The analysis of the need and availability of green open based on the oxygen demand in Depok City, West Java, Indonesia

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Abstract. The increase of population in Depok from 2015 to 2017 is from 2,106,000 people to 2,254,513 people. The population growth will impact the increasing needs of land built. One of the ecology function of green open space is as a producer of oxygen. This study is calculates the needs for green open space based on the oxygen requirements of two variables, the need for human oxygen and motorized vehicles. Then calculate the area and distribution of green open space from the SPOT image using the NDVI algorithm. Analyze the availability of green open space requirements based on oxygen demands. The result with the increasing number of population and motorized vehicles, more green open space must be prepared in the city. Observation of green open space and distribution in Depok was carried out from 2015 – 2017, to find out the balance between the availability of green open space and the increase of population and motorized vehicles. The result of this study provide the advise for the government regarding the Minister of Public Works Regulation No. 5 of 2008 about Guidelines for the Provisions and Use of Green Open Space.

1. Introduction
The population of Depok City based on the statistics in 2015 is 2,106,000 and keep growth until 2,254,513 in 2017 [1]. The increase of population will have an impact on the built-up land such as residential areas and the apartment for housing, business buildings, such as shops and services as a manifestation of increasing human activity. The increase of built-up land will threaten the reduction of green open space in Depok.

Green open space is an important element of the city, its related to one of the main (intrinsic) functions of green open space, that contained in Minister of Public Works Regulation No. 5 of 2008 about the Guidelines for the Provision and Utilization of Green Open Space, that guaranteeing the provision of open green space as part of the air circulation system (city lungs), micro climate regulators so the air and water circulation systems can run smoothly natural, as shade, producers of oxygen, rainwaters absorbers, providers of wildlife habitats, pollutant absorbent for air, water and soil media, and windbreaker [2]. In the minister of Public Works Regulation No. 05 of 2008 about Guidelines for the Provision and Utilization of Green Open Space, provision of green open space in urban areas divided into three type, provision of Green Open Space based on area, provision of Green Open Space based on population, provision of Green Open Space based on specific function needs [2].

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2. Methods

2.1 Study Area
Geographically, Depok is located between 06°19’ – 19°28’ South and 106°43’ – 106°55’ East. Depok is one of the youngest area in West Java with an area around 200.29 km$^2$ which borders with three regencies and one province that is:
- North: Sub-district Ciputat, District Tangerang and DKI Region
- East: Sub-district Pondok Gede, Bekasi City, dan Sub-district Gunung Putri, District Bogor.
- South: Sub-district Cibinong dan sub-district Bojong Gede, District Bogor.
- West: Sub-district Parung dan Sub-district Gunung Sindur District Bogor

![Figure 1. Map of Depok City](image-url)

2.2 Materials
- Satellite Data: SPOT image, the image used in this research is SPOT Image 6 and 7 with a spatial resolution of 6 meters. The image is obtained from USGS, the image used is the image of Depok in 2015 and 2017 to process NDVI.
- Software: Idrisi Selva 17, ENVI 5.1, Ermapper 7.0 dan Arc GIS 10.3.

2.3 Data Analysis
- Geometric and Radiometric correction: Correction made by the SPOT image used in this study are ortho systematic geometric correction, where the correction value based on the results of the recording and assisted with DEM. Whereas radiometric correction is correcting error records of sunlight reflection values due to atmospheric factors, sensor damage, intensity and the direction of sunlight, topographic influences, etc.
- Vegetation Index: Used as an algorithm in the analysis of landholders vegetation. The vegetation index is an optical measurement of the greenness of the vegetation canopy, composite properties of leaf chlorophyll, leaf area, structure and cover of vegetation canopy [3]. NDVI is a vegetation index or vegetation photosynthetic activity, and one of the most frequently used vegetation indices. The NDVI vegetation index is based on the observation that different types of light waves. NDVI values range is from -1 to 1, where values of 0 are often used (assumed) as vegetated and non-vegetated pixel boundaries. Values that represent vegetation in the range 0.1 to 0.7, above this value illustrate the level of health of vegetation cover (Wahyunto et al., 2006)
• NDVI equation is:

\[ \text{NDVI} = \frac{(\text{NIR} - \text{RED})}{(\text{NIR} + \text{RED})} \]  

(1)

• Determination of green space in whole Depok Region and public green open space boundary of the vegetation index value of the SPOT data.

• Calculation of oxygen requirements for humans:
On average, human need 600 liters \( \text{O}_2 \) to breathe everyday, 1kg of \( \text{O}_2 \) is equivalent to 0.00144 liters of \( \text{O}_2 \) [2]. Oxygen needs for every human being are assumed to be the same under normal conditions, so the calculation according to Minister of Public Works Regulation No 5 of 2008 is:

• Needed for \( \text{O}_2 \) (gram/day) = total population x 864 grams/day

• Calculation of oxygen requirements for motorized vehicles carried out by vehicle type.
Oxygen requirements according to the classification of motorized vehicles [2], such as Table 1.

| Classification     | Minimal Power (PS) | Fuel Needs (kg/PS) | Oxygen requirements per liter BB (Kg) | Oxygen Needs (Kg/day) | Oxygen Needs (gram/day) |
|--------------------|--------------------|--------------------|--------------------------------------|------------------------|-------------------------|
| Motorcycle         | 1                  | 0.21               | 2.77                                 | 0.5817                 | 581.7                   |
| Passenger Vehicle  | 20                 | 0.21               | 2.77                                 | 11.634                 | 11.634                  |
| Truck              | 50                 | 0.21               | 2.77                                 | 29.085                 | 29.085                  |
| Bus                | 100                | 0.16               | 2.86                                 | 45.760                 | 45.760                  |

• Looking for oxygen demand for motorized vehicles, average daily traffic (vehicles per day) multiplied by oxygen demand (grams per day).

• Calculation of the area of green open space needed by a city based on oxygen needs [2].

\[ LT = \frac{Pt + Kt}{(54)(0.9375)(2)} \]  

(2)

\( Lt \) is the area of Green Open Space in year to \( t \) (m\(^2\))
\( Pt \) is the amount of oxygen needed for resident in year \( t \)
\( Kt \) is the amount of oxygen needed for motorized vehicles on year \( t \)
54 is a constant that shows that 1m\(^2\) of land produces 54 grams of plant dry weight per day
0.9375 is a constant that shows that 1 gram of plant dry weight is equivalent to oxygen production of 0.9375 grams
2 is the number of seasons in Indonesia

3. Results and Discussions

3.1 Image processing SPOT 2015 and SPOT 2017
The satellite image that will be processed by the vegetation index is the image of SPOT 6/7 in Depok, which has been carried out in the form of geometric correction that is related to the exact position on the earth surface, and radiometric corrections of correct reflectance values of recorded objects.
The satellite image of Depok is cut by using the public green open space bound by the DPUPR Depok City office in Figure 2. Green Open Space divided into public green open spaces and private green open spaces. Private green open space is owned by an institution or an individual that used for limited circles, among others in the form of a garden or yard / community owned / private ulding planted with plants. Whereas public open space is owned and managed by the regional city government that used for the benefit of the people.

3.2 Vegetation Index Algorithm

This study is calculating the extent of green open space that is still maintained by the presence of green plants or has decreased, or not green anymore. A region is widely monitored the number of the plants in the region, using SPOT satellite data using red bands and infrared as the method of the algorithm. The whole vegetation index process is carried out in Depok and in the public open space area. Search for the right threshold to distinguish of the vegetation object. The overall vegetation index of the depot can be seen in Figure 4, and the vegetation index of public green open space in figure 5.

Figure 2. a. SPOT image of Depok in 2015; b. SPOT image of Depok in 2017

Figure 3. a. SPOT image of public green open space in Depok in 2015, b. SPOT image of public green open space in Depok in 2017
After obtaining the threshold or get the boundaries where vegetation or not vegetation is seen from the index and into its image visually. Then the threshold is obtained for each image, then will obtained the vegetation and not the vegetation, the value for the entire city of Depok is in figure 6 and 7.

3.3 Green Open Space Depok City

Green open space is an elongated area of group, which uses more open, where plants grow, both those that plants grow naturally and deliberately planted. Green open space overgrown with plants in Depok can be seen in figure 6 for 2015 and 2017. On figure 6/7, where green open space overgrown with plants in 2015 were 7430,383 Ha, and the rest were non-vegetation covering 12,598,617 Ha. Then in 2017 for vegetated green open space areas decreased to 5,687,640 Ha, as well as non-vegetation increasing to 14,342,360 Ha seen in figure 6. Based on the government regulation, the provision of green space which is overgrown by plants is 30% of the total area, where the total area of Depok is 20,029 Ha where 30% is 6000 Ha, then in 2015 is sufficient, whereas 2017 is decreasing. For public green open spaces that the green is still survived can be seen from 2015 to 2017 that decreased by 400 Ha. The provisions of public green open space are 20% of the area is 4 Ha, then public green open space is still less than half of the provisions.

3.4 Calculating green open space based on the oxygen requirements

Determine how many green open space that city needs based on the oxygen needs, where the object observed is human oxygen and motorized vehicles. The average of human needs is 600 liters of O2 to breathe everyday. 1 kg of O2 is equivalent to 0.00144 liters of O2 (Wisesa, 1988 in Minister of Public Works Regulation No. 5 of 2008).

Figure 4. Vegetation Index Depok City in 2015, and Vegetation Index Depok City in 2017

Figure 5. Vegetation Index Depok City in 2015, and Vegetation Index Depok City in 2017
Table 2. Vegetation of Green Open Space

| Vegetation of Green Open Space | 2015     | 2017     |
|-------------------------------|----------|----------|
| Depok City                    | 7,430.383| 5,687.640|
| Public                        | 2,432.524| 2,036.091|

Figure 6. a. Open green space of Depok in 2015 and b. Open green space of Depok in 2017

Oxygen need for every human being are assumed to be the same under normal condition according to Minister of Public Works Regulation No. 5 of 2008 is: Needed of O2 (gram /day) = total population x 864 grams /day.

Table 3. Human Oxygen Needs

| Years | Total Population | Oxygen Needs (gram /day) | Total Population Oxygen Demands (gram /day) |
|-------|------------------|---------------------------|---------------------------------------------|
| 2015  | 2,106,100        | 840                       | 1,769,124,000 grams /day                      |
| 2017  | 2,254,513        | 840                       | 1,893,790,920 grams /day                      |

Table 4. Oxygen Requirements From Motorized Vehicles

| Years | Vehicle Types     | Number of Vehicles in Traffic / day | Oxygen Needs (gram /day) | Total Oxygen Needs (gram /day) |
|-------|-------------------|-------------------------------------|---------------------------|--------------------------------|
| 2015  | Motorcycle        | 542,518                             | 582                       | 315,745,476                     |
|       | Private Car       | 150,572                             | 11,634                    | 1,751,754,648                    |
|       | Passenger Transportation | 28,400                  | 45,760                    | 1,299,584,000                    |
|       | Truck             | 10,882                              | 29,760                    | 323,848,320                      |
The area of green open space that have to maintained seen from the need for oxygen, considering the function of green open space as a producer of oxygen should be an area of 5.392.65 Ha in 2015 and must be increase with the increase of population and motorized vehicles is equal to 5.534.85 Ha.

4. Conclusion
Determining the extent of green open space of a city that must be maintaining is not enough by just looking at the area, but it must be looking at the population and certain functions. Like the City of Depok, viewed from the area, the overall area of green open space, both public and private, is sufficient in 2015 which is 7.430.383 Ha. And less in 2017, based on the rule of 30% of total area, Depok should have 6 Ha. For 2015 and 2017, the vegetation of green open space is sufficient based on the oxygen demand, but if the population growth and motorized vehicles increase again, the vegetation of green open space needs to be increase again.

References
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