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Land Procurement for Green Open Spaces in South Jakarta Using GIS-based Multiple Criteria Analysis

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Abstract

The Province of Special Capital Region of Jakarta (DKI Jakarta) with an area of 662 sq km has become a living space for 10 million people. In 2035 the population is projected to be 11, 459 million people. Development in Jakarta is massive and rapid with high developed land, so that the conversion of Green Open Spaces to become non-green area could not be avoided. This problem gives rise to the awareness of the importance of environmental balance in the city's development, which is manifested in the development of Green Open Spaces. The issue is how to find additional land for the green spaces of the Capital City. This research examines the situation in South Jakarta, where the whole existing Green Open Spaces has only reached 4,95% of the targeted 30% of the total area of South Jakarta. Data was gathered from physical and administrative mapping which was further analysed using the Geographic Information System (GIS)-based Multi Criteria Analysis (Land Suitability parameters for the Development of Green Open Spaces), and several spatial and non-spatial aspects including access to water resources, population density, building density, inundation events, land carrying capacity, and ideal temperature and humidity. From the results of the analysis a classification was formulated based on urgency whereby 9,43 ha was found to be very important, 235 ha important, and 321,33 ha quite important. This clustering model provides priority information in the land procurement of Green Open Spaces, so that Green City can be implemented in South Jakarta.

Keywords: land procurement; green open spaces; green city; Geographic Information System

Introduction

As a metropolitan area, development in Jakarta is massive and rapid. Province of DKI Jakarta with an area of 662 km2 has become a living spaces for 10 million people, even in 2035 the population in DKI Jakarta is projected to be 11, 459 million people (Central Bureau of Statistics, 2018). The function of Jakarta as the capital city, with the functions

of government and economy encourages the incessant development of building and also residences. The conversion of Green Open Spaces to become non-green area couldn't be avoided.

The urban development basically will increasingly change. The development dynamics that occur very quickly and rapidly require the government to take anticipation action of the ongoing changes and the impacts that will follow. Industrial activities, trade and services, government service centers, social services, economic activities and settlements are in urban area as the human activity center. Development in this region tends to be directed at physical development which is identical to the provision of facilities and infrastructure for various human activities. So that the conversion from green open spaces becomes non green spaces couldn't be avoided. Therefore the government needs to in procure land for green open spaces (Setiowati *et al.,* 2019). Green Open Spaces (GOS) plays an important role in sustainable city development and city ecology that is able to provide economic, social, and environmental benefits (Chiesura, 2004; Zhou dan Wang, 2011 in Yuhong *et al*., 2014). Green Open Spaces also plays an important role in regulating urban ecosystems and guard against climate change with the existence of plants that naturally reduce the evaporation of water temperatures in urban environments (Oleson, K. W *et al*., 2010).

Based on Law of the Republic of Indonesia No. 26 of 2007 about Spatial Planning, plans for provision and and utilization of green spaces become one of the contents in the city urban spatial planning which consist of public green open spaces with the proportion of 30% of the total area of the city and private green open spaces with the proportion of 10% of the total area od the city. (Mardiaman dan Mubarok A, 2017) in their research said that to fulfill the 30% needs of green open spaces needed commitment of the government by making Children-Friendly Integrated Public Spaces (RPTRA) as an effort to support Jakarta to be green and a city that is profitable for children. RPTRA itself is an asset of the Local government, the spaces that is used for serving or activities of citizens in socializing and managing air temperature in the city. During 2001-2014, from the satellite images analysis showed that trees in Jakarta increased by 5,1% while the built area increased by around 13%. This causes the surface temperatures to increase by around 2-4°C, while the air temperatures increase by around 2-3°C during 2001-2014 (Ramdhoni S *et al.* 2015). Determine GOS in urban area is not only from the temperature level, but can also use the type of land cover, vegetation density (NDVI) which combined with densely populated populations and and land price (Humaida N *et al.* 2015). From the calculations of GOS using NDVI, it was obtained that in 2007 DKI Jakarta had GOS reaching 29% but in 2013 had only 9% remained of the total area (Febrianti Nur dan Sofan P, 2014). The most influential factor on green open spaces is the building pressure in the planning area of green open spaces, which can help the government in properly planning green open space which can then be implemented effectively (Garcia-garcia M, *et al.* 2020).

The Green planning in South Jakarta as stipulated in the Detail Spatial Planning (Rencana Detail Tata Ruang, RDTR) of DKI Jakarta, includes 6 green sub-zones, urban parks sub-zones (H.2), cemetery sub-zones (H.3), green lane sub-zones (H.4), high voltage green sub-zones (H.5), railroad safety green sub-zones (H.6) and recreational green sub-zones (H.7). Those sub-zones plan is distributed throughout the administrative area of South Jakarta with a total number of 3.276 area and total area of the green plan reaches ± 14.374.189,65 m^2 or ± 1.437 Ha. In fact, the plan doesn't match the reality on the ground. Green areas, one by one, began to turn into residential and economic support functions. Its role as a guardian for water quality, oxygen supplier,

and biodiversity protection seems to be less important than economic value of land use change. Disasters are inevitable, social and recreation spaces is limited, concrete forests become the substitutes.

The lost of Green Open Space (GOS) from the face of the city is a disaster. Cities are starting to be overloaded, more crowded and congested, limited land, water shortage, the threat of flooding and poor air quality. Normally a disaster, people will look for something valueable, realized to find for land and provide back green spaces in the Capital. This study uses GIS-Based MultI Criteria Analysis which is a powerful system for refinement in the use of non-spatial and spatial data in producing useful information to make significant results. This aims to encourage the achiement of land procurement for Green Open Space is by compile a general plan of land procurement in the form of a study that examines land priorities for land procurement for Green Open Spaces in the Province of DKI Jakarta.

Data and Methods

Methods used in the implementation of the preparation of land documents review activities for land procrement plan for green open spaces in South Jakarta through the study of secondary data and data analysis both quantitatively and qualitatively. Then the both spatial and non-spatial data are analyzed using ArcGIS with system of GIS-Based Multi Criteria Analysis.

Data Collection and Study

Data collected is in the form of secondary data derived from literature and goverment agencies of Province DKI Jakarta, related to regulations and policies as well as physical and non-physical conditions from the planning area of Green Open Spaces of DKI Jakarta. Secondary data related to GOS policy includes Law of the Republic of Indonesia Number 26 of 2007 concerning Spatial Planning, Regulation of The Minister of Public Works Number 5/PRT/M/2008 concerning Guidelines for Provision of Utilization of Green Open Space in Urban Area, Masterplan of Green Open Space of DKI Jakarta 2018-2038 and Regional Regulation Number 1 of 2014 concerning the Detailed Spatial Planning and the Zoning Regulation of DKI Jakarta. Secondary data related to planning area of Green Open Space are including Shapefile of Detailed Spatial Planning (RDTR) of South Jakarta, Shapefile of Parcels of National Land Agency (BPN) of South Jakarta, Shapefile of Parcels of Land Claims, Ownership, Use and Utilization (Penguasaan, Pemilikan Penggunaan, dan Pemanfaatan Tanah/P4T) South Jakarta, Shapefile of Green Open Spaces Asset of South Jakarta Government, Shapefile of Land Use South Jakarta and Shapefile of Vacant Land of South Jakarta. The data was obtained from related websites and institutional surveys in DKI Jakarta.

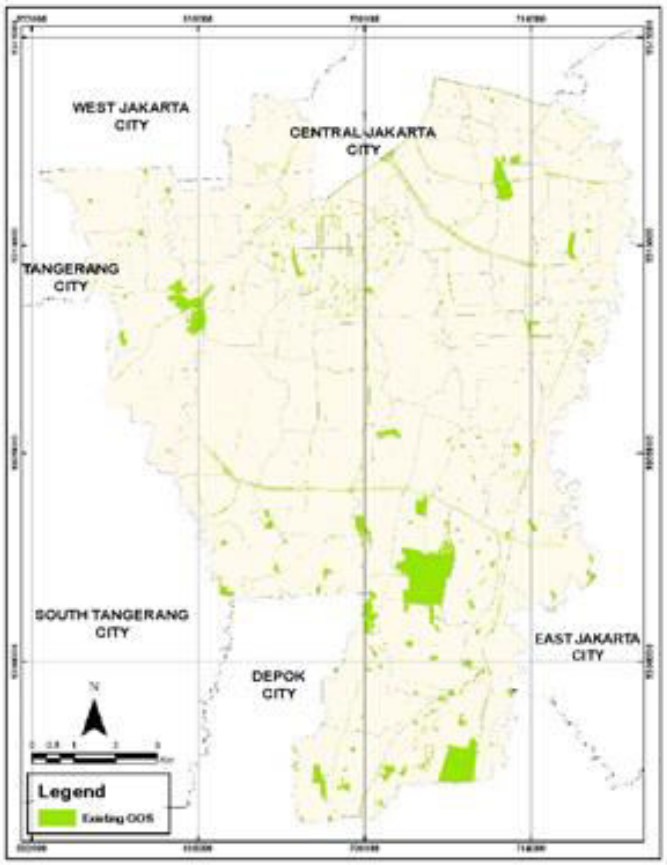


Figure 1. *Distribution of GOS in South Jakarta (Source, Detailed Spatial Planning)*

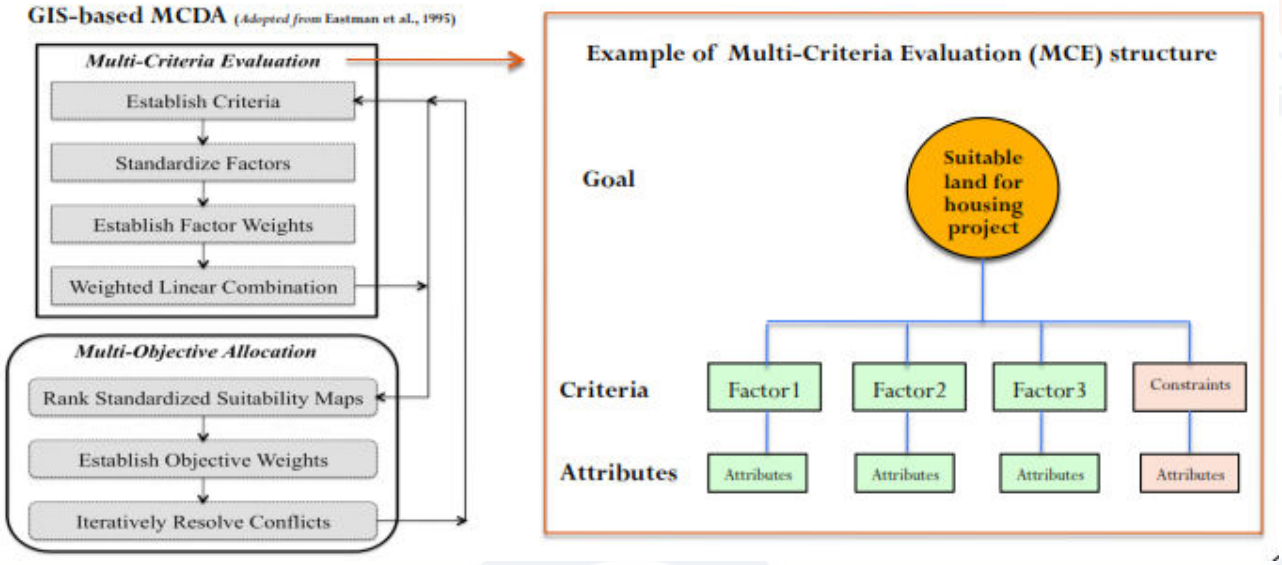
Data Analysis Technique

Consideration in the determination of land for GOS procurement is by overlaying data analysis starting from Detailed Spatial Planning (RDTR), parcels from National Land Agency (BPN) and parcels from P4T data. Overlay can be done by *indentity, union, intersection, and up date* method. In overlay analysis, the data used are Detailed Spatial Planning (RDTR) of South Jakarta, Parcels from National Land Agency (BPN), and Parcels from P4T. The result of the overlay of those data are the green planning (status as land). The green plan with land status is then overlaid (erase) with the License of Land Appointment and Utilization (Surat Izin Penunjukkan Penggunaan Tanah, SIPPT). After this, there will be obtained the Non-asset GOS potential. Non-asset Potential GOS is overlaid (erase) against the Local Government Asset GOS. The results of the overlay of all data from Detailed Spatial Planning (RDTR) South Jakarta, parcels from National Land Agency (BPN), parcels from P4T, License of Land Appointment and Utilization (SIPPT) and GOS of Government Asset are corrected Green Open Space that can be used as observations to the next stage.

GIS-Based Multi Criteria Analysis

GIS-MCA is a stage that integrates and changes the criteria or mapping factors (geographical data) and preferences from decision maker to achieve final assessment of alternative decisions In application of GIS-MCA to a problem, there are 2 important

things, ie Decisions and Criteria, which are divided into 2 things, Factors and Limitations.



To be able to apply GIS-MCA method effectively and efficiently, structured and systematic stages are needed.

- Determination of objectives or problems
  To determine objectives in solving a problem should refer to SMART
  S = Spesific
  M = Measurabl e
  A = Attainable
  R = Relevant
  T = Time Bound
- Determination of the criteria (Factor/Delimiter)
- Standardization of score of factor/criteria
- Determination of Score of Each Factor / Criteria
  - Ranking
    This score is by ranking the factor with values 1, 2 and 3 where 1 is less suitable and 3 is the most suitable
  - Rating
    Scoring factor using percentiles where factor 1 with lowest percent value is less suitable and factor 3 with high percent value is more suitable
  - AHP (Analytical Hierarchy Process) (Saaty, 1980)
    The AHP uses a matrix where each criteria is compared with other criteria, from the most important to the less important on a scale of 1-9

  Ranking, rating and AHP are usually converted into scoring numbers in 0-1 or 0-100
- Aggregate the criteria
  All the criteria values use the basic algorithm of addition
  *GOS Potential = ([Existjaing GOS]*5) + ([Road Distance]*5) + ([River Distance]*5) + ([Population Density]*15)+([Building Density]*15) + ([Inundation]*20) + ([Land Carrying Capacity]*20) + ([Humidity Temperature]*15)*
- Validation / Verification of Analysis Results

Verification by evaluating the accuracy of the analysis results based on field verification.

Result and Discussion

South Jakarta is located at 106'22'42 East Longitude (EL) up to 106'58'18 EL, and 5'19'12 South Latitude (SL). The total area of Administrative City of South Jakarta, based on Governor's Decree Number 171 of 2007, is 145,73 km2. Based on data from Identification of Existing GOS from Provincial Forestry Services of DKI Jakarta in 2018, in South Jakarta currently has GOS area of 696,80 ha, which consist of group/area GOS of 557.63 ha and longways/lane GOS of 141,17 ha. In terms of total area, the existing of GOS in South Jakarta only reached 4.95% from the total area of South Jakarta, with a total area of only **9.713.262,2 m².**

Table 1. Assets of Green Open Spaces in DKI Jakarta, Administrative Region of South Jakarta (Analysis, 2020)

No.	District	GOS	
		Total Area	Total Width m²
1.	Cilandak	100	1.171.716,9
2.	Jagakarsa	233	3.263.194,0
3.	Kebayoran Baru	348	1.645.095,6
4.	Kebayoran Lama	144	1.015.616,2
5.	Mampang Prapatan	63	63.977,0
6.	Pancoran	93	358.548,3
7.	Pasar Minggu	248	550.641,5
8.	Pesanggrahan	90	166.103,7
9.	Setiabudi	105	1.209.804,8
10.	Tebet	134	268.564,2
Total		**1558**	**9.713.262,2**

Spatial Analysis of GOS Needs

Land Carrying Capacity

The analysis results of land carrying capacity of DKI Jakarta show that land carrying capacity for South Jakarta region that has not been exceeded includes 20 Kelurahan (villages) in good condition and 29 keluarahan in moderate condition. Meanwhile, the condition of the regions with land carrying capacity that has been exceeded are found in six kelurahan, namely North Gandaria, North Cipete, Pela Mampang, Bukit Duri, Menteng Atas, and Pasar Manggis. The condition of current land carrying capacity determines the land suitability for GOS development which is divided into 3 classifications, including normal, urgent and very urgent. Based on the overlay results, the GOS potential including very urgent is 1.285 parcels, urgent is 12.266 parcels and normal is 26.364 parcels.

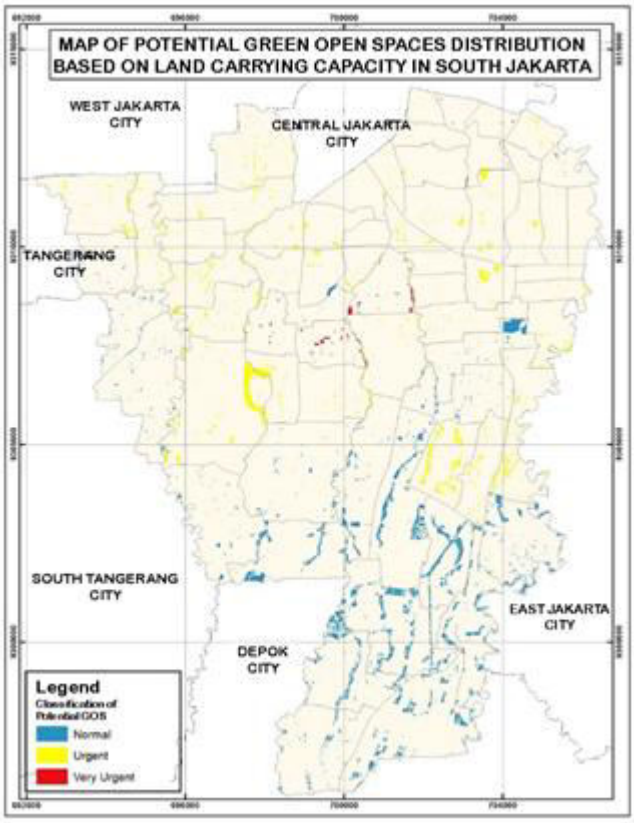


Figure 3. *GOS based on Land Carrying Capacity (Analysis, 2020)*

Population Density

Population density in an area reflects the amount of burden or pressure that must be supported by the environment. This is related to meet the needs of city facilities and infrastructures and waste that can cause pollution. On the other hand, population density is also a parameter for GOS needs so that the ecological, economic and social benefits of GOS can be directly felt by the resident. Therefore, the more dense the number of population in an area the wider the standard of GOS that must be met. The population density classification consists of very urgent > 201 people/ha, urgent 151-200 people/ha and normal <150 people/ha. Distribution of GOS potential based on population density can be obtained through the overlay stage of population density map with potential GOS map that has been corrected. Based on the results of the overlay, the GOS potential which classified as very urgent is 5.525 parcels, urgent is 13.388 parcels, and normal is 21.010 parcels.

GOS Potential Analysis to Inundation Occurrence

The more green open space applying the rainwater sub reservoir, the greater the amount of inundations (flood) can be reduced in urban settlements. All GOS (30% of city area) can be used to preventive flood control and reduce inundation up to 48%. The flood occurrence is identified as the inundation occurrence intensity for each RT/RW so that it can be known the intensity of the inundation that occurs annually. Normal

intensity is the RT/RW areas that are affected less that 2 times a year, areas that are urgently need GOS is the area which intensity affected 2-4 times a year, and the criteria of very urgent for inundation intensity that happen during 2015-2018 had inundation intensity more than 4 times a year.

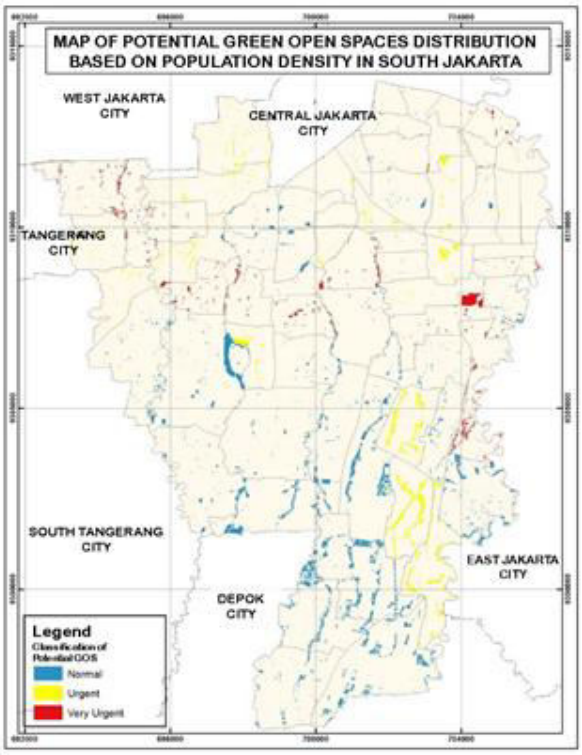


Figure 4. *GOS based on Population Density (Analysis, 2020)*

Figure 5. *GOS based on Flood Occurrence (Analysis, 2020)*

Based on the overlay results, there are only a few corrected GOS potential available in some areas that are very urgent to the intensity of inundation occurrence, namely in the District of Mampang Prapatan and Kebayoran Baru. The number of land parcels for normal priority is 23.775 parcels, and for urgent is 16.149 land parcels and for very urgent is 363 land parcels.

Analysis of GOS Potential Against Land Surface Temperature

For South Jakarta area, Land Surface Temperature (LST) in 2018 obtained from medium scale remote sensing data analysis of Landsat 8 OLI Image is in range of 23.78 – 39.13 °C. The temperature class itself is divided into 3 classification, which are normal for temperatures < 24°C, temperature with urgent GOS priority for temperatures between 24 - 26°C and temperatures with GOS priority very urgent for temperatures > 26°C.

For the distribution of GOS potential against land surface temperature is mostly dominated by the classification of very urgent because of temperature in Jakarta is dominated by uncomfortable temperatures, only a small portion of corrected GOS classified in the normal class because it is located beside existing Green Open Space. The number of land parcels for normal priority is 64 parcels, for urgent priority is 4.978 land parcels and for very urgent priority is 36.052 land parcels.

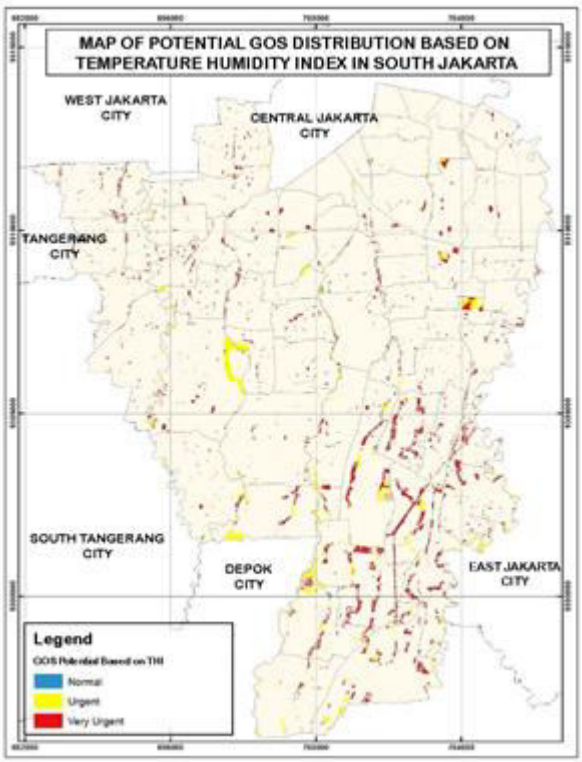


Figure 6. *GOS based on Temperature Index (Analysis, 2020)*

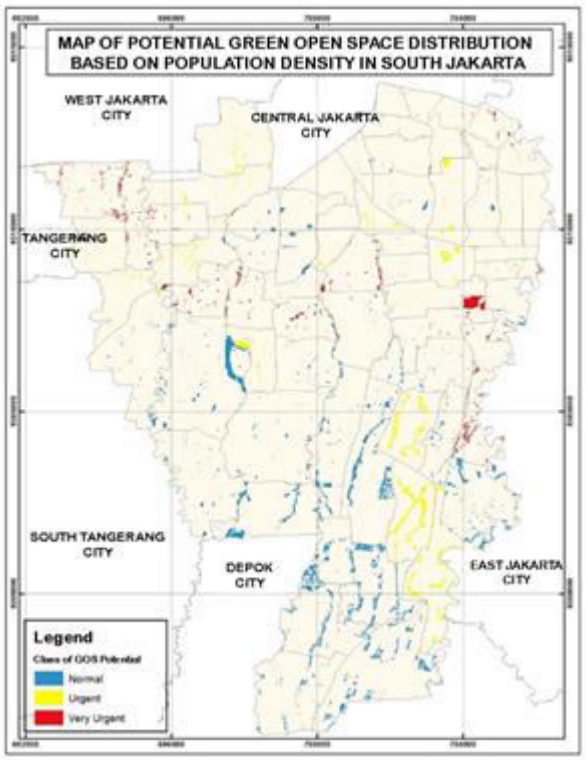


Figure 7. *GOS based on Population Density (Analysis, 2020)*

Population Density

On the other hand, population density is also a parameter of GOS needs so that the ecological, economic, and social benefits of GOS can be directly felt by the resident. Therefore, the more dense the number of population in an area, the wider GOS standard that must be met. To determine the land suitability for GOS development, kelurahan with low population density are included in the normal classification. The Urgent classification is intended for kelurahan with moderate population density, while the one with high population density is classified as very urgent.

Distribution of potential GOS based on population density can be obtained through the overlay stage of population density map with the GOS potential map that has been corrected. Based on the overlay results, the GOS potential classified as very urgent is 5.525 land parcels, urgent is 13.388 land parcels, and normal is 21.010 land parcels.

Building Density

The building density needs to be considered in the development of GOS because it is related to how much not developed land that can be utilized as land for absorption in an area. The area with high BCR value requires the development of GOS due to lack of water catchment areas so that it is included in very urgent for land suitability classification for GOS development. Areas with medium BCR value are classified as urgent and the low building densities are classified as normal.

To obtain the distribution of GOS potential based on building density, then the overlay stage is carried out for building density map with the corrected GOS potential

map. Based on the results of the overlay, the GOS potential included as very urgent is 17 land parcels, urgent is 6.959 parcels, and normal is 33.108 parcels.

Figure 8. *GOS based on Building Density (Analysis, 2020)*

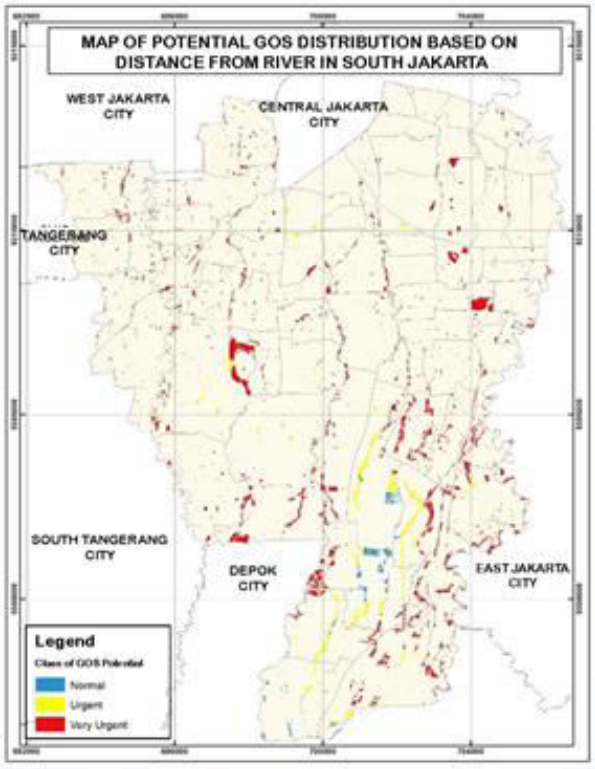


Figure 9. *River Proximity Access (Analysis, 2020)*

Analysis of GOS Potential for River Proximity Access

Parameter of the river proximity access is the parameter needed to supply the continuity of sustainable GOS. The river is one of the low cost and sustainable water supplies. The result of buffering analysis on river objects are then overlaid with corrected GOS to get the land parcels that have normal, urgent, and very urgent priority. The results of the process show that the corrected GOS is mostly potentially very urgent while only a small proportion is urgent and normal. For normal priorities there are 2463 land parcels, for urgent priorities there are 9239 land parcels, while for very urgent priorities there are 28579 land parcels.

Analysis of GOS Potential Toward Existing GOS

Parameter of existing GOS is the parameter that is used so that the GOS that will be built later will not overlap with other GOS, so that the functions and benefits of GOS to be built are less effective and efficient. The classification of proximity access is Very Urgent > 750 meters, Urgent 374-750 meters and Normal < 374 meters (Pantalone, 2010 with modifications). The processing results show that most of the land parcels is in very urgent class, as many as 38.273 land parcels, for urgent is as many as 1.832 land parcels and for very urgent priority is as many as 66 land parcels. For very urgent priorities are located at the outermost border of the city of South Jakarta.

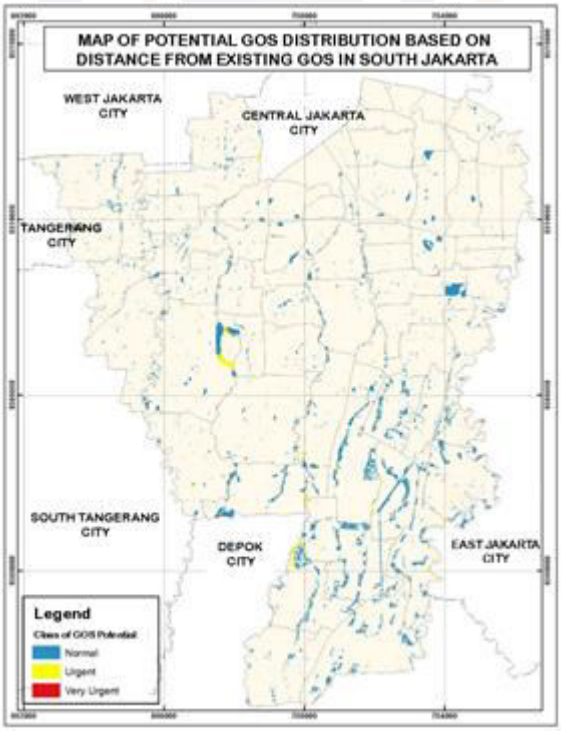


Figure 10. *GOS Existing (Analysis, 2020)*

Conclusion

The classification result of priority of GOS potential for each parameter that has been combined produces 44582 land parcels and 3 priority class as follows:

- *Very Urgent* Cluster is the cluster that most require the provision of GOS reviewed based on 8 parameters. This cluster has a total score of 230-300 which is almost 80% of the conditions in each of the above parameters are urgent. There are 1.174 land parcels that classified in *Very Urgent* Cluster. The total area of land parcels of the *Very Urgent* Cluster is 9,43 ha.

- *Urgent* Cluster is the cluster that moderately needs a GOS procurement reviewed based on 8 parameters. This cluster has a total score of 170-229 where there are several parameters that have very high urgency but some of the parameters have normal urgency. There are 19.250 land parcels that included in the *Urgent* Cluster. This areas have urgent priority because several of these 8 parameters are in the class which have potential to become very urgent in the future if they are not immediately arranged. The total area of land parcels in the *Urgent* Cluster is 235 ha.

- *Normal* Cluster is the cluster that doesn't require the provision of GOS, having total score of 100-169 where the urgency of each parameter is mostly normal and only a few parameter that *urgent* or *very urgent.* There are 24.158 land parcels that included in the *Normal* Cluster. The distribution of the *normal* cluster is mostly

located in the southern part of South Jakarta. The total area of land parcels in *Normal* Cluster is 321,33 ha.

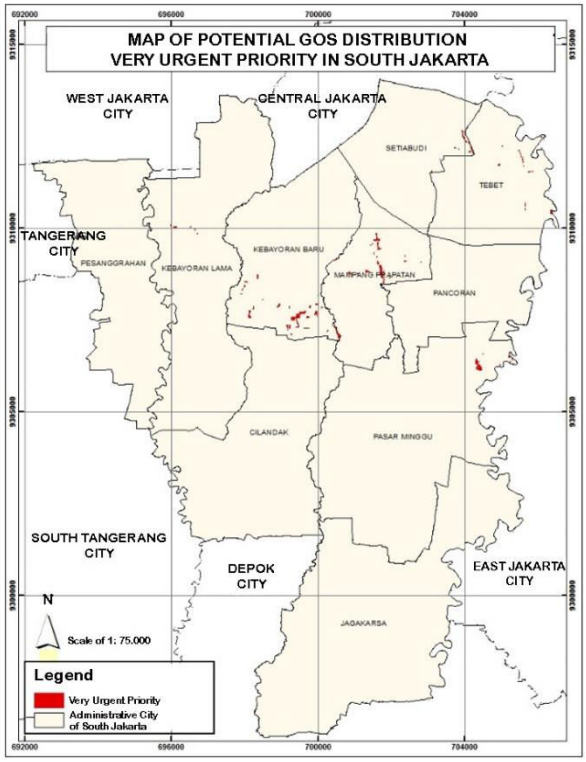


Figure 11. *Distribution of Very Urgent GOS Potential (Analysis, 2020)*

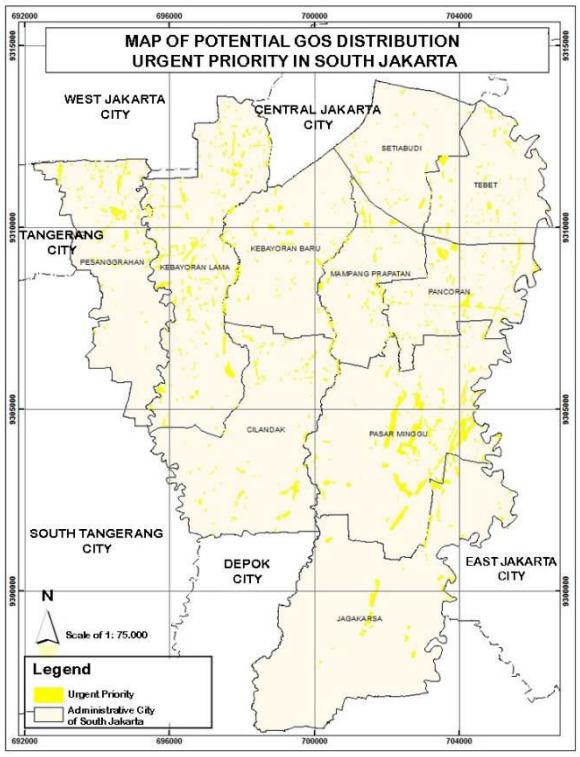


Figure 12. *Distribution of Urgent GOS Potential (Analysis, 2020)*

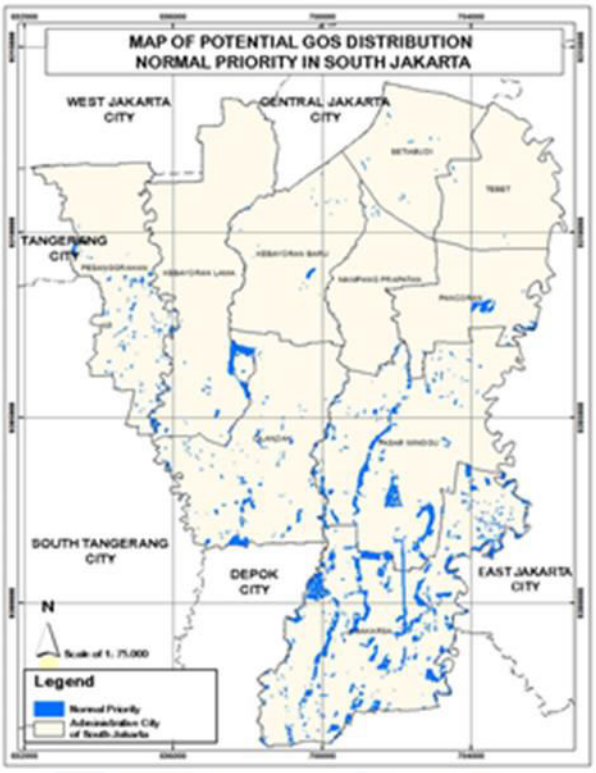


Figure 13. *Distribution of Normal GOS Potential (Analysis, 2020)*

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