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Green Open Space Requirements as a Recharge Area to Meet the Needs of Domestic Groundwater (Case Study in DKI Jakarta)

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ABSTRACT

High population growth and limited land Owned by Causing the growth of physical development in the city of Jakarta is done by converting agricultural land, forests and other open space to land awoke with pavement and building structures. This decreases the area of green open space (green open space) so That the space is reduced water infiltration. With the above issues, the aims to find green open space requirements needed for the Jakarta area is the recharge area in order to meet the needs of domestic groundwater. Used the method is to create a spatial model of spatial dynamics, spacious and presence of existing green open space requires spatial data Lansat image. Green open space required as recharge areas using data on the number and rate of population growth, per capita total water consumption, supply capacity of PAM, the potential of the lake or away, annual rainfall and potential green open space allocation. Based on the discussions That there then cans be found With an estimated population of DKI Jakarta Until the year 2016 = 7,804,846, then the domestic water needs of the population That year (2016) amounted to 427,315,322.20 m³/year.The total green open space needed to meet domestic water needs of Jakarta in 2016 is 16,180.54 hectares or 24.92% of the total area of DKI Jakarta.

Keywords

Green Open Space, recharge area, the Soil Water Domestic

1. INTRODUCTION

Now, Jakarta has more water loss compare to several decades ago. This is happened because of reducing open spaces as areas for water penetrating into soil. Many open spaces have been converted into built-up spaces. This purpose is to meet the socioeconomic needs of the urban population itself.

In many ways, increasing of soil hardening is not accompanied by an effort to add the penetration of water into soil to compensate equally amount if there is no hardening activity. Many agricultural and forest areas previously acted as areas for penetrating of rain water into the soil naturally has changed due to the building on or reducing vegetation. Reducing of ground water supply will cause clear decreasing of ground water level. The negative impact of this phenomenon is very large. In addition to the more expensive supplies of ground as water source of clean water, it is also causing sea water intrusion into the mainland, as it is now found in Northern Jakarta.

2. RESEARCH OBJECTIVES

The purpose of the study were:

- (1) Assess the presence of existing green open space and its ability to meet the needs of domestic groundwater.
- (2) Assess the needs of local green open space as Recharge Area to Meet the Needs of Domestic Ground Water in Jakarta area.

3. LITERATURE REVIEW

3.1. Green Open Space

Open space is defined as a space in cities or urban areas, in the form of an area or region, with the open space utilization characterized with no built-up space, very low density built-up space, an/or very low altitude space. Green open space is open space filled naturally or cultivated by green plants or vegetation such as agricultural and plantation plants.

3.2. The function of green open space

The functions of green open space are:

1. As a medium to maintain the sustainability of ecosystem functions and environmental conservation in urban areas
2. As a refuge of plant seeds (germplasm). With the green open spaces, the seeds of plants will be saved from environmental destruction.
3. As ground water recharge area. Ground water is vital for human needs. Based on observation, ground water in many large cities have mixed with seawater. Sea water has seeped into land. Examples, seawater in the Jakarta city has seeped into around National Monument area.
4. As a medium to improve local climate.
5. As the lungs of the city. This is other benefit except greenery view..
6. As an area for sports and recreation. In the green open spaces, urban communities will carry out sports easily. Therefore, it also has function as a medium to improve urban communities' health.
7. As a medium to create greenery, freshness, health, cleanliness and beauty of the city.

3.3. Green Open Space as Recharge Area

In the urban forest area, plant root systems and litters turn into humus will enlarge the number of soil pores. The humus is more hygroscopic with a great ability to absorb water (Bernatzky, 1978) so that the moisture of forest land will increase.

Upstream serve as water catchment areas, they should be planted with crops have low evapotranspiration. In addition, root system and litters can improve soil porosity so that a lot of rain water will infiltrate into the soil and only a little of water will become runoff.

If heavy rain occurs, the rain water will seep down into the deeper layers of soil to be water infiltration and ground water. Thus, forest city built on water catchment areas of the city will be able to overcome the problem of water with producing good quality water.

Wide of green open space required as a place to infiltrate water can be calculated by using a modified approach based on the water needs of the urban forest area (Fakuara, 1987):

$$La = \frac{Po \cdot K (1 + r - c) t - PAM - Pa}{z} \quad (1)$$

- La : wide of urban forest to be built
- Po : total population
- K : water consumption per capita (l / day)
- r : rate of increase in water consumption
- c : controlling factor
- PAM : water companies supply capacity
- t : year
- Pa : potential soil water
- z : the ability of urban forests in storing water

4. METHODOLOGY

Data preparing is the first activity in this study. The secondary data obtained are ground water, distribution maps of infiltration rate, spatial data, Landsat image, the number and rate of population growth, supply capacity of PAM (Drinking Water Company) and rainfall. Rainfall data used are hourly data from 2003 to 2007 and monthly data from 1997 to 2006.

The steps taken in this research as follows:

- 1). Literature Review
- 2). Surveys and Data Collection
- 3). Analysis and Discussion

The calculation of the water needs of domestic (households) and domestic groundwater supplies based on the assumptions as follows:

- The calculation was made each region (for 5 areas of DKI Jakarta)
- Domestic water needs were calculated for 10 years from 2006 to 2016
- Water requirement per capita was of 150 liters/day/person or 54.75 m³/year/person

Ground water to meet domestic water needs was obtained from the existing green open space (in 2006), planned green open space and other potential water from the lake or *situ* in DKI Jakarta, and Water supply from PAM Jakarta in DKI Jakarta as a reducer factor of ground water needs

The wide of existing green open space area (in 2006) was obtained by spatial analysis of land suitability map. In this analysis, Landsat images were interpreted by using Erdas E 8.5 and Arc View 3.3.

5. RESULTS AND DISCUSSION

5.1. Existing Area of green open space in 2006 and the Water Meets the Land Domestic Capabilities

Based on the map of Jakarta lansat in 2006 created spatial maps of land based on its designation of Jakarta area. The result of spatial data processing by using Erdas 85 and Arcview 3.3:

Table 1 Area of existing green open space (in 2006) in the Jakarta area

Year	Area of existing green open space in 2006 Central Jakarta	Area of existing green open space in 2006 West Jakarta	Area of existing green open space in 2006 North Jakarta	Area of existing green open space in 2006 South Jakarta	Area of existing green open space in 2006 East Jakarta	Area of existing green open space in 2006 DKI Jakarta	Percentage of green open space in 2006 DKI Jakarta
	hectares	hectares	hectares	hectares	hectares	hectares	%
2006	531,36	2.233,41	2.768,91	4.636,81	5.857,58	16.028,05	24,68
2007	531,36	2.233,41	2.768,91	4.636,81	5.857,58	16.028,05	24,68
2008	531,36	2.233,41	2.768,91	4.636,81	5.857,58	16.028,05	24,68
2009	531,36	2.233,41	2.768,91	4.636,81	5.857,58	16.028,05	24,68
2010	531,36	2.233,41	2.768,91	4.636,81	5.857,58	16.028,05	24,68
2011	531,36	2.233,41	2.768,91	4.636,81	5.857,58	16.028,05	24,68
2012	531,36	2.233,41	2.768,91	4.636,81	5.857,58	16.028,05	24,68
2013	531,36	2.233,41	2.768,91	4.636,81	5.857,58	16.028,05	24,68
2014	531,36	2.233,41	2.768,91	4.636,81	5.857,58	16.028,05	24,68
2015	531,36	2.233,41	2.768,91	4.636,81	5.857,58	16.028,05	24,68
2016	531,36	2.233,41	2.768,91	4.636,81	5.857,58	16.028,05	24,68

Based on the calculation of the domestic (household) water needs and domestic groundwater supplies in the Jakarta area as shown below:

Table 2 The Domestic Water Needs and Domestic Ground Water Supply of the Jakarta area

Year	Domestic Water Needs DKI Jakarta	Supply PAM DKI Jakarta	Volume of Ground Water from Existing RIH (2006) DKI Jakarta	Other Potential Volume of Water (Lake / lakes) DKI Jakarta	Percentage adequacy
	(m3/year)	(m3/year)	(m3/year)	(m3/year)	%
2006	622.927.577,00	163.554.874,00	311.538.799,69	5.086.613,56	77,08
2007	625.989.352,67	164.509.926,49	311.538.799,69	5.086.613,56	76,86
2008	629.071.362,20	165.635.913,61	311.538.799,69	5.086.613,56	76,66
2009	632.173.745,86	166.938.908,85	311.538.799,69	5.086.613,56	76,49
2010	635.296.644,85	168.425.541,44	311.538.799,69	5.086.613,56	76,35
2011	638.440.201,42	170.103.027,84	311.538.799,69	5.086.613,56	76,24
2012	641.604.558,80	171.979.205,45	311.538.799,69	5.086.613,56	76,15
2013	644.789.861,23	174.062.569,23	311.538.799,69	5.086.613,56	76,10
2014	647.996.253,95	176.362.310,98	311.538.799,69	5.086.613,56	76,08
2015	651.223.883,27	178.888.361,61	311.538.799,69	5.086.613,56	76,09
2016	654.472.896,50	181.651.436,78	311.538.799,69	5.086.613,56	76,13

5.2. Area of green open space and Capability Plan Meets Domestic Ground Water

To meet domestic groundwater needs, DKI Jakarta still need more additional green open space called planned green open space in West Jakarta (Kembangan and Cengkareng Districts) in 2006 and in East Jakarta (Cipayung District) in 2016. The area wide and volume of produced water are shown in Tabel 3 and 4.

Table 3 Area of green open space in each area Plan Needed in DKI Jakarta

Year	Green Open Space Plan Area for The Center Jakarta	Green Open Space Plan Area for The West Jakarta	Green Open Space Plan Area for The North Jakarta	Green Open Space Plan Area for The South Jakarta	Green Open Space Plan Area for The East Jakarta	Green Open Space Plan Area for The DKI Jakarta	Percentage of Green Open Space Plan for DKI Jakarta
	hectares	hectares	hectares	hectares	hectares	hectares	%
2006	-	135,38	-	-	-	135,38	0,21
2007	-	135,38	-	-	-	135,38	0,21
2008	-	135,38	-	-	-	135,38	0,21
2009	-	135,38	-	-	-	135,38	0,21
2010	-	135,38	-	-	-	135,38	0,21
2011	-	135,38	-	-	-	135,38	0,21
2012	-	135,38	-	-	-	135,38	0,21
2013	-	135,38	-	-	-	135,38	0,21
2014	-	135,38	-	-	-	135,38	0,21
2015	-	135,38	-	-	-	135,38	0,21
2016	-	135,38	-	-	17,11	152,49	0,23

Table 4 Volume of Green Open Space Plan Needed in each area of DKI Jakarta

Year	The Volume of Green Open Space Plan in Center Jakarta	The Volume of Green Open Space Plan in West Jakarta	The Volume of Green Open Space Plan in North Jakarta	The Volume of Green Open Space Plan in South Jakarta	The Volume of Green Open Space Plan in East Jakarta	The Volume of Green Open Space Plan in DKI Jakarta
	(m3/thn)	(m3/thn)	(m3/thn)	(m3/thn)	(m3/thn)	(m3/thn)
2006	-	2.011.065,84	-	-	-	2.011.065,84
2007	-	2.011.065,84	-	-	-	2.011.065,84
2008	-	2.011.065,84	-	-	-	2.011.065,84
2009	-	2.011.065,84	-	-	-	2.011.065,84
2010	-	2.011.065,84	-	-	-	2.011.065,84
2011	-	2.011.065,84	-	-	-	2.011.065,84
2012	-	2.011.065,84	-	-	-	2.011.065,84
2013	-	2.011.065,84	-	-	-	2.011.065,84
2014	-	2.011.065,84	-	-	-	2.011.065,84
2015	-	2.011.065,84	-	-	-	2.011.065,84
2016	-	2.011.065,84	-	-	354.215,58	2.365.281,42

Based on water needs of domestic soil, the total green open space as catchment areas to meet domestic ground water are shown in Table 5 below.

Table 5 Total Green Open Space to Meet Domestic Ground Water Needs in DKI Jakarta

Year	Area Green Open Space Needs In Central Jakarta	Area Green Open Space Needs In West Jakarta	Area Green Open Space Needs In North Jakarta	Area Green Open Space Needs In South Jakarta	Area Green Open Space Needs In East Jakarta	Area Green Open Space Needs In DKI Jakarta	Percentage Of Green Open Space Of DKI Jakarta
	(Hectares)	(Hectares)	(Hectares)	(Hectares)	(Hectares)	(Hectares)	%
2006	531,36	2.368,79	2.768,91	4.636,81	5.857,58	16.163,43	24,89
2007	531,36	2.368,79	2.768,91	4.636,81	5.857,58	16.163,43	24,89
2008	531,36	2.368,79	2.768,91	4.636,81	5.857,58	16.163,43	24,89
2009	531,36	2.368,79	2.768,91	4.636,81	5.857,58	16.163,43	24,89
2010	531,36	2.368,79	2.768,91	4.636,81	5.857,58	16.163,43	24,89
2011	531,36	2.368,79	2.768,91	4.636,81	5.857,58	16.163,43	24,89
2012	531,36	2.368,79	2.768,91	4.636,81	5.857,58	16.163,43	24,89
2013	531,36	2.368,79	2.768,91	4.636,81	5.857,58	16.163,43	24,89
2014	531,36	2.368,79	2.768,91	4.636,81	5.857,58	16.163,43	24,89
2015	531,36	2.368,79	2.768,91	4.636,81	5.857,58	16.163,43	24,89
2016	531,36	2.368,79	2.768,91	4.636,81	5.874,68	16.180,54	24,92

6. CONCLUSIONS AND SUGGESTIONS

Results of research can be concluded i.e.:

1. Wide area of green open space in 2006 is 16,028.05 Hectares or 24.68% of DKI Jakarta area. This area can produce ground water volume is 311,538,799.69 m³/year (74.10% -77.09% sufficiency). This is minimum green open space which must be maintained to meet the needs of domestic groundwater.
2. Existing green open space in 2006 (24.68% of Jakarta area) should be maintained to meet domestic water needs of Jakarta residents. In 2006, Jakarta needs to add green open space in Kembangan and Cengkareng Districts, West Jakarta (0.21% of DKI Jakarta). In 2016, green open space should be added in Cipayung District, East Jakarta (0.23% of Jakarta).
3. The total green open space (planned green open space + green open space 2006) are needed to meet the needs of domestic groundwater of DKI Jakarta in 2006-2015 is approximately 24.89% of Jakarta and in 2016 is 24.92% of Jakarta.

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