowering population policy strategies, utilizing water and energy resources, maintaining environmental health based on city planning that takes sides. On the principle of sustainable development

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