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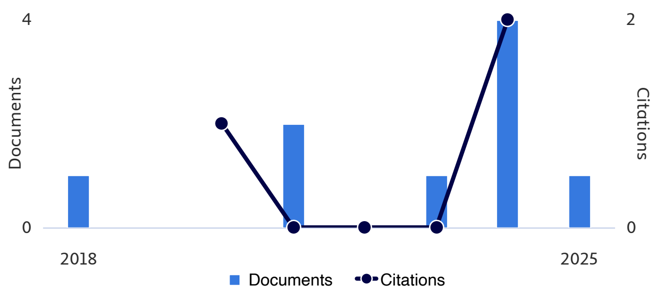


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Agricultural and Biological Sciences
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Environmental Science
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**PUBLISHER**

EM International

**H-INDEX**

# 15

**PUBLICATION TYPE**

Journals

**ISSN**

0971765X

**COVERAGE**

1997-2020

**INFORMATION**

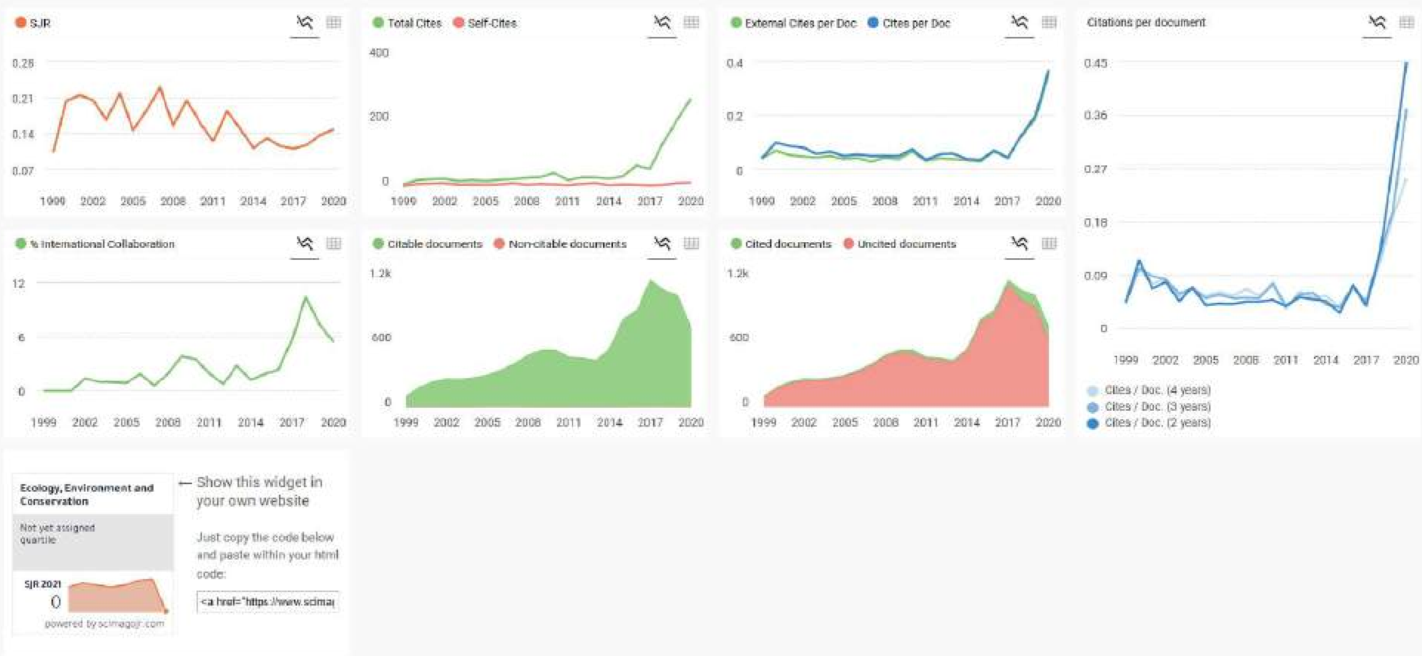
Homepage

How to publish in this journal

r_trivedy@bharatmail.co.in

**SCOPE**

Published Quarterly Since 1995. Ecology, Environment and Conservation is published in March, June, September and December every year. ECOLOGY, ENVIRONMENT AND CONSERVATION is one of the leading International environmental journal. It is widely subsribed in India and abroad by Institutions and Individuals in education and research as well as by Industries, Govt. Departments and Research Institutes.



*Eco. Env. & Cons. 27 (1) : 2021; pp. (146-151)*
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*ISSN 0971–765X*

# Identification of oxygen production and oxygen demands in parks and green paths as an environmental sustainability effort in Selong area, Jakarta, Indonesia

**Nur Intan Simangunsong[1] and Rini Fitri[2]**

***[1,2]Department of Landscape Architecture, Faculty of Landscape Architecture and Environmental Technology, Universitas Trisakti, Jalan Kyai Tapa No.1 Jakarta 11440 Indonesia***

(Received 15 June, 2020; accepted 28 July, 2020)

**ABSTRACT**

The availability of land for parks and green paths in the city of Jakarta is increasingly limited, so we need green open space that provides maximum value for the city community and surrounding communities.The purpose of this study is to identify how much oxygen is produced by the Parks and Green paths to the oxygen demand of residents and vehicles in the Selong Area. The method used in this study is an evaluative analysis method (calculating oxygen production from vegetation based on the number and type of trees; calculating the oxygen needs of residents and vehicles) and efforts to increase oxygen production. The study was conducted in 12 parks and 18 green paths in Selong area. The calculation results show that a park planted with many trees does not guarantee that more oxygen will be produced if the selection of tree species is not right. Characteristics of trees that are broad-crowned, leafy and pile more produce oxygen. This research is expected to increase government and community awareness of the importance of the existence of green open space for the sustainability of oxygen availability in urban areas and can be a reference for park development.

***Key words:*** *Oxygen needs, Oxygen production, Parks and green paths, Sustainability*

## Introduction

The lack of availability of green open space compared to build space is one of the basic problems that are common in urban area. Selong area occupies an area of 1.40 km with a population of 3,369 people (BPS, 2019). The area of green open space in the form of parks that is currently recorded is 26,463 $m^2$ and green paths 17830,653 $m^2$ (Suku Dinas Kehutanan Jakarta Selatan, 2019). The ratio of parks and green paths is 3.02% of the total area of Selong (Daroyni, 2010) asserted that the DKI Jakarta government has reserved 13.94% of its area to become a green space area as stated in the 2000-2010 Jakarta Regional Spatial Plan (RUTRW), but in 2003 DKI Jakarta's green space area was 9.12% and in 2007 it was estimated to remain 6.2% because all remaining space has been commercialized. Ideally, the area of green open space is 30% (Joga, 2011).

Urban green open spaces in the form of parks, green paths affects the improvement of microclimatic conditions in urban areas (Georgi, 2010); as producers of oxygen and absorbers of rainwater; in the long run are intangible to maintain the availability of groundwater (Peraturan Menteri Pekerjaan Umum, 2008) and water is a source of life (Arsyad,

2006); The main focus of the role of urban forests is on environmental services (Kuchelmeister, 2000; Tyrvainen, 2005; Schwab, 2009). The role of urban forests is the main focus on environmental services Park as part of the urban forest is defined as a stretch of green area with a minimum area of 0.25 ha located in urban areas with various types of trees, free-crowned, deep root system, plant spacing of canopy structure with a height above 3 meters (Subarudi, 2015). The vegetation effects outdoor microclimate in terms of thermal environment and comfort in the urban environment (Yang, 2019). Trees in cities have been shown to play a role in the formation of a microclimate, in improving air quality and reducing carbon dioxide, and in protecting the city's water supply (Akbari, 2001; Nowak, 2006); Lafortezza, 2009; Biao, 2010). Thus, the 3.02% available land is expected to be able to produce oxygen as needed to maintain environmental sustainability. Furthermore, green open spaces such as parks and green paths can function as the lungs of the city because they are oxygen producers whose function has not yet been replaced. According to Muis (2020) the role of oxygen is vital for humans because its function is so important, lack of O2 will have a serious impact on health. Humans need O2 from the air as much as 600 L/day equivalent to 864 g/day to produce energy in the body and emit 480 L of carbon dioxide ($CO_2$). The aim of this research is:

1. Calculating the oxygen needs of the population and vehicles passing
2. Calculating the oxygen productionability of city parks and green paths.

The results of the analysis of production and demand for oxygen are important for evaluating the selection of vegetation types and policies in managing parks and green paths.

## Methods

This research was conducted in 12 Parks and 18 Green paths, located in the Selong area, Kebayoran Baru, South of Jakarta. The study was conducted from March to July 2019. The research was conducted with the stages of collecting primary data and secondary data after which data analysis was carried out. Primary data is taken from the field while secondary data is taken from related agencies. The data used in this study include data on the number of residents, the number of motorized vehicles that cross the Selong area, parks, green paths, the number and types of trees used therein. The data was obtained from the Dinas Kehutanan DKI Jakarta (Forestry Service agency and the South Jakarta City Administration's Forestry Service Department, counting trees and tree species conducted in the field. After that, an analysis is carried out to get the oxygen needs of the population, motorized vehicles and oxygen production in the parks and green paths.

Oxygen is needed in human respiration as well as in the combustion process of vehicle fuel. The detailed requirements for humans and vehicles are as follows:

**a. Human Oxygen Needs**

The average human needs 600 liters of oxygen to breathe every day, 1 kg of oxygenis equivalent to 0.00144 liters of oxygen (Wisesa, 1988). Oxygen needs of every human being are assumed to be the same under normal conditions, so the calculation according to Wisesa (1988) is:
Oxygen needs (kg/day) = total population x 0.864 kg/day
Oxygen needs (tons/year) = total population x 0.3154 tons/year

**b. Vehicle oxygen demand**

The calculation is done with the assumption that in 1 kg of gasoline requires 2.77 kg of oxygen and in 1 kg of diesel requires 2.88 kg of oxygen (Muis, 2020). Thus, the calculation can be made as follows:
Gasoline mass (kg) =volume of gasoline (liters) x 0.7
Gasoline oxygen Needs (kg) = mass of gasoline x 2.77
Calculation of the number of passing vehicles is obtained from the average of vehicles passing through the morning and evening assuming the fuel consumption of each car is 0.1 L/km. In this study, it is assumed that vehicles passing by use gasoline.

**c. Oxygen Production Ability**

Oxygen production ability calculation is done by inventorying trees to find out the number and species of trees contained in the study site, without using the oxygenproduction ability of each tree species. Selected trees with criteria of stem diameter at breast height or Diameter at Breast Height (DBH); tree height; header model; and the physical condition of the tree. Calculation of oxygen production capability in trees is as follows: oxygen production ability of protective trees = number of trees x 1.2 kg/

day (Kusminingrum, 2008).

## Results and Discussion

Basically, all life activities require oxygen (O2). Of all types of consumers, those who consume a lot of O2 are humans, motor vehicles and livestock. Humans consume O2 to burn food substances in the body, while motor vehicles require O2 to burn fuel. Apart from that O2 for livestock is used for metabolism in the body.Analysis of oxygen demand of the population and vehicles can be seen in the following Table.

From Table 1. the results of the calculation of oxygen demand for human breathing in 2019 and oxygen demand for the fuel combustion process in vehicles was 13,429.94 kg/day. So, the average total daily oxygen demand in the Selong area for humans and the vehicles in 2019 was 16,340.75 kg/day. Oxygen demand will increase along with the increase in population and vehicles. Based on Table 1, oxygen demand is the most widely used for vehicle.

The need for oxygen for combustion of vehicle engines is very dependent on the type of vehicle, the type of fuel used, vehicle power and the length of time the vehicle is used. The types of motorized vehicles that are taken into account in the study of green space requirements based on oxygen fulfillment consist of: (a) Passenger vehicles, including sedans, jeeps and the like, ambulances and other small passenger cars, (b) Load Vehicles, included in this category are trucks, dump trucks, small trucks, tanker cars, tractors, tow trucks and other types of commercial vehicles, (c) Bus Vehicles, this type includes large size buses, medium size buses and other heavy passenger vehicles, and (d) Motorcycles, in the form of two-wheeled vehicles, tricycles and the like.

### O2 production capability of the parks

Basically, oxygen is a gas type which is free in the atmosphere, it can pass everywhere when no one is limiting. So that, the study assumes that Selong area is a closed environment, no O2 either coming in or out as well as produced only from green open space in research area. Green open space is an area in the earth surface looking at 2D which is covered by plants whether floor types or even height trees. The ability of trees in production can be calculated from the number of protective trees in parks and green paths. The calculation of oxygen production produced by a tree is obtained from the number of trees multiplied by the ability of a protective tree to produce oxygen which is 1.2 kg/day. Measurement of the ability to produce oxygen is carried out in 12 parks and 18 green paths in the Selong area managed by the the DKI Jakarta Forestry Service agency. The ability and number of trees to produce oxygen in the Park and Green paths in Selong Village can be seen in Table 2 and 3.

Table 2 shows the ability of oxygen production in the park which is an average of 1.01 kg/day. Trees with the highest average oxygen production found in Sriwijaya Park, which is 1.2 kg/day; are the results of 69 trees that produce 82.80 kg/day. The tree species in Sriwijaya Park are dominated by wide-crowned trees such as Mahogany, Beringin, Glodokan, and Tanjung. The tree with the lowest average oxygen production is Taman Empu Sendok which is 0.75 kg/day, resulting from 43 trees that produce 32.40 kg/day. There are small leafy and not-crowned tree species such as Coconut, Palm and

**Table 1.** Oxygen demand for population and vehicle

| No | Location (street) in Selong Area | Vehicle | | | Population in Selong Area | |
|---|---|---|---|---|---|---|
| | | Amount | The mass of gasoline (kg) | Oxygen demand (kg) | Amount | Oxygen demand(Kg) |
| 1 | Trunojoyo St | 10,586 | 741.02 | 2,052.62 | | |
| 2 | Pattimura St | 9,294 | 650.58 | 1,802.1 | | |
| 3 | Sisingamangaraja St | 23,178 | 1,622.46 | 4,494.21 | | |
| 4 | Raden Patah St | 7,265 | 508.55 | 1,408.68 | | |
| 5 | Kertanegara St | 9,527.4 | 666.91 | 1,847.36 | | |
| 6 | Gunawarman St | 6,505.8 | 455.4 | 1,261.47 | | |
| 7 | Senopati St | 2,906 | 203.42 | 563.47 | | |
| | Total | 69,262.2 | 4,848.34 | 13,429.91 | 3,369 | 2,910.81 |

*(Source:* Private. 2019)

Cambodia. Overall, the highest oxygen production was produced in Mataram Park in the amount of 151.20 kg/day while the lowest in Taman Rajasa 1 was 25.20 kg/day.

Table 3 shows that the results of the calculation of the ability of oxygen production in the green paths are on average 1,199 kg/day, greater than the production of parks. The use of Mahogany tree with a wide diameter of 5-6 meters with a height of 6-10 meters is dominant in the green paths. In quantity, the number of trees in the green paths is greater than in the parks.

Table 4, shows that there are 32 species of 714 trees in the park, only 661 trees which according to character can produce oxygen 672 kg/day. Compare this with the green paths having 7 types of trees from 4273 trees producing 5125 kg of oxygen/day. In the park, it was found that the utilization of

**Table 2.** Parks, number of protective trees and paths production capability

| No | Park | Size ($m^2$) | Number of Protective trees | O2 production (kg/day) |
|---|---|---|---|---|
| 1. | Jenggala Park | 1800 | 54 | 44.40 |
| 2. | Sanjaya 1 Park | 1900 | 71 | 78.00 |
| 3. | Sanjaya 2 Park | 2400 | 42 | 46.80 |
| 4. | Daha Park | 1213 | 30 | 34.80 |
| 5. | Sriwijaya Park | 1500 | 69 | 82.80 |
| 6 | Mataram Park | 3490 | 154 | 151.20 |
| 7 | Prudensial Park | 4089 | 80 | 91.20 |
| 8 | Cemara Park | 1635 | 34 | 36.00 |
| 9 | Mpu Sendok & Mpu Sendok Dalam Park | 1110 | 43 | 32.40 |
| 10 | Rajasa 1 Park | 700 | 28 | 25.20 |
| 11 | Rajasa 2 Park | 2846 | 56 | 49.20 |
| 12 | Gunawarman Park | 3780 | 56 | 58.80 |
| | Total | 26463 | 661 | 672.00 |

(*Source:* Private. 2019)

**Table 3.** Size, number of trees, oxygen production capability of Green path

| No | Green path Name | Size ($m^2$) | Number of Protective trees | Oxygen production (kg/day) |
|---|---|---|---|---|
| 1. | Adityawarman | 900 | 160 | 192 |
| 2. | Purnawarman | 540 | 60 | 72 |
| 3. | Pattimura | 10,653 | 1,200 | 1,440 |
| 4. | Gunawarman | 5,031 | 470 | 564 |
| 5. | Galuh | 1,600 | 240 | 288 |
| 6. | Rajasa | 700 | 20 | 24 |
| 7. | Sriwijaya | 1,875 | 470 | 564 |
| 8. | Sriwijaya I & II | 900 | 60 | 72 |
| 9. | Raden Patah | 2,309 | 490 | 588 |
| 10. | Kertanegara | 835 | 600 | 720 |
| 11. | Senopati | 2,575 | 500 | 600 |
| 12. | Gunawarman – Belitung st | 7 | - | 0 |
| 13. | Gunawarman – Erlangga st | 5 | - | 0 |
| 14. | Gunawarman – Kertanegara st | 20 | 1 | 1.2 |
| 15. | Gunawarman - Daksa IV st | 34 | - | 0 |
| 16. | Gunawarman – Senjaya st | 8 | - | 0 |
| 17. | Senopati – Suryo st | 462 | 2 | 0 |
| 18. | Senopati – Bakti st | 19 | - | 0 |
| | Total | 28,473 | 4,273 | 5,125.2 |

(*Source:* Private. 2019)

**Table 4.** Types and numbers of trees in Park and Green path

| No | Types of Trees | Parks | Green paths |
|---|---|---|---|
| 1 | Tanjung / *Mimusopselengi* | 159 | 60 |
| 2 | Pete /*Parkiaspeciosa* | 8 | |
| 3 | Glodokan /*Polyalthialongifolia* | 159 | 160 |
| 4 | Palem /*Dypsislutescens* | 27 | |
| 5 | Angsana /*Pterocarpus indicus* | 31 | 3 |
| 6 | Kelapa / *Cocos nucifera* | 12 | |
| 7 | Saputangan /*Maniltoa grandiflora* | 1 | |
| 8 | Ketapang /*Terminalia catappa* | 13 | |
| 9 | Jati / *Tectonagrandis* | 7 | |
| 10 | Kamboja/ *Plumeria alba* | 13 | |
| 11 | Tabebuya /*Tabebuia sp* | 24 | |
| 12 | Cemara / *Casuarina sumatrana* | 1 | |
| 13 | Nangka /*Arthocarpusheterophyllus* | 2 | |
| 15 | Palem kipas / *Livistonasaribus* | 22 | |
| 16 | Mahoni /*Sweteniamahogani* | 152 | 3,970 |
| 17 | Flamboyan /*Delonix regia* | 1 | |
| 18 | Sawo kecik/*Manilkarakauki* | 10 | |
| 19 | Beringin / *Ficusbenyamina* | 20 | 2 |
| 20 | Salam /Syzygiumpolyanthum | 5 | |
| 21 | Jamblang /*Syzigiumcumini* | 1 | |
| 22 | Trembesi / *Samaneasaman* | 11 | 20 |
| 23 | Sikat botol /*Callistemon viminalis* | 8 | |
| 24 | Akasia /*Acasiamangium* | 1 | |
| 25 | Kiara Payung/ *Felliciumdecipiens* | 4 | 58 |
| 26 | Mangga/ *Mangiferaindica* | 8 | |
| 27 | Dadap/ *Erythrina cristagalli* | 1 | |
| 28 | Mengkudu/ *Morindacitrifolia* | 1 | |
| 29 | Kersen / *Muntingiacalabura* | 1 | |
| 30 | Bambu / *Bambusasp* | 2 | |
| 31 | Karet / *Heveabrasiliensis* | 1 | |
| 32 | Kayu putih/*Melaleuca leucadendra* | 7 | |
| | Total | 714 | 4,273 |

(*Source:* Private. 2019)

fine and small leafy trees, while in the green paths was dominated by wide-canopy, dense leafy trees and optimal growth.

## Conclusion

The calculation results show that parks planted with many trees does not guarantee that more oxygen will be produced if the selection of tree species is not right. Characteristics of trees that are broad-crowned, leafy and pile more produce oxygen. Need to add the right trees as an optimal oxygen producer in the park. The selection of tree species that are not in accordance with the objectives and functions. The selection of fast-growing and aesthetic species is a priority regardless of the ability of trees to produce optimal oxygen. Integrated planning, management, and maintenance are needed in one agency. Further research is needed to model a development of vegetation that can optimize oxygen production.

## Acknowledgements

In this research, the author received help from various parties. Thank you to Forestry Service agency and the South Jakarta City Administration's Forestry Service Department, for the data provided; to Trisakti University, Department of Landscape Architecture for the support of research funding and Olivia's assistance in collecting data in the field.

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# NIM_Selong

*by* Nur Intan Mangunsong

**Submission date:** 10-Apr-2023 08:22AM (UTC+0700)
**Submission ID:** 2059977906
**File name:** naskah_EEC-Identification_Oxygen_Selong_Area_2.pdf (482.13K)
**Word count:** 5327
**Character count:** 27754

*Eco. Env. & Cons. 27 (1) : 2021; pp. (146-151)*
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# Identification of oxygen production and oxygen demands in parks and green paths as an environmental sustainability effort in Selong area, Jakarta, Indonesia

**Nur Intan Simangunsong[1] and Rini Fitri[2]**

***[1,2]Department of Landscape Architecture, Faculty of Landscape Architecture and Environmental Technology, Universitas Trisakti, Jalan Kyai Tapa No.1 Jakarta 11440 Indonesia***

(Received 15 June, 2020; accepted 28 July, 2020)

**ABSTRACT**

The availability of land for parks and green paths in the city of Jakarta is increasingly limited, so we need green open space that provides maximum value for the city community and surrounding communities.The purpose of this study is to identify how much oxygen is produced by the Parks and Green paths to the oxygen demand of residents and vehicles in the Selong Area. The method used in this study is an evaluative analysis method (calculating oxygen production from vegetation based on the number and type of trees; calculating the oxygen needs of residents and vehicles) and efforts to increase oxygen production. The study was conducted in 12 parks and 18 green paths in Selong area. The calculation results show that a park planted with many trees does not guarantee that more oxygen will be produced if the selection of tree species is not right. Characteristics of trees that are broad-crowned, leafy and pile more produce oxygen. This research is expected to increase government and community awareness of the importance of the existence of green open space for the sustainability of oxygen availability in urban areas and can be a reference for park development.

***Key words:*** *Oxygen needs, Oxygen production, Parks and green paths, Sustainability*

## Introduction

The lack of availability of green open space compared to build space is one of the basic problems that are common in urban area. Selong area occupies an area of 1.40 km with a population of 3,369 people (BPS, 2019). The area of green open space in the form of parks that is currently recorded is 26,463 $m^2$ and green paths 17830,653 $m^2$ (Suku Dinas Kehutanan Jakarta Selatan, 2019). The ratio of parks and green paths is 3.02% of the total area of Selong (Daroyni, 2010) asserted that the DKI Jakarta government has reserved 13.94% of its area to become a green space area as stated in the 2000-2010 Jakarta Regional Spatial Plan (RUTRW), but in 2003 DKI Jakarta's green space area was 9.12% and in 2007 it was estimated to remain 6.2% because all remaining space has been commercialized. Ideally, the area of green open space is 30% (Joga, 2011).

Urban green open spaces in the form of parks, green paths affects the improvement of microclimatic conditions in urban areas (Georgi, 2010); as producers of oxygen and absorbers of rainwater; in the long run are intangible to maintain the availability of groundwater (Peraturan Menteri Pekerjaan Umum, 2008) and water is a source of life (Arsyad,

2006); The main focus of the role of urban forests is on environmental services (Kuchelmeister, 2000; Tyrvainen, 2005; Schwab, 2009). The role of urban forests is the main focus on environmental services Park as part of the urban forest is defined as a stretch of green area with a minimum area of 0.25 ha located in urban areas with various types of trees, free-crowned, deep root system, plant spacing of canopy structure with a height above 3 meters (Subarudi, 2015). The vegetation effects outdoor microclimate in terms of thermal environment and comfort in the urban environment (Yang, 2019). Trees in cities have been shown to play a role in the formation of a microclimate, in improving air quality and reducing carbon dioxide, and in protecting the city's water supply (Akbari, 2001; Nowak, 2006); Lafortezza, 2009; Biao, 2010). Thus, the 3.02% available land is expected to be able to produce oxygen as needed to maintain environmental sustainability. Furthermore, green open spaces such as parks and green paths can function as the lungs of the city because they are oxygen producers whose function has not yet been replaced. According to Muis (2020) the role of oxygen is vital for humans because its function is so important, lack of O2 will have a serious impact on health. Humans need O2 from the air as much as 600 L/day equivalent to 864 g/day to produce energy in the body and emit 480 L of carbon dioxide ($CO_2$). The aim of this research is:

1. Calculating the oxygen needs of the population and vehicles passing
2. Calculating the oxygen productionability of city parks and green paths.

The results of the analysis of production and demand for oxygen are important for evaluating the selection of vegetation types and policies in managing parks and green paths.

## Methods

This research was conducted in 12 Parks and 18 Green paths, located in the Selong area, Kebayoran Baru, South of Jakarta. The study was conducted from March to July 2019. The research was conducted with the stages of collecting primary data and secondary data after which data analysis was carried out. Primary data is taken from the field while secondary data is taken from related agencies. The data used in this study include data on the number of residents, the number of motorized vehicles that cross the Selong area, parks, green paths, the number and types of trees used therein. The data was obtained from the Dinas Kehutanan DKI Jakarta (Forestry Service agency and the South Jakarta City Administration's Forestry Service Department, counting trees and tree species conducted in the field. After that, an analysis is carried out to get the oxygen needs of the population, motorized vehicles and oxygen production in the parks and green paths.

Oxygen is needed in human respiration as well as in the combustion process of vehicle fuel. The detailed requirements for humans and vehicles are as follows:

### a. Human Oxygen Needs

The average human needs 600 liters of oxygen to breathe every day, 1 kg of oxygenis equivalent to 0.00144 liters of oxygen (Wisesa, 1988). Oxygen needs of every human being are assumed to be the same under normal conditions, so the calculation according to Wisesa (1988) is:

Oxygen needs (kg/day) = total population x 0.864 kg/day

Oxygen needs (tons/year) = total population x 0.3154 tons/year

### b. Vehicle oxygen demand

The calculation is done with the assumption that in 1 kg of gasoline requires 2.77 kg of oxygen and in 1 kg of diesel requires 2.88 kg of oxygen (Muis, 2020). Thus, the calculation can be made as follows:

Gasoline mass (kg) =volume of gasoline (liters) x 0.7

Gasoline oxygen Needs (kg) = mass of gasoline x 2.77

Calculation of the number of passing vehicles is obtained from the average of vehicles passing through the morning and evening assuming the fuel consumption of each car is 0.1 L/km. In this study, it is assumed that vehicles passing by use gasoline.

### c. Oxygen Production Ability

Oxygen production ability calculation is done by inventorying trees to find out the number and species of trees contained in the study site, without using the oxygenproduction ability of each tree species. Selected trees with criteria of stem diameter at breast height or Diameter at Breast Height (DBH); tree height; header model; and the physical condition of the tree. Calculation of oxygen production capability in trees is as follows: oxygen production ability of protective trees = number of trees x 1.2 kg/

day (Kusminingrum, 2008).

## Results and Discussion

Basically, all life activities require oxygen (O2). Of all types of consumers, those who consume a lot of O2 are humans, motor vehicles and livestock. Humans consume O2 to burn food substances in the body, while motor vehicles require O2 to burn fuel. Apart from that O2 for livestock is used for metabolism in the body.Analysis of oxygen demand of the population and vehicles can be seen in the following Table.

From Table 1. the results of the calculation of oxygen demand for human breathing in 2019 and oxygen demand for the fuel combustion process in vehicles was 13,429.94 kg/day. So, the average total daily oxygen demand in the Selong area for humans and the vehicles in 2019 was 16,340.75 kg/day. Oxygen demand will increase along with the increase in population and vehicles. Based on Table 1, oxygen demand is the most widely used for vehicle.

The need for oxygen for combustion of vehicle engines is very dependent on the type of vehicle, the type of fuel used, vehicle power and the length of time the vehicle is used. The types of motorized vehicles that are taken into account in the study of green space requirements based on oxygen fulfillment consist of: (a) Passenger vehicles, including sedans, jeeps and the like, ambulances and other small passenger cars, (b) Load Vehicles, included in this category are trucks, dump trucks, small trucks, tanker cars, tractors, tow trucks and other types of commercial vehicles, (c) Bus Vehicles, this type includes large size buses, medium size buses and other heavy passenger vehicles, and (d) Motorcycles, in the form of two-wheeled vehicles, tricycles and the like.

### O2 production capability of the parks

Basically, oxygen is a gas type which is free in the atmosphere, it can pass everywhere when no one is limiting. So that, the study assumes that Selong area is a closed environment, no O2 either coming in or out as well as produced only from green open space in research area. Green open space is an area in the earth surface looking at 2D which is covered by plants whether floor types or even height trees. The ability of trees in production can be calculated from the number of protective trees in parks and green paths. The calculation of oxygen production produced by a tree is obtained from the number of trees multiplied by the ability of a protective tree to produce oxygen which is 1.2 kg/day. Measurement of the ability to produce oxygen is carried out in 12 parks and 18 green paths in the Selong area managed by the the DKI Jakarta Forestry Service agency. The ability and number of trees to produce oxygen in the Park and Green paths in Selong Village can be seen in Table 2 and 3.

Table 2 shows the ability of oxygen production in the park which is an average of 1.01 kg/day. Trees with the highest average oxygen production found in Sriwijaya Park, which is 1.2 kg/day; are the results of 69 trees that produce 82.80 kg/day. The tree species in Sriwijaya Park are dominated by wide-crowned trees such as Mahogany, Beringin, Glodokan, and Tanjung. The tree with the lowest average oxygen production is Taman Empu Sendok which is 0.75 kg/day, resulting from 43 trees that produce 32.40 kg/day. There are small leafy and not-crowned tree species such as Coconut, Palm and

**Table 1.** Oxygen demand for population and vehicle

| No | Location (street) in Selong Area | Vehicle | | | Population in Selong Area | |
|---|---|---|---|---|---|---|
| | | Amount | The mass of gasoline (kg) | Oxygen demand (kg) | Amount | Oxygen demand(Kg) |
| 1 | Trunojoyo St | 10,586 | 741.02 | 2,052.62 | | |
| 2 | Pattimura St | 9,294 | 650.58 | 1,802.1 | | |
| 3 | Sisingamangaraja St | 23,178 | 1,622.46 | 4,494.21 | | |
| 4 | Raden Patah St | 7,265 | 508.55 | 1,408.68 | | |
| 5 | Kertanegara St | 9,527.4 | 666.91 | 1,847.36 | | |
| 6 | Gunawarman St | 6,505.8 | 455.4 | 1,261.47 | | |
| 7 | Senopati St | 2,906 | 203.42 | 563.47 | | |
| | Total | 69,262.2 | 4,848.34 | 13,429.91 | 3,369 | 2,910.81 |

*(Source:* Private. 2019)

Cambodia. Overall, the highest oxygen production was produced in Mataram Park in the amount of 151.20 kg/day while the lowest in Taman Rajasa 1 was 25.20 kg/day.

Table 3 shows that the results of the calculation of the ability of oxygen production in the green paths are on average 1,199 kg/day, greater than the production of parks. The use of Mahogany tree with a wide diameter of 5-6 meters with a height of 6-10 meters is dominant in the green paths. In quantity, the number of trees in the green paths is greater than in the parks.

Table 4, shows that there are 32 species of 714 trees in the park, only 661 trees which according to character can produce oxygen 672 kg/day. Compare this with the green paths having 7 types of trees from 4273 trees producing 5125 kg of oxygen/day. In the park, it was found that the utilization of

**Table 2.** Parks, number of protective trees and paths production capability

| No | Park | Size ($m^2$) | Number of Protective trees | O2 production (kg/day) |
|---|---|---|---|---|
| 1. | Jenggala Park | 1800 | 54 | 44.40 |
| 2. | Sanjaya 1 Park | 1900 | 71 | 78.00 |
| 3. | Sanjaya 2 Park | 2400 | 42 | 46.80 |
| 4. | Daha Park | 1213 | 30 | 34.80 |
| 5. | Sriwijaya Park | 1500 | 69 | 82.80 |
| 6 | Mataram Park | 3490 | 154 | 151.20 |
| 7 | Prudensial Park | 4089 | 80 | 91.20 |
| 8 | Cemara Park | 1635 | 34 | 36.00 |
| 9 | Mpu Sendok & Mpu Sendok Dalam Park | 1110 | 43 | 32.40 |
| 10 | Rajasa 1 Park | 700 | 28 | 25.20 |
| 11 | Rajasa 2 Park | 2846 | 56 | 49.20 |
| 12 | Gunawarman Park | 3780 | 56 | 58.80 |
| | Total | 26463 | 661 | 672.00 |

(*Source:* Private. 2019)

**Table 3.** Size, number of trees, oxygen production capability of Green path

| No | Green path Name | Size ($m^2$) | Number of Protective trees | Oxygen production (kg/day) |
|---|---|---|---|---|
| 1. | Adityawarman | 900 | 160 | 192 |
| 2. | Purnawarman | 540 | 60 | 72 |
| 3. | Pattimura | 10,653 | 1,200 | 1,440 |
| 4. | Gunawarman | 5,031 | 470 | 564 |
| 5. | Galuh | 1,600 | 240 | 288 |
| 6. | Rajasa | 700 | 20 | 24 |
| 7. | Sriwijaya | 1,875 | 470 | 564 |
| 8. | Sriwijaya I & II | 900 | 60 | 72 |
| 9. | Raden Patah | 2,309 | 490 | 588 |
| 10. | Kertanegara | 835 | 600 | 720 |
| 11. | Senopati | 2,575 | 500 | 600 |
| 12. | Gunawarman – Belitung st | 7 | - | 0 |
| 13. | Gunawarman – Erlangga st | 5 | - | 0 |
| 14. | Gunawarman – Kertanegara st | 20 | 1 | 1.2 |
| 15. | Gunawarman - Daksa IV st | 34 | - | 0 |
| 16. | Gunawarman – Senjaya st | 8 | - | 0 |
| 17. | Senopati – Suryo st | 462 | 2 | 0 |
| 18. | Senopati – Bakti st | 19 | - | 0 |
| | Total | 28,473 | 4,273 | 5,125.2 |

(*Source:* Private. 2019)

**Table 4.** Types and numbers of trees in Park and Green path

| No | Types of Trees | Parks | Green paths |
|---|---|---|---|
| 1 | Tanjung / *Mimusopselengi* | 159 | 60 |
| 2 | Pete / *Parkiaspeciosa* | 8 | |
| 3 | Glodokan / *Polyalthialongifolia* | 159 | 160 |
| 4 | Palem / *Dypsislutescens* | 27 | |
| 5 | Angsana / *Pterocarpus indicus* | 31 | 3 |
| 6 | Kelapa / *Cocos nucifera* | 12 | |
| 7 | Saputangan / *Maniltoa grandiflora* | 1 | |
| 8 | Ketapang / *Terminalia catappa* | 13 | |
| 9 | Jati / *Tectonagrandis* | 7 | |
| 10 | Kamboja/ *Plumeria alba* | 13 | |
| 11 | Tabebuya / *Tabebuia sp* | 24 | |
| 12 | Cemara / *Casuarina sumatrana* | 1 | |
| 13 | Nangka / *Arthocarpusheterophyllus* | 2 | |
| 15 | Palem kipas / *Livistonasaribus* | 22 | |
| 16 | Mahoni / *Sweteniamahogani* | 152 | 3,970 |
| 17 | Flamboyan / *Delonix regia* | 1 | |
| 18 | Sawo kecik/ *Manilkarakauki* | 10 | |
| 19 | Beringin / *Ficusbenyamina* | 20 | 2 |
| 20 | Salam /Syzygiumpolyanthum | 5 | |
| 21 | Jamblang / *Syzigiumcumini* | 1 | |
| 22 | Trembesi / *Samaneasaman* | 11 | 20 |
| 23 | Sikat botol / *Callistemon viminalis* | 8 | |
| 24 | Akasia / *Acasiamangium* | 1 | |
| 25 | Kiara Payung/ *Felliciumdecipiens* | 4 | 58 |
| 26 | Mangga/ *Mangiferaindica* | 8 | |
| 27 | Dadap/ *Erythrina cristagalli* | 1 | |
| 28 | Mengkudu/ *Morindacitrifolia* | 1 | |
| 29 | Kersen / *Muntingiacalabura* | 1 | |
| 30 | Bambu / *Bambusasp* | 2 | |
| 31 | Karet / *Heveabrasiliensis* | 1 | |
| 32 | Kayu putih/ *Melaleuca leucadendra* | 7 | |
| | Total | 714 | 4,273 |

(*Source:* Private. 2019)

fine and small leafy trees, while in the green paths was dominated by wide-canopy, dense leafy trees and optimal growth.

## Conclusion

The calculation results show that parks planted with many trees does not guarantee that more oxygen will be produced if the selection of tree species is not right. Characteristics of trees that are broad-crowned, leafy and pile more produce oxygen. Need to add the right trees as an optimal oxygen producer in the park. The selection of tree species that are not in accordance with the objectives and functions. The selection of fast-growing and aesthetic species is a priority regardless of the ability of trees to produce optimal oxygen. Integrated planning, management, and maintenance are needed in one agency. Further research is needed to model a development of vegetation that can optimize oxygen production.

## Acknowledgements

In this research, the author received help from various parties. Thank you to Forestry Service agency and the South Jakarta City Administration's Forestry Service Department, for the data provided; to Trisakti University, Department of Landscape Architecture for the support of research funding and Olivia's assistance in collecting data in the field.

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Department of Landscape Architecture
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UNIVERSITAS TRISAKTI - Jakarta - INDONESIA
jl. Kiai Tapa no 1 Jakarta 11440 - INDONESIA
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Department of Landscape Architecture
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jl. Kiai Tapa no 1 Jakarta 11440 - INDONESIA
Fax : +62 - 21 - 5602575
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UNIVERSITAS TRISAKTI - Jakarta - INDONESIA
jl. Kiai Tapa no 1 Jakarta 11440 - INDONESIA
Fax : +62 - 21 - 5602575
Mobile : +62 - 816 - 957513
Email : nurintan@trisakti.ac.id , intansimangunsong@yahoo.com


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**EEC-34.pdf**
2543K

*Eco. Env. & Cons. 27 (1) : 2021; pp. (145-150)*
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*ISSN 0971–765X*

# Identification of oxygen production and oxygen demands in parks and green paths as an environmental sustainability effort in Selong area, Jakarta, Indonesia

**Nur Intan Simangunsong[1] and Rini Fitri[2]**

***[1,2]Department of Landscape Architecture, Faculty of Landscape Architecture and Environmental Technology, Universitas Trisakti, Jalan Kyai Tapa No.1 Jakarta 11440 Indonesia***

(Received 15 June, 2020; accepted 28 July, 2020)

**ABSTRACT**

The availability of land for parks and green paths in the city of Jakarta is increasingly limited, so we need green open space that provides maximum value for the city community and surrounding communities.The purpose of this study is to identify how much oxygen is produced by the Parks and Green paths to the oxygen demand of residents and vehicles in the Selong Area. The method used in this study is an evaluative analysis method (calculating oxygen production from vegetation based on the number and type of trees; calculating the oxygen needs of residents and vehicles) and efforts to increase oxygen production. The study was conducted in 12 parks and 18 green paths in Selong area. The calculation results show that a park planted with many trees does not guarantee that more oxygen will be produced if the selection of tree species is not right. Characteristics of trees that are broad-crowned, leafy and pile more produce oxygen. This research is expected to increase government and community awareness of the importance of the existence of green open space for the sustainability of oxygen availability in urban areas and can be a reference for park development.

***Key words:*** *Oxygen needs, Oxygen production, Parks and green paths, Sustainability*

## Introduction

The lack of availability of green open space compared to build space is one of the basic problems that are common in urban area. Selong area occupies an area of 1.40 km with a population of 3,369 people (BPS, 2019). The area of green open space in the form of parks that is currently recorded is 26,463 m$^2$ and green paths 17830,653 m$^2$ (Suku Dinas Kehutanan Jakarta Selatan, 2019). The ratio of parks and green paths is 3.02% of the total area of Selong (Daroyni, 2010) asserted that the DKI Jakarta government has reserved 13.94% of its area to become a green space area as stated in the 2000-2010 Jakarta Regional Spatial Plan (RUTRW), but in 2003 DKI Jakarta's green space area was 9.12% and in 2007 it was estimated to remain 6.2% because all remaining space has been commercialized. Ideally, the area of green open space is 30% (Joga, 2011).

Urban green open spaces in the form of parks, green paths affects the improvement of microclimatic conditions in urban areas (Georgi, 2010); as producers of oxygen and absorbers of rainwater; in the long run are intangible to maintain the availability of groundwater (Peraturan Menteri Pekerjaan Umum, 2008) and water is a source of life (Arsyad,

***Corresponding author's email:** nurintan@trisakti.ac.id

2006); The main focus of the role of urban forests is on environmental services (Kuchelmeister, 2000; Tyrvainen, 2005; Schwab, 2009). The role of urban forests is the main focus on environmental services Park as part of the urban forest is defined as a stretch of green area with a minimum area of 0.25 ha located in urban areas with various types of trees, free-crowned, deep root system, plant spacing of canopy structure with a height above 3 meters (Subarudi, 2015). The vegetation effects outdoor microclimate in terms of thermal environment and comfort in the urban environment (Yang, 2019). Trees in cities have been shown to play a role in the formation of a microclimate, in improving air quality and reducing carbon dioxide, and in protecting the city's water supply (Akbari, 2001; Nowak, 2006); Lafortezza, 2009; Biao, 2010). Thus, the 3.02% available land is expected to be able to produce oxygen as needed to maintain environmental sustainability. Furthermore, green open spaces such as parks and green paths can function as the lungs of the city because they are oxygen producers whose function has not yet been replaced. According to Muis (2020) the role of oxygen is vital for humans because its function is so important, lack of O2 will have a serious impact on health. Humans need O2 from the air as much as 600 L/day equivalent to 864 g/day to produce energy in the body and emit 480 L of carbon dioxide ($CO_2$). The aim of this research is:

1. Calculating the oxygen needs of the population and vehicles passing
2. Calculating the oxygen productionability of city parks and green paths.

The results of the analysis of production and demand for oxygen are important for evaluating the selection of vegetation types and policies in managing parks and green paths.

## Methods

This research was conducted in 12 Parks and 18 Green paths, located in the Selong area, Kebayoran Baru, South of Jakarta. The study was conducted from March to July 2019. The research was conducted with the stages of collecting primary data and secondary data after which data analysis was carried out. Primary data is taken from the field while secondary data is taken from related agencies. The data used in this study include data on the number of residents, the number of motorized vehicles that cross the Selong area, parks, green paths, the number and types of trees used therein. The data was obtained from the Dinas Kehutanan DKI Jakarta (Forestry Service agency and the South Jakarta City Administration's Forestry Service Department, counting trees and tree species conducted in the field. After that, an analysis is carried out to get the oxygen needs of the population, motorized vehicles and oxygen production in the parks and green paths.

Oxygen is needed in human respiration as well as in the combustion process of vehicle fuel. The detailed requirements for humans and vehicles are as follows:

**a. Human Oxygen Needs**

The average human needs 600 liters of oxygen to breathe every day, 1 kg of oxygenis equivalent to 0.00144 liters of oxygen (Wisesa, 1988). Oxygen needs of every human being are assumed to be the same under normal conditions, so the calculation according to Wisesa, 1988 is:

Oxygen needs (kg/day) = total population x 0.864 kg/day

Oxygen needs (tons/year) = total population x 0.3154 tons/year

**b. Vehicle oxygen demand**

The calculation is done with the assumption that in 1 kg of gasoline requires 2.77 kg of oxygen and in 1 kg of diesel requires 2.88 kg of oxygen (Muis, 2020). Thus, the calculation can be made as follows:

Gasoline mass (kg) =volume of gasoline (liters) x 0.7

Gasoline oxygen Needs (kg) = mass of gasoline x 2.77

Calculation of the number of passing vehicles is obtained from the average of vehicles passing through the morning and evening assuming the fuel consumption of each car is 0.1 L/km. In this study, it is assumed that vehicles passing by use gasoline.

**c. Oxygen Production Ability**

Oxygen production ability calculation is done by inventorying trees to find out the number and species of trees contained in the study site, without using the oxygenproduction ability of each tree species. Selected trees with criteria of stem diameter at breast height or Diameter at Breast Height (DBH); tree height; header model; and the physical condition of the tree. Calculation of oxygen production capability in trees is as follows: oxygen production ability of protective trees = number of trees x 1.2 kg/

day (Kusminingrum, 2008).

## Results and Discussion

Basically, all life activities require oxygen (O2). Of all types of consumers, those who consume a lot of O2 are humans, motor vehicles and livestock. Humans consume O2 to burn food substances in the body, while motor vehicles require O2 to burn fuel. Apart from that O2 for livestock is used for metabolism in the body.Analysis of oxygen demand of the population and vehicles can be seen in the following Table.

From Table 1. the results of the calculation of oxygen demand for human breathing in 2019 and oxygen demand for the fuel combustion process in vehicles was 13,429.94 kg/day. So, the average total daily oxygen demand in the Selong area for humans and the vehicles in 2019 was 16,340.75 kg/day. Oxygen demand will increase along with the increase in population and vehicles. Based on Table 1, oxygen demand is the most widely used for vehicle.

The need for oxygen for combustion of vehicle engines is very dependent on the type of vehicle, the type of fuel used, vehicle power and the length of time the vehicle is used. The types of motorized vehicles that are taken into account in the study of green space requirements based on oxygen fulfillment consist of: (a) Passenger vehicles, including sedans, jeeps and the like, ambulances and other small passenger cars, (b) Load Vehicles, included in this category are trucks, dump trucks, small trucks, tanker cars, tractors, tow trucks and other types of commercial vehicles, (c) Bus Vehicles, this type includes large size buses, medium size buses and other heavy passenger vehicles, and (d) Motorcycles, in the form of two-wheeled vehicles, tricycles and the like.

### O2 production capability of the parks

Basically, oxygen is a gas type which is free in the atmosphere, it can pass everywhere when no one is limiting. So that, the study assumes that Selong area is a closed environment, no O2 either coming in or out as well as produced only from green open space in research area. Green open space is an area in the earth surface looking at 2D which is covered by plants whether floor types or even height trees. The ability of trees in production can be calculated from the number of protective trees in parks and green paths. The calculation of oxygen production produced by a tree is obtained from the number of trees multiplied by the ability of a protective tree to produce oxygen which is 1.2 kg/day. Measurement of the ability to produce oxygen is carried out in 12 parks and 18 green paths in the Selong area managed by the the DKI Jakarta Forestry Service agency. The ability and number of trees to produce oxygen in the Park and Green paths in Selong Village can be seen in Table 2 and 3.

Table 2 shows the ability of oxygen production in the park which is an average of 1.01 kg/day. Trees with the highest average oxygen production found in Sriwijaya Park, which is 1.2 kg/day; are the results of 69 trees that produce 82.80 kg/day. The tree species in Sriwijaya Park are dominated by wide-crowned trees such as Mahogany, Beringin, Glodokan, and Tanjung. The tree with the lowest average oxygen production is Taman Empu Sendok which is 0.75 kg/day, resulting from 43 trees that produce 32.40 kg/day. There are small leafy and not-crowned tree species such as Coconut, Palm and

**Table 1.** Oxygen demand for population and vehicle

| No | Location (street) in Selong Area | Vehicle | | | Population in Selong Area | |
|---|---|---|---|---|---|---|
| | | Amount | The mass of gasoline (kg) | Oxygen demand (kg) | Amount | Oxygen demand(Kg) |
| 1 | Trunojoyo St | 10,586 | 741.02 | 2,052.62 | | |
| 2 | Pattimura St | 9,294 | 650.58 | 1,802.1 | | |
| 3 | Sisingamangaraja St | 23,178 | 1,622.46 | 4,494.21 | | |
| 4 | Raden Patah St | 7,265 | 508.55 | 1,408.68 | | |
| 5 | Kertanegara St | 9,527.4 | 666.91 | 1,847.36 | | |
| 6 | Gunawarman St | 6,505.8 | 455.4 | 1,261.47 | | |
| 7 | Senopati St | 2,906 | 203.42 | 563.47 | | |
| | Total | 69,262.2 | 4,848.34 | 13,429.91 | 3,369 | 2,910.81 |

*(Source:* Private. 2019)

Cambodia. Overall, the highest oxygen production was produced in Mataram Park in the amount of 151.20 kg/day while the lowest in Taman Rajasa 1 was 25.20 kg/day.

Table 3 shows that the results of the calculation of the ability of oxygen production in the green paths are on average 1,199 kg/day, greater than the production of parks. The use of Mahogany tree with a wide diameter of 5-6 meters with a height of 6-10 meters is dominant in the green paths. In quantity, the number of trees in the green paths is greater than in the parks.

Table 4, shows that there are 32 species of 714 trees in the park, only 661 trees which according to character can produce oxygen 672 kg/day. Compare this with the green paths having 7 types of trees from 4273 trees producing 5125 kg of oxygen/day. In the park, it was found that the utilization of

**Table 2.** Parks, number of protective treesand paths production capability

| No | Park | Size ($m^2$) | Number of Protective trees | O2 production (kg/day) |
|---|---|---|---|---|
| 1. | Jenggala Park | 1800 | 54 | 44.40 |
| 2. | Sanjaya 1 Park | 1900 | 71 | 78.00 |
| 3. | Sanjaya 2 Park | 2400 | 42 | 46.80 |
| 4. | Daha Park | 1213 | 30 | 34.80 |
| 5. | Sriwijaya Park | 1500 | 69 | 82.80 |
| 6 | Mataram Park | 3490 | 154 | 151.20 |
| 7 | Prudensial Park | 4089 | 80 | 91.20 |
| 8 | Cemara Park | 1635 | 34 | 36.00 |
| 9 | Mpu Sendok & Mpu Sendok Dalam Park | 1110 | 43 | 32.40 |
| 10 | Rajasa 1 Park | 700 | 28 | 25.20 |
| 11 | Rajasa 2 Park | 2846 | 56 | 49.20 |
| 12 | Gunawarman Park | 3780 | 56 | 58.80 |
| | Jumlah | 26463 | 661 | 672.00 |

(*Source:* Private. 2019)

**Table 3.** Size, number of trees, oxygen production capability of Green path

| No | Green path Name | Size ($m^2$) | Number of Protective trees | Oxygen production (kg/day) |
|---|---|---|---|---|
| 1. | Adityawarman | 900 | 160 | 192 |
| 2. | Purnawarman | 540 | 60 | 72 |
| 3. | Pattimura | 10,653 | 1,200 | 1,440 |
| 4. | Gunawarman | 5,031 | 470 | 564 |
| 5. | Galuh | 1,600 | 240 | 288 |
| 6. | Rajasa | 700 | 20 | 24 |
| 7. | Sriwijaya | 1,875 | 470 | 564 |
| 8. | Sriwijaya I & II | 900 | 60 | 72 |
| 9. | RadenPatah | 2,309 | 490 | 588 |
| 10. | Kertanegara | 835 | 600 | 720 |
| 11. | Senopati | 2,575 | 500 | 600 |
| 12. | Gunawarman – Belitung st | 7 | - | 0 |
| 13. | Gunawarman – Erlangga st | 5 | - | 0 |
| 14. | Gunawarman – Kertanegara st | 20 | 1 | 1.2 |
| 15. | Gunawarman - Daksa IV st | 34 | - | 0 |
| 16. | Gunawarman – Senjaya st | 8 | - | 0 |
| 17. | Senopati – Suryo st | 462 | 2 | 0 |
| 18. | Senopati – Bakti st | 19 | - | 0 |
| | | 28,473 | 4,273 | 5,125.2 |

(*Source:* Private. 2019)

**Table 4.** Types and numbers of trees in Park and Green path

| No | Types of Trees | Parks | Green paths |
|---|---|---|---|
| 1 | Tanjung / *Mimusopselengi* | 159 | 60 |
| 2 | Pete /*Parkiaspeciosa* | 8 | |
| 3 | Glodokan /*Polyalthialongifolia* | 159 | 160 |
| 4 | Palem /*Dypsislutescens* | 27 | |
| 5 | Angsana /*Pterocarpus indicus* | 31 | 3 |
| 6 | Kelapa / *Cocos nucifera* | 12 | |
| 7 | Saputangan /*Maniltoa grandiflora* | 1 | |
| 8 | Ketapang /*Terminalia catappa* | 13 | |
| 9 | Jati / *Tectonagrandis* | 7 | |
| 10 | Kamboja/ *Plumeria alba* | 13 | |
| 11 | Tabebuya /*Tabebuia sp* | 24 | |
| 12 | Cemara / *Casuarina sumatrana* | 1 | |
| 13 | Nangka /*Arthocarpusheterophyllus* | 2 | |
| 15 | Palem kipas / *Livistonasaribus* | 22 | |
| 16 | Mahoni /*Sweteniamahogani* | 152 | 3,970 |
| 17 | Flamboyan /*Delonix regia* | 1 | |
| 18 | Sawo kecik/*Manilkarakauki* | 10 | |
| 19 | Beringin / *Ficusbenyamina* | 20 | 2 |
| 20 | Salam /Syzygiumpolyanthum | 5 | |
| 21 | Jamblang /*Syzigiumcumini* | 1 | |
| 22 | Trembesi / *Samaneasaman* | 11 | 20 |
| 23 | Sikat botol /*Callistemon viminalis* | 8 | |
| 24 | Akasia /*Acasiamangium* | 1 | |
| 25 | Kiara Payung/ *Felliciumdecipiens* | 4 | 58 |
| 26 | Mangga/ *Mangiferaindica* | 8 | |
| 27 | Dadap/ *Erythrina cristagalli* | 1 | |
| 28 | Mengkudu/ *Morindacitrifolia* | 1 | |
| 29 | Kersen / *Muntingiacalabura* | 1 | |
| 30 | Bambu / *Bambusasp* | 2 | |
| 31 | Karet / *Heveabrasiliensis* | 1 | |
| 32 | Kayu putih/*Melaleuca leucadendra* | 7 | |
| | Total | 714 | 4,273 |

(*Source:* Private. 2019)

fine and small leafy trees, while in the green paths was dominated by wide-canopy, dense leafy trees and optimal growth.

## Conclusion

The calculation results show that parks planted with many trees does not guarantee that more oxygen will be produced if the selection of tree species is not right. Characteristics of trees that are broad-crowned, leafy and pile more produce oxygen. Need to add the right trees as an optimal oxygen producer in the park. The selection of tree species that are not in accordance with the objectives and functions. The selection of fast-growing and aesthetic species is a priority regardless of the ability of trees to produce optimal oxygen. Integrated planning, management, and maintenance are needed in one agency. Further research is needed to model a development of vegetation that can optimize oxygen production.

## Acknowledgements

In this research, the author received help from various parties. Thank you to Forestry Service agency and the South Jakarta City Administration's Forestry Service Department, for the data provided; to Trisakti University, Department of Landscape Architecture for the support of research funding and Olivia's assistance in collecting data in the field.

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Intan Mangunsong <nurintan@trisakti.ac.id>

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Nur Intan Mangunsong[1] and Rini Fitri[2]
[1,2]Department of Landscape Architecture,
Faculty of Landscape Architecture and
Environmental Technology, Trisakti University,
Jalan Kyai Tapa No.1 Jakarta 11440 Indonesia


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*Eco. Env. & Cons. 27 (1) : 2021; pp. (146-151)*
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**Nur Intan Simangunsong[1] and Rini Fitri[2]**

***[1,2]Department of Landscape Architecture, Faculty of Landscape Architecture and Environmental Technology, Universitas Trisakti, Jalan Kyai Tapa No.1 Jakarta 11440 Indonesia***

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The lack of availability of green open space compared to build space is one of the basic problems that are common in urban area. Selong area occupies an area of 1.40 km with a population of 3,369 people (BPS, 2019). The area of green open space in the form of parks that is currently recorded is 26,463 m$^2$ and green paths 17830,653 m$^2$ (Suku Dinas Kehutanan Jakarta Selatan, 2019). The ratio of parks and green paths is 3.02% of the total area of Selong (Daroyni, 2010) asserted that the DKI Jakarta government has reserved 13.94% of its area to become a green space area as stated in the 2000-2010 Jakarta Regional Spatial Plan (RUTRW), but in 2003 DKI Jakarta's green space area was 9.12% and in 2007 it was estimated to remain 6.2% because all remaining space has been commercialized. Ideally, the area of green open space is 30% (Joga, 2011).

Urban green open spaces in the form of parks, green paths affects the improvement of microclimatic conditions in urban areas (Georgi, 2010); as producers of oxygen and absorbers of rainwater; in the long run are intangible to maintain the availability of groundwater (Peraturan Menteri Pekerjaan Umum, 2008) and water is a source of life (Arsyad,

2006); The main focus of the role of urban forests is on environmental services (Kuchelmeister, 2000; Tyrvainen, 2005; Schwab, 2009). The role of urban forests is the main focus on environmental services Park as part of the urban forest is defined as a stretch of green area with a minimum area of 0.25 ha located in urban areas with various types of trees, free-crowned, deep root system, plant spacing of canopy structure with a height above 3 meters (Subarudi, 2015). The vegetation effects outdoor microclimate in terms of thermal environment and comfort in the urban environment (Yang, 2019). Trees in cities have been shown to play a role in the formation of a microclimate, in improving air quality and reducing carbon dioxide, and in protecting the city's water supply (Akbari, 2001; Nowak, 2006); Lafortezza, 2009; Biao, 2010). Thus, the 3.02% available land is expected to be able to produce oxygen as needed to maintain environmental sustainability. Furthermore, green open spaces such as parks and green paths can function as the lungs of the city because they are oxygen producers whose function has not yet been replaced. According to Muis (2020) the role of oxygen is vital for humans because its function is so important, lack of O2 will have a serious impact on health. Humans need O2 from the air as much as 600 L/day equivalent to 864 g/day to produce energy in the body and emit 480 L of carbon dioxide ($CO_2$). The aim of this research is:

1. Calculating the oxygen needs of the population and vehicles passing
2. Calculating the oxygen productionability of city parks and green paths.

The results of the analysis of production and demand for oxygen are important for evaluating the selection of vegetation types and policies in managing parks and green paths.

## Methods

This research was conducted in 12 Parks and 18 Green paths, located in the Selong area, Kebayoran Baru, South of Jakarta. The study was conducted from March to July 2019. The research was conducted with the stages of collecting primary data and secondary data after which data analysis was carried out. Primary data is taken from the field while secondary data is taken from related agencies. The data used in this study include data on the number of residents, the number of motorized vehicles that cross the Selong area, parks, green paths, the number and types of trees used therein. The data was obtained from the Dinas Kehutanan DKI Jakarta (Forestry Service agency and the South Jakarta City Administration's Forestry Service Department, counting trees and tree species conducted in the field. After that, an analysis is carried out to get the oxygen needs of the population, motorized vehicles and oxygen production in the parks and green paths.

Oxygen is needed in human respiration as well as in the combustion process of vehicle fuel. The detailed requirements for humans and vehicles are as follows:

**a. Human Oxygen Needs**

The average human needs 600 liters of oxygen to breathe every day, 1 kg of oxygenis equivalent to 0.00144 liters of oxygen (Wisesa, 1988). Oxygen needs of every human being are assumed to be the same under normal conditions, so the calculation according to Wisesa (1988) is:
Oxygen needs (kg/day) = total population x 0.864 kg/day
Oxygen needs (tons/year) = total population x 0.3154 tons/year

**b. Vehicle oxygen demand**

The calculation is done with the assumption that in 1 kg of gasoline requires 2.77 kg of oxygen and in 1 kg of diesel requires 2.88 kg of oxygen (Muis, 2020). Thus, the calculation can be made as follows:
Gasoline mass (kg) =volume of gasoline (liters) x 0.7
Gasoline oxygen Needs (kg) = mass of gasoline x 2.77
Calculation of the number of passing vehicles is obtained from the average of vehicles passing through the morning and evening assuming the fuel consumption of each car is 0.1 L/km. In this study, it is assumed that vehicles passing by use gasoline.

**c. Oxygen Production Ability**

Oxygen production ability calculation is done by inventorying trees to find out the number and species of trees contained in the study site, without using the oxygenproduction ability of each tree species. Selected trees with criteria of stem diameter at breast height or Diameter at Breast Height (DBH); tree height; header model; and the physical condition of the tree. Calculation of oxygen production capability in trees is as follows: oxygen production ability of protective trees = number of trees x 1.2 kg/

day (Kusminingrum, 2008).

## Results and Discussion

Basically, all life activities require oxygen (O2). Of all types of consumers, those who consume a lot of O2 are humans, motor vehicles and livestock. Humans consume O2 to burn food substances in the body, while motor vehicles require O2 to burn fuel. Apart from that O2 for livestock is used for metabolism in the body.Analysis of oxygen demand of the population and vehicles can be seen in the following Table.

From Table 1. the results of the calculation of oxygen demand for human breathing in 2019 and oxygen demand for the fuel combustion process in vehicles was 13,429.94 kg/day. So, the average total daily oxygen demand in the Selong area for humans and the vehicles in 2019 was 16,340.75 kg/day. Oxygen demand will increase along with the increase in population and vehicles. Based on Table 1, oxygen demand is the most widely used for vehicle.

The need for oxygen for combustion of vehicle engines is very dependent on the type of vehicle, the type of fuel used, vehicle power and the length of time the vehicle is used. The types of motorized vehicles that are taken into account in the study of green space requirements based on oxygen fulfillment consist of: (a) Passenger vehicles, including sedans, jeeps and the like, ambulances and other small passenger cars, (b) Load Vehicles, included in this category are trucks, dump trucks, small trucks, tanker cars, tractors, tow trucks and other types of commercial vehicles, (c) Bus Vehicles, this type includes large size buses, medium size buses and other heavy passenger vehicles, and (d) Motorcycles, in the form of two-wheeled vehicles, tricycles and the like.

### O2 production capability of the parks

Basically, oxygen is a gas type which is free in the atmosphere, it can pass everywhere when no one is limiting. So that, the study assumes that Selong area is a closed environment, no O2 either coming in or out as well as produced only from green open space in research area. Green open space is an area in the earth surface looking at 2D which is covered by plants whether floor types or even height trees. The ability of trees in production can be calculated from the number of protective trees in parks and green paths. The calculation of oxygen production produced by a tree is obtained from the number of trees multiplied by the ability of a protective tree to produce oxygen which is 1.2 kg/day. Measurement of the ability to produce oxygen is carried out in 12 parks and 18 green paths in the Selong area managed by the the DKI Jakarta Forestry Service agency. The ability and number of trees to produce oxygen in the Park and Green paths in Selong Village can be seen in Table 2 and 3.

Table 2 shows the ability of oxygen production in the park which is an average of 1.01 kg/day. Trees with the highest average oxygen production found in Sriwijaya Park, which is 1.2 kg/day; are the results of 69 trees that produce 82.80 kg/day. The tree species in Sriwijaya Park are dominated by wide-crowned trees such as Mahogany, Beringin, Glodokan, and Tanjung. The tree with the lowest average oxygen production is Taman Empu Sendok which is 0.75 kg/day, resulting from 43 trees that produce 32.40 kg/day. There are small leafy and not-crowned tree species such as Coconut, Palm and

**Table 1.** Oxygen demand for population and vehicle

| No | Location (street) in Selong Area | Vehicle | | | Population in Selong Area | |
|---|---|---|---|---|---|---|
| | | Amount | The mass of gasoline (kg) | Oxygen demand (kg) | Amount | Oxygen demand(Kg) |
| 1 | Trunojoyo St | 10,586 | 741.02 | 2,052.62 | | |
| 2 | Pattimura St | 9,294 | 650.58 | 1,802.1 | | |
| 3 | Sisingamangaraja St | 23,178 | 1,622.46 | 4,494.21 | | |
| 4 | Raden Patah St | 7,265 | 508.55 | 1,408.68 | | |
| 5 | Kertanegara St | 9,527.4 | 666.91 | 1,847.36 | | |
| 6 | Gunawarman St | 6,505.8 | 455.4 | 1,261.47 | | |
| 7 | Senopati St | 2,906 | 203.42 | 563.47 | | |
| | Total | 69,262.2 | 4,848.34 | 13,429.91 | 3,369 | 2,910.81 |

(*Source:* Private. 2019)

Cambodia. Overall, the highest oxygen production was produced in Mataram Park in the amount of 151.20 kg/day while the lowest in Taman Rajasa 1 was 25.20 kg/day.

Table 3 shows that the results of the calculation of the ability of oxygen production in the green paths are on average 1,199 kg/day, greater than the production of parks. The use of Mahogany tree with a wide diameter of 5-6 meters with a height of 6-10 meters is dominant in the green paths. In quantity, the number of trees in the green paths is greater than in the parks.

Table 4, shows that there are 32 species of 714 trees in the park, only 661 trees which according to character can produce oxygen 672 kg/day. Compare this with the green paths having 7 types of trees from 4273 trees producing 5125 kg of oxygen/day. In the park, it was found that the utilization of

**Table 2.** Parks, number of protective trees and paths production capability

| No | Park | Size ($m^2$) | Number of Protective trees | O2 production (kg/day) |
|---|---|---|---|---|
| 1. | Jenggala Park | 1800 | 54 | 44.40 |
| 2. | Sanjaya 1 Park | 1900 | 71 | 78.00 |
| 3. | Sanjaya 2 Park | 2400 | 42 | 46.80 |
| 4. | Daha Park | 1213 | 30 | 34.80 |
| 5. | Sriwijaya Park | 1500 | 69 | 82.80 |
| 6 | Mataram Park | 3490 | 154 | 151.20 |
| 7 | Prudensial Park | 4089 | 80 | 91.20 |
| 8 | Cemara Park | 1635 | 34 | 36.00 |
| 9 | Mpu Sendok & Mpu Sendok Dalam Park | 1110 | 43 | 32.40 |
| 10 | Rajasa 1 Park | 700 | 28 | 25.20 |
| 11 | Rajasa 2 Park | 2846 | 56 | 49.20 |
| 12 | Gunawarman Park | 3780 | 56 | 58.80 |
| | Total | 26463 | 661 | 672.00 |

(*Source:* Private. 2019)

**Table 3.** Size, number of trees, oxygen production capability of Green path

| No | Green path Name | Size ($m^2$) | Number of Protective trees | Oxygen production (kg/day) |
|---|---|---|---|---|
| 1. | Adityawarman | 900 | 160 | 192 |
| 2. | Purnawarman | 540 | 60 | 72 |
| 3. | Pattimura | 10,653 | 1,200 | 1,440 |
| 4. | Gunawarman | 5,031 | 470 | 564 |
| 5. | Galuh | 1,600 | 240 | 288 |
| 6. | Rajasa | 700 | 20 | 24 |
| 7. | Sriwijaya | 1,875 | 470 | 564 |
| 8. | Sriwijaya I & II | 900 | 60 | 72 |
| 9. | Raden Patah | 2,309 | 490 | 588 |
| 10. | Kertanegara | 835 | 600 | 720 |
| 11. | Senopati | 2,575 | 500 | 600 |
| 12. | Gunawarman – Belitung st | 7 | - | 0 |
| 13. | Gunawarman – Erlangga st | 5 | - | 0 |
| 14. | Gunawarman – Kertanegara st | 20 | 1 | 1.2 |
| 15. | Gunawarman - Daksa IV st | 34 | - | 0 |
| 16. | Gunawarman – Senjaya st | 8 | - | 0 |
| 17. | Senopati – Suryo st | 462 | 2 | 0 |
| 18. | Senopati – Bakti st | 19 | - | 0 |
| | Total | 28,473 | 4,273 | 5,125.2 |

(*Source:* Private. 2019)

**Table 4.** Types and numbers of trees in Park and Green path

| No | Types of Trees | Parks | Green paths |
|---|---|---|---|
| 1 | Tanjung / *Mimusopselengi* | 159 | 60 |
| 2 | Pete /*Parkiaspeciosa* | 8 | |
| 3 | Glodokan /*Polyalthialongifolia* | 159 | 160 |
| 4 | Palem /*Dypsislutescens* | 27 | |
| 5 | Angsana /*Pterocarpus indicus* | 31 | 3 |
| 6 | Kelapa / *Cocos nucifera* | 12 | |
| 7 | Saputangan /*Maniltoa grandiflora* | 1 | |
| 8 | Ketapang /*Terminalia catappa* | 13 | |
| 9 | Jati / *Tectonagrandis* | 7 | |
| 10 | Kamboja/ *Plumeria alba* | 13 | |
| 11 | Tabebuya /*Tabebuia sp* | 24 | |
| 12 | Cemara / *Casuarina sumatrana* | 1 | |
| 13 | Nangka /*Arthocarpusheterophyllus* | 2 | |
| 15 | Palem kipas / *Livistonasaribus* | 22 | |
| 16 | Mahoni /*Sweteniamahogani* | 152 | 3,970 |
| 17 | Flamboyan /*Delonix regia* | 1 | |
| 18 | Sawo kecik/*Manilkarakauki* | 10 | |
| 19 | Beringin / *Ficusbenyamina* | 20 | 2 |
| 20 | Salam /Syzygiumpolyanthum | 5 | |
| 21 | Jamblang /*Syzigiumcumini* | 1 | |
| 22 | Trembesi / *Samaneasaman* | 11 | 20 |
| 23 | Sikat botol /*Callistemon viminalis* | 8 | |
| 24 | Akasia /*Acasiamangium* | 1 | |
| 25 | Kiara Payung/ *Felliciumdecipiens* | 4 | 58 |
| 26 | Mangga/ *Mangiferaindica* | 8 | |
| 27 | Dadap/ *Erythrina cristagalli* | 1 | |
| 28 | Mengkudu/ *Morindacitrifolia* | 1 | |
| 29 | Kersen / *Muntingiacalabura* | 1 | |
| 30 | Bambu / *Bambusasp* | 2 | |
| 31 | Karet / *Heveabrasiliensis* | 1 | |
| 32 | Kayu putih/*Melaleuca leucadendra* | 7 | |
| | Total | 714 | 4,273 |

(*Source:* Private. 2019)

fine and small leafy trees, while in the green paths was dominated by wide-canopy, dense leafy trees and optimal growth.

## Conclusion

The calculation results show that parks planted with many trees does not guarantee that more oxygen will be produced if the selection of tree species is not right. Characteristics of trees that are broad-crowned, leafy and pile more produce oxygen. Need to add the right trees as an optimal oxygen producer in the park. The selection of tree species that are not in accordance with the objectives and functions. The selection of fast-growing and aesthetic species is a priority regardless of the ability of trees to produce optimal oxygen. Integrated planning, management, and maintenance are needed in one agency. Further research is needed to model a development of vegetation that can optimize oxygen production.

## Acknowledgements

In this research, the author received help from various parties. Thank you to Forestry Service agency and the South Jakarta City Administration's Forestry Service Department, for the data provided; to Trisakti University, Department of Landscape Architecture for the support of research funding and Olivia's assistance in collecting data in the field.

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