Green open space masterplan at Jakarta Capital City, Indonesia for climate change mitigation

R Setiowati, H S Hasibuan and R H Koestoer
School of Environmental Science, University of Indonesia, Jl. Salemba Raya, Kenari, Senen, Jakarta, 10430, Indonesia

Corresponding author: hayati.hasibuan@ui.ac.id

Abstract. The number of Green Open Space (GOS) in Jakarta has been decreased by 23% from 1983 to 2013. Currently, the area is only about 4.65% (3,080.89 ha) and still far from the public GOS target based on Act No. 26 the Year 2007 which targeted at least 20% of the Province area. The planning of green zone in Jakarta Spatial Planning 2020 is only about 11.7% (7,749.36 ha) of the total area. Based on the Local Regulation No. 1 the Year 2008 on Jakarta Mid Term Development Planning 2007-2012, Jakarta Capital City Government (JCCG) should create GOS Masterplan as a development guide of GOS to the future. The government has not completed the master plan yet. The government committed by lowering down the emission by 30% in 2030. The study aims to analyze the need for GOS Masterplan in Jakarta to increase both GOS’s quality and quantity. The objective of this study is to investigate the planning document of GOS Masterplan. The method used by reviewing the GOS Masterplan according to Jakarta Spatial Planning 2030 in order to support Local Action Plan for Greenhouse Gas Emission Reduction at 2030 for climate mitigation.

1. Introduction
Urban expansion has increased in recent decades as a result of development. The consequences of urban built-up areas development cause decreasing of GOS. The diminishing urban green space due to urbanization has a negative impact on ecosystem services, psychological well-being, and urban health [1]. The topic of GOS has recently become important because as population numbers increase, the amount of GOS available is also reducing. Over the past two decades, many studies have focused on understanding the impact of urban green space on heating in urban environments.

The GOS is a green area built to provide benefits that are critical to health and well-being throughout life and contribute to the sustainability of an area [2]. Urban GOS has become a major element of a city's transformation into a more natural environment [3]. Urban GOS has a social and psychological function for the inhabitants of the city as well as being key to the sustainability of a city [4]. The experience of being in a natural urban environment can provide positive and beneficial feelings in meeting human needs in a non-material way [4]. One important element of the urban landscape is the presence of open spaces such as fields, parks, main roads, and other land uses that make it visually possible to overcome urban problems [5]. The existence of small parks scattered in the urban area is important to form space and habitat [6]. Urban GOS distribution becomes an important element in a city to form an urban green network.
As a result of rapid development and population growth, the presence of GOS is decreasing in Jakarta. By 1983 to 2013, GOS in Jakarta decreased 23%, from 259.884 km\(^2\) (40%) became the only remaining 110.450 km\(^2\) (17\%) [7].

The study aims to analyze the importance of GOS Masterplan in Jakarta both for the GOS’s quality and quantity which generated urban climate change. The objective of this study is to investigate the planning document such as GOS Masterplan, which could anticipate climate change problem and become the main issue of urban development.

2. Literature review
Some studies have done on the GOS issues affecting of land use changes in urban areas. The simulation model of 2030 resulted that the smallest area of green space being in Jakarta compared to Metro Manila and Kuala Lumpur. However, compared to Masterplan 2030, GOS is predicted to increase in Jakarta and Metro Manila when compared to Kuala Lumpur [1]. So, the study of land cover change is very useful in projecting rapidly expanding urban planning.

In the aspect of GOS for urban heat island mitigation, the study resulted in the determination effect of GOS on Urban Heat Island (UHI) mitigation in every season of the year (4 seasons) [8]. Using the landscape approach, it observed about the effect of different types of GOS on UHI also. This study explains the problem of UHI's rise in urban areas. In addition, urban GOS has a significant cooling effect among all seasons except winter, but the effect varies greatly between different seasons and GOS types.

Meanwhile, UHI has a function to increase the green areas flourish throughout Jakarta and prioritize the development of GOS in areas with high surface temperature (> 30\(^\circ\)C) [9]. In addition, the construction of GOS adapted to the conditions and availability of existing land, controlling the rise of land construction and tall buildings along the coast, as well as focusing on settlement and business areas vertically. The surface temperature in Jakarta area tends to increase rapidly by showing UHI phenomenon [10]. The characteristics of UHI in Jakarta indicated by high surface temperature (> 34\(^\circ\)C) in downtown, then down towards sub-urban either north, south, west, or east.

The increasing development in Jakarta causes changes in land cover including lowering the amount of GOS [11]. From 2002-2012, built up area in Jakarta increase from 39,026.45 ha to 46,404.76 ha (69\% of the total area of Jakarta). Those changes resulted in a decrease in green land cover in Jakarta from 21,769.26 ha (32.79\%) to 10,939.56 ha (16.48\%). At the same period, the observation conducted by [12] found that the area of GOS in Jakarta in 2013 by 14.94\%, with 53.49\% of them in the form of standing trees and green part that shown in the east and south of Jakarta.

3. Research methodology

3.1. Study area
The total area of Jakarta is 7,659.02 km\(^2\), consisting of a land area of 661.52 km\(^2\), including 110 islands in Kepulauan Seribu, and an ocean of 6,997.50 km\(^2\). In the Jakarta northern boundary stretches a 32 km long coast which houses of 13 rivers, 2 canals, and 2 floods canal. Jakarta consists of lowland with an average height of 7 meters above sea level, and most of the characteristics are below the sea level. This condition caused some areas in Jakarta to be vulnerable to puddle, either due to high rainfall or rob. Furthermore, in Figure 1 can be seen that the western boundary of Jakarta Province is Banten Province, while in the south and east bordering the area of West Java Province.
3.2. Method
The method used spatial analysis by Geographical Information System, and by reviewing the GOS Masterplan according to Jakarta Mid Term Development Planning and Jakarta Spatial Planning 2030 in order to support Local Action Plan for Greenhouse Gases (GHG) Emission Reduction at 2030.

4. Result and discussions

4.1. GOS in Jakarta
Jakarta does not yet have a definite data related to the amount of GOS that is owned and managed. There are differences data in the size of GOS owned and managed by several regional apparatus organizations in Jakarta. Data from the Forestry Agency in 2018 states that the extent of GOS in Jakarta until the first semester of 2017 is only 4.65%. This is different from the data held by the Environment Agency in 2017 which states that the achievement of GOS in Jakarta in 2015 amounted to 11.97%. In 2017, Spatial Planning and Environmental Bureau also calculate the achievement of GOS is only 7.67%. This difference is the problem of determining the baseline of GOS in Jakarta today. Each of the regional apparatus organizations in Jakarta has different calculation methods. GOS Public baseline achievement in Jakarta required for future targeting. Public GOS data at the Forestry Agency can be seen in Table 1.
Table 1. Green public open space managed by Forestry Agency

| No. | Type            | Area (m²)     | Percentage (%) |
|-----|-----------------|---------------|----------------|
| 1.  | Park            | 14,088,903.00 | 2.13           |
| 2.  | Green line      | 7,864,106.60  | 1.19           |
| 3.  | Cemetery        | 6,313,315.00  | 0.95           |
| 4.  | City Forest     | 2,542,600.00  | 0.38           |
|     | **Amount**      | **30,808,924.60** | **4.65**        |

Source: Forestry Agency (2017) [13]

If using public GOS data that owned and managed by the Forestry Agency then Jakarta ranks lowest when compared to other big cities in Indonesia and big cities abroad. The realization of the GOS public is still far from the target of 20% by 2030. Comparison of the wide of existing GOS between Jakarta and major cities in Indonesia such as Bandung, Semarang, Yogyakarta, Surabaya, Medan, Denpasar, and Makassar, can be seen in Table 2.

Table 2. The amount of Green Open Space in Indonesia

| No. | City     | Area (Ha) | Percentage (%) | Year | Source                                      |
|-----|----------|-----------|----------------|------|---------------------------------------------|
| 1.  | Jakarta  | 3,080.89  | 4.65           | 2017 | Data Forestry Agency JCCG                  |
| 2.  | Bandung  | 2,027.63  | 12.12          | 2013 | RPJMD 2013-2018 City of Bandung            |
| 3.  | Semarang | 16,166.26 | 43.26          | 2015 | RPJMD 2016-2021 City of Semarang           |
| 4.  | Yogyakarta| 1,067.95  | 32.86          | 2011 | RPJMD 2012 -2016 City of Yogyakarta        |
| 5.  | Surabaya | 7,225.29  | 21.60          | 2016 | Data Sanitary and GOS Agency City of Surabaya|
| 6.  | Medan    | 1,325.50  | 5.00           | 2011 | RPJMD 2011 – 2015 City of Medan            |
| 7.  | Denpasar | 4,636.09  | 36.28          | 2014 | RPJMD 2016-2021 City of Denpasar           |
| 8.  | Makassar | 1,460.65  | 8.31           | 2016 | Data BLHD City of Makassar                 |

Source: Researcher (2018)

While the comparison of GOS in Jakarta with major cities such as Singapore, Kuala Lumpur, Seoul, Vienna, Hongkong, Tokyo, London and New York can be seen in Table 3.
Table 3. The amount of Green Open Space in the World

| No. | City          | Area (Ha) | Percentage (%) | Year   | Source                                                                 |
|-----|---------------|-----------|----------------|--------|-------------------------------------------------------------------------|
| 1.  | Jakarta       | 3,080.89  | 4.65           | 2017   | Jakarta Forestry Agency, JCCG                                           |
| 2.  | Singapura     | 33,835.30 | 47.00          | 2007   | CUGE, National Parks Board                                              |
| 3.  | Kuala Lumpur  | 7,367.76  | 23.80          | 2000   | CHKL, Kuala Lumpur Structure Plan 2020                                  |
| 4.  | Seoul         | 16,098.32 | 26.6           | 2015   | Seoul Metropolitan Government                                           |
| 5.  | Vienna        | 18,864.30 | 45.5           | 2014   | Vienna Annual Statistic                                                 |
| 6.  | Tokyo         | 16,410.00 | 7.5            | 2015   | Bureau of Urban Development Tokyo Metropolitan Government Greenspace Information for Greater London CIC |
| 7.  | London        | 51,876.00 | 33             | 2013   | Greenspace Information for Greater London CIC                           |
| 8.  | New York      | 21,303.00 | 27             | 2010   | Department of City Planning Land Use                                   |
| 9.  | Hongkong      | 110,160.00| 40             | 2015   | Agriculture, Fisheries, and Conservation Department                     |

Source: Researcher (2018)

Table 3 indicated that Singapore ranks first in terms of the area of GOS when compared to major cities in the world such as Jakarta, Kuala Lumpur, Seoul, Vienna, Hongkong, Tokyo, London, and New York. Currently, Singapore is known as a city with the term "Singapore as a Garden City" because of the proportion of its GOS achievements in 2007 is 47% of its territory [12].

4.2. Green open space plan based on spatial plan Jakarta 2030

Jakarta has a green plan including public and private GOS, as set forth in Regional Regulation No. 1 of 2012. The percentage of green plan amount is only 11.7% (7,749.36 ha). Referring to Chapter V Direction in Regional Regulation No. 1 of 2008 on the Medium Term Regional Medium-Term Plan (RPJMD) for 2007-2012, JCCG is directed to develop Master Plan of GOS. In addition to those directives, referring to Article 79 of Regional Regulation 1 of 2012, JCCG is also required to make governor regulation on GOS and its development. The green plan in Jakarta can be seen in Figure 2.

Although the preparation of GOS Master Plan has been mandated according to the regulation until now JCCG does not have GOS Master Plan about GOS development. Based on Law Number 26 the year 2007 on Spatial Planning, the provision of GOS based on urban area is at least 30% consisting of 20% GOS Public and 10% GOS Private. JCCG is also targeting the same amount of GOS equal to Law Number 26 the year 2007 as set forth in Part Two of Spatial Planning Article 6 paragraph (5) letter b of Regional Regulation 1 the year 2012 on Spatial Planning Jakarta 2030. Although the target of GOS Public in Jakarta is 20%, the green plan zonation stipulated in Regional Regulation 1 the year 2012 is only 11.7% (7,749.36 ha).
4.3. Green open space for climate change mitigation

Urbanization and climate change coupled with contemporary global processes that interact on the earth surface with feedback effects on each other and are predicted to escalate with time. Multiple alternatives exist that can address climate change and its effects in cities. The choice of a solution depends on the political, social, economic conditions and resources available to design and implement an intervention. Urban GOS constitute a low-cost local strategy that can easily be adopted and practiced in most human settlements at a limited scale and with limited institutional support [15]. But in Jakarta, the progress of urban GOS area still below the expectation, both the amount of space area and the distribution. As a result, the function of GOS to enhance the climate change mitigation in Jakarta, still far under the capacity.

Based on Presidential Regulation No. 71 of 2011, the Local Government is mandated to conduct an inventory of GHG. JCCG is committed to reducing emissions by 30% in 2030 and stated in the Governor Regulation Number 131 of 2012. Jakarta Regional Action Plan - GHG was using base year in 2005. The projections show that without mitigation, GHG emissions in Jakarta by 2030 reach 116 million tons of CO2e per year. Based on this, the amount of emission reduction that must be done to fulfill the 30% commitment is 35 million tons of CO2e. Reporting of activities related to GHG emissions have been carried out by JCCG from 2006 to 2015.

The AFOLU sector in Jakarta categorized as forest (mangrove area, built GOS) and other uses. Mitigation actions in the AFOLU sector in 2016-2017 include data collection of the changes on GOS which affected by fly-over projects and construction of roads, drainage channels, construction of Child-Friendly Park Public Space, and land acquisition. Approximately 2,600 trees were affected by the project causing a decrease of 70.0 Gg of carbon absorbed. Recapitulation of carbon capture mitigation actions in the GOS from 2012 to 2016 in Jakarta can be seen in Table 4.
Table 4. Carbon capture mitigation actions in the green space sector from 2012 to 2016

| Mitigation Action       | Reporting (ton CO2e) | Monitoring | Evaluation | Mitigation Action (ton CO2e) |
|-------------------------|----------------------|------------|------------|-----------------------------|
|                         | 2012     | 2013      | 2014       | 2015        | 2016         |
| Green Open Space        | 8.456    | 1.494     | 653.05     | 741.3       | 671.34       |

Source: Environmental Agency (2017) [16]

JCCG through Forestry Agency has acquired land to increase GOS development. Recapitulation of land acquisition carried out by the Forestry Agency from 2012 to 2017 which is 50 Ha per year. The land acquisition targets was only achieved in 2015, while it was not for the other years. Total land acquisition target GOS in 2012 - 2017 is 3,000,000 m$^2$ (300 ha), but the achievement was only 1,115,306 m$^2$ (111.53 ha) or 37.18% of the target (see the Figure 3).

Figure 3. Land acquisition for Green Open Space by Forestry Agency year 2012-2017

Source: Spatial Planning and Environmental Bureau (2018) [17]

5. Conclusion

With the number of green public open space in Jakarta is less than 20%, Jakarta Province still has a lack of capacity in overcoming the effect of UHI and in dealing with climate change mitigation. The absence of GOS Master Plan causes JCCG not to have guidance and long-term plan that is applicable and measurable in achieving 30% GOS target by 2030. The target of green public open space in Jakarta is 20%, but the green plan zonation stipulated in Regional Regulation 1 the year 2012 is only 11.7% (7,749.36 Ha).

Acknowledgment

Funding for this study was provided by the grant of the Final Task Academic Writing issued by Directorate of Research and Public Services, Universitas Indonesia.

References

[1] Nor A M N, Corstanje R, Harris J A and Brewer T 2017 Ecological Indicators 81 274-284
[2] Villanueva K, Badland H, Hooper P, Kooohsari M J, Mavoa S, Davern M, Roberts R, Goldfeld S and Giles-Corti B 2015 Applied Geography 57 112-119
[3] Chiang K and Tan A 2009 Vertical Greenery for The Tropic (Singapore: Npark)
[4] Chiesura A 2004 Landscape and Urban Planning 68 129–138
[5] Enger E D and Bradley S 2010 Environmental Science Twelfth Edition (Washington:
Washington University)
[6] Cunningham W P and Cunningham M A 2008 Environmental Science A Global Concern Tenth Edition (New York: Mc Graw Hill Higher Edition)
[7] Budiman A, Sulistyantara B and Zain A F M 2014 Jurnal Lanskap Indonesia 6 7-15
[8] Yang C, He X, Wang R, Yan F, Yu L, Bu K, Yang J, Chang L and Zhang S 2017 Forest 8 153
[9] Rushayati S B, Prasetyo L B, Puspaningsih N and Rachmawati E 2016 Procedia Environmental Sciences 33 221–229
[10] Rushayati S B and Hermawan R 2013 Media Konservasi 18 96 – 100
[11] Septa A F 2015 Analisis ketersediaan ruang terbuka hijau (RTH) Kota Jakarta dengan menggunakan remote sensing (RS) dan geography information system (GIS) Thesis (Bogor: Institut Pertanian Bogor)
[12] Nurbaya A 2015 Distribusi Tipologi Kepemilikan RTH DKI Jakarta Menggunakan Teknik Remote Sensing Citra Satelit Resolusi Tinggi Thesis (Bogor: Institut Pertanian Bogor)
[13] Forestry Agency 2017 Presentation to the Governor regarding data on management of green open space for by Jakarta Forestry Agency (Jakarta: Jakarta Capital City Government)
[14] Regional Regulation No. 1 of 2012 about Jakarta Spatial Plan 2030
[15] Nero B F, Callo-Concha D, Anning A and Denich M 2017 Procedia Engineering 198 69 – 83
[16] Environmental Agency 2017 Final report on activity on controlling climate change impacts in Jakarta (Jakarta: Jakarta Capital City Government)
[17] Spatial Planning and Environmental Bureau 2018 Quarterly report on monitoring the implementation of the development of a green open space system (Jakarta: Jakarta Capital City Government)