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Analysis of Open Space Needs as a Water Catchment Area in Samarinda City

Dimas Bintang Mudrajad, Prasetyo, Wardhana, and Ahmad Riza
Lecturer in the Architecture Study Program, Facultyof Engineering,
Universityof 17 Agustus 1945 Samarinda
Author Correspondence :Dimas Bintang Mudrajad

Abstract
Samarinda is a city that is in the developing stage and builds a city where development Samarinda positive look towards the city in the form of improved infrastructure facilities and infrastructure to enhance economic development, while the development of the city of Samarinda toward negative occurrence or minimize the reduction of open space and its ecological function as preparation of the land for housing, land clearing mines coal and others that decrease the water catchment areas causing flooding or inundation.
Samarinda city has an area of open space of 301.204 Km² consisting of public open space with an area of 159.256 km² and private open space with an area of 141.946 km² of totaSamarinda area, which has an area of 718 km². From the calculations performed,the open space requirement as a reduction puddle (Flood), Samarinda requiresan open space area of 47.332 km² which entered into public open space so that the pool of water (flooding) can be reduced.
Keywords: Space Evidenced, Water Catchment Areas

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I. Introduction

Rapid development has led to an increase in the needs of life, including the need for land resources. The need for land in urban areas is increasing with population growth and the socioeconomic activities that come with it. This increase in land needs implies the increasing variety of functions in urban areas, such as government, trade and services, and industry, due to its advantages in terms of facilities and ease of accessibility to attract various activities to agglomerate.

Concerning limited land characteristics, the dynamics of the development of activities in urban areas give rise to competition between land uses, leading to increasing land-use changes with increasing intensity. The result caused by urban development is the tendency to shift city functions to the urban fringe, which is called the process of debiting the city's physical appearance outwards (urban sprawl) (Kustiwan and Anugrahani, 2000; Giyarsih, 2001).

The shift in function in the periphery area is land previously intended as a forest area and water catchment area, changing its function to become a residential area, mining, and other business activities. The decreasing open land due to the need for built-up land that occurs in urbanized areas gives the logical consequence that the more significant the change in forest land use and water catchment areas to urban use has an impact on environmental damage. The environmental damage that occurs is a decrease in the number and quality of the environment, including a decrease in the quality of the existence of natural resources such as soil, water systems, and biodiversity.

Based on rainfall data in the Samarinda City area shows that the average annual rain is 2,343 mm, and the maximum daily rain that has ever occurred and recorded at the Temindung Station in Samarinda City is 132 mm. Based on the existing conditions mentioned above, it is indicated that Samarinda City has a relatively high average rain. This high rainfall significantly affects the emergence of inundation (flood) areas in Samarinda City.

Samarinda is a city in the developing and building stage, where the development of Samarinda city in a positive direction is seen in the increase in city infrastructure in the form of facilities and infrastructure to increase economic development. In contrast, the development of Samarinda city towards the negative occurrence of reducing or minimizing open space and its ecological function due to the maturation of land for housing, opening coal mining land, and others that impact decreased water catchment areas, causing flooding or inundation.

II. Research Methods

A. **Research Locations**

Samarinda City is the research location for the Analysis of Open Space Needs as a Water Catchment Area.

B. Research Instruments

1. Existing open space condition survey related to the area and type of open space in the research area.
2. Survey physical conditions, including slope, rainfall, soil type, and land use.
3. Conduct an analysis of open space as a water catchment area in the research area

C. Data Collection Techniques

In data collection techniques, the data collected is in accordance with the Analysis of Open Space Needs to Reduce Stagnant Water (Flood) in Samarinda City, including:

a. Primary data, including field condition surveys and interviews with relevant agencies, communities and other relevant stakeholders in the planning area to obtain accurate and valid data and information.

b. Secondary data includes literature studies on existing planning and related policies, statistical data from BPS and reports from affiliated offices/agencies.

The first step in this study is to identify the study area's condition, including slope, rainfall, soil type, and land use. At this stage, in addition to the most recent data and information (the year of preparation), time series data and information are also collected.

4. Data Analysis Techniques

Data analysis techniques were carried out in the Analysis of Open Space Needs for Water Catchment Areas and the Reduction of Waterlogging (Flooding) in Samarinda City.

The amount of rainwater discharge can be known from the amount of rainfall from meteorological bodies obtained the maximum amount of rainfall.

Ch maks = (R maks) ...... [1]

The amount of discharge due to rainfall is:

Q = V . A .... [2]

Dimana :

Q = water discharge

V = speed

A = area (km^2).

The Catchment Area is a drainage area that receives rainfall during the Rain Intensity time, resulting in runoff discharge that the channel must accommodate until it flows to the end of the channel.

To calculate the area of water catchment can be used the formula:

$$A = \frac{1}{2}\left(X1.Y2 + X2.Y3 + ...X_n.Y_{n+1} - Y1.X2 - Y2.X3 - .....Y_{n.}X_{n+1}\right)$$

Dimana :

A = Luas area (km^2).

X1,X2,X3,Xn...... = The coordinate point of the x-axis reviewed from the Topographic Map.

Y1,Y2,Y3,Yn...... = The coordinate point of the y-axis reviewed from the Topographic Map.

The flow velocity in the channel is determined using the Manning formula:

$$V = \frac{1}{n} \bullet R^{\frac{2}{3}} \bullet S^{\frac{1}{2}}$$

Dimana :

V = Flow velocity (m/det)

R = Hydraulic radius (m)

I = River slope (energy)

n = Manning roughness coefficient

The area of open space needed as a place to absorb water is calculated using a modified approach to the area of urban forests based on water needs with the following formula (Fakuara, 1987):

$$\underline{La = Po.\ K\ (1 + R - C)^t - PAM - Pa}$$

Keterangan :
Lt = Land Area as a Water Catchment Area
Po = number of inhabitants of the city
K = Water consumption (liters/day)
R = The rate at which water consumption increases(usually concomitant with the rate of increase in the population of the local town)
C = Correction factor (the magnitude depends on theeffortgovernment in the declining rate of population growth)
PAM = water supply capacity by PAM (m^3/year)
Pa = water potential that has not been mandated at this time (m^3/year)
z = the ability of water to absorb water

III. Result And Discussion

A. Result

The problem of flooding, in general, is closely related to the development of urban areas, which is always accompanied by an increase in population, activities, and land needs, both for settlements and economic activities. Due to limited land in urban areas, there is an intervention of urban activities on land that should function as conservation areas and green open spaces. As a result, the water catchment area is getting narrower, increasing surface flow and erosion. This impactsrivers' silting (narrowing) so that water overflows and triggers flood disasters, especially in the downstream areas.

Related to the problems mentioned above, the area of waterlogging (flooding) that occurs in Samarinda City, in essence, correlates with the rapid development of urban areas, which is no longer following the proper function. The following is a waterlogging area (flood) located in Samarinda City.

1. Land Slope

Samarinda City is divided into a slope of 0-2 % covering an area of 219.61 km² or 30.61% of the area of Samarinda City, 3-14 % covering an area of 198.58 km² or 27.68%, while a slope above 40% covering an area of 105.71 km² or 14.66%.

Table 1. Topography in Samarinda City

Number	Topography	Area (km2)	Percentage (%)
1	0 – 7	173,40	24,17
2	7 – 25	294,86	41,10
3	25 – 100	233,02	32,48
4	100 – 200	15,14	2,11
5	➢ 200	1,58	0,14

Source : RTRW of Samarinda City 2005-2014 and RPIJM of Samarinda City 2012

2. Rainfall

Samarinda is located on the banks of the Mahakam River. East Kalimantan province includes a Humide Tropical climate with rainfall ranging from 1500-4500 mm per year. The average minimum air temperature is 21°C, and the maximum is 34°C with day and night temperature differences between 5° - 7° C.

The minimum temperature generally occurs from October to January, while the maximum temperature occurs between July and August. The average air humidity reaches 86 %, with an average wind speed of 5 knots per hour.

The rainfall used by Samarinda City is obtained from the Temindung Airport Rainfall Logging Station (BMKG). Data on the average daily rain at Temindung Station from 1992 to 2011 (20 years).

Table 2. Average Daily rainfall (mm) Per yearFrom Temindung Samarinda Airport Station

No	Year	Average Daily rainfall (mm)	No	Year	Average Daily rainfall (mm)
1	1992	94,30	11	2001	66,30
2	1993	90,00	12	2002	87,70
3	1994	141,80	13	2003	118,20
4	1995	82,00	14	2004	108,00
5	1996	79,10	15	2005	132,10
6	1997	94,60	16	2006	94,40
7	1998	85,00	17	2007	117,10
8	1999	117,10	18	2008	132,10
9	2000	83,80	19	2009	86,50

10	2001	101,60	20	2010	105,50

Source: Calculation Result Data from BMKG Temindung

3. Land Use

Agricultural land use for five years, starting from 2007 to 2011, has decreased, while for non-agricultural land, it has increased. This can be seen in 2007; the area of agricultural land in Samarinda City was 37,985 Ha. In 2011 it was 33,435 Ha, while for non-agricultural land, in 2007, it was 33,815 Ha, and 2011 it was 38,944 Ha.
One of the causes of waterlogging (flooding) is the condition of residential areas in Samarinda City, where many Samarinda community settlements still live in the Mahakam River border area, the Karang Mumus River border, steep hilly areas, and so on.
Based on conditions in the field, settlements in Samarinda City have increased; this can be seen in the density of residential buildings that have been built starting from the Mahakam River Border area and the Karang Mumus River to hilly areas that make Samarinda City a slum area and the potential for waterlogging (flooding) during rains or when the Mahakam River water is high.

4. Open Space in Samarinda

The most open space is found in Samarinda Ulu District, which is 70,481 Km² or 9.82% of the area. In contrast, the least open space area is found in Samarinda City District, which is 1,662 Km² or 0.23% of the area. The total open area in Samarinda City is 301,204 Km²

Table 3. Existing Conditions of Open Space InSamarinda City

No	District	District Area](km²)	Open Space	
			Area (km^2)	%
1	Palaran	221,29	37,466	5,22
2	Samarinda Seberang	12,49	3,347	0,47
3	Loa JananIlir	26,13	3,507	0,49
4	Samarinda Ulu	22,12	6,572	0.92
5	Samarinda Kota	11,12	1,662	0,23
6	SamarindaIlir	17,18	6,065	0,84
7	Sambutan	100,95	12,620	1,76
8	Sungai Kunjang	43,04	13,956	1,50
9	Sungai Pinang	34,16	3,580	0,50
10	Samarinda Utara	229,52	70,481	9,82
11	Public Open Space		159,256	22,18
12	Private Open Space		141,948	19,77
Total			301,204	41,95

Source: Regional Profile 2012, Bappeda Kota Samarinda

IV. Discussion

With an overall area of 71,800 km2², the population density of Samarinda City in 2011 was 1,052 inhabitants/km2, which means that every square kilometer averages 1,052 inhabitants. This condition shows an increase in population density of 8 people / km² from 2009 of 846 people / km². The highest population density is found in Samarinda Ulu District at 5,633 people/km², and the lowest population density is in Samarinda Kota District at 2,982 people/km².

The population increase above will be followed by an increase in infrastructure needs, such as settlements, clean water facilities and infrastructure, education, and other community services. The city's development has noticeably reduced the open space area as a water catchment area.

From these conditions, there needs to be vigilance of the Samarinda City government against the disaster that will arise, namely the area of waterlogging (flooding). To find out the area of waterlogging (flood) in Samarinda City, secondary data is needed, namely land slope, soil type, rainfall, and land use (related to the open space area).

1. Land Slope

Based on the slope, the area of Samarinda City is divided into a slope of 0-2% covering an area of 219.61 km² or 30.61% of the area of Samarinda City, 3-14% covering an area of 198.58 km² or 27.68%, while a slope above 40% covering an area of 105.71 km² or 14.66%.
Based on the Samarinda City Land Slope Map, it can be seen that the hilly topography with a flat land slope is located in the downstream area, the undulating land slope is in the central area, while the steep and very steep land slope is in the upstream area.
Based on these characteristics, once rainwater falls, water from the upstream area immediately flows down with a short concentration time. In contrast, the open space area as a water catchment area that is decreasing cannot absorb water optimally, so water will flow to the surface of the soil, which causes waterlogging areas (floods) on roads and residential areas. In addition, the upstream and central areas in Samarinda City are widely used as

mining areas so that water will quickly flow to the downstream areas, which ultimately increases the risk of waterlogging areas (floods).

In overcoming the problem of waterlogging (flooding), the regulation of land slope can be engineered by humans, one of which is by making a well-planned siring terrace to prevent the accumulation of rainwater in the planting field. With the planting plane's slope adjusted to the slope of the hill, rainwater falling onto the planting field can be regulated or flowed directly to the lower place through an irrigation or drainage system.

2. Soil Type

The soil types found in Samarinda City are Ultisot, Entisol, Hitosol, Inceptosol, monolignol or Podsol, Alluvial, and Organosol soils. Podzolic soil is the most abundant type of soil found in Samarinda city, which is 30 hectares. 010 Ha (45.45 %), while the type of land with a minor area is Alluvial, covering an area of 3,453 Ha (4.81 %),

Following the characteristics and properties of podzolic soil located in Samarinda City, it is necessary to have a large enough open space area so that rainwater can be absorbed by the soil optimally and does not cause too much runoff, causing waterlogging areas (floods).

3. Rainfall

Concerning waterlogging areas (floods), the rain factor is one of the main factors that cause the emergence of water generation (flooding), which is caused by high rainfall. In addition, rainfall is the cause of waterlogging (flooding) that is difficult to engineer for humans. To overcome this problem, it is necessary to have an excellentopen space area so that the water area (flood) does not increase.

Conditions In the last six months of 2007, the highest rainfall occurred in April 2007 (81.3 mm). However,significant floods occurred in February, with 50.1 mm of rainfall. November 1, 2007, recorded 70.5 mm/day; November 25, 2007, recorded 80 mm/day (dawn to evening). On about 1 and 2 January 2007, there were floods in several places, when a rainfall high of 50 mm was recorded. In June 2007 (57.0 mm), Sunday 17/6/2007 (57 mm), Saturday 16/6/2007 (25.2 mm), Monday 18/6/2007 (23.3 mm), and Wednesday 20/6/2007 (9.5 mm).In early November 2008, floods occurred everywhere in Samarinda; at that time, rainfall was recorded at 57.5 - 70 mm/day, and rain occurred for days. In mid-November,rainfall was recorded at 70 mm/day. On November 14, 2008, at 2:30 p.m., a rain intensity of 52 mm was recorded.

4. Land Use

In 2011, land use in houses, buildings, and surrounding courtyards was the most dominant land use with an area of 25,944 ha, followed by non-agricultural land (roads, rivers, lakes, barren land, etc.) with an area of 12,124 ha.

On the land use map, you can see the density of residential areas in waterlogging areas (floods), where the area has a flat slope of the land, such as on Cendrawasihstreet and its surroundings. In addition to residential buildings, there are also many constructions of trade and service facilities and infrastructure, such as malls and shophouses, by not considering the area of open space as a water catchment area (flood).

Po = 755.630 people
K = 1.300 l/year
PAM = 1.051.200 m^3/year
Pa = 157.680 m^3/year
z = 2049,82 m^3/second
Lt = <u>1.870 x (755.600) - 1.051.200 - 157.680</u>
2049,82
= 47, 332 Km^2

Based on the data obtained related to the population, water supply capacity, water consumption, water potential that has not been utilized, and the results of calculating the soil's ability to absorb water, it is known:

1. The total population of Samarinda City in 2011 was 755,630 people
2. The area of Samarinda City is 718Km^2.
3. The water supply capacity by PDAM Samarinda City annually is 1,051,200 m^3/year.
4. Water consumption by residents of Samarinda City every year is 1,300 l / year.
5. The potential for water that has not been mandated in Samarinda City is 25.18 m3 / second.
6. The ability of the soil to absorb water following the calculation of rain discharge is seen from the aspects of the land slope, rainfall, soil type, and land use pattern of 2049.82 m^3 / second.

V. Conclusion

From the calculation of the need for open space located in Samarinda City, the area of open space as a water catchment area is 47,332 Km².

The need for an open area based on the total population in Samarinda City of 755,630 people requires open space covering an area of 1,511 Km². The most open space is needed for the highest population of 124,609 people covering an area of 0.249 Km² in Samarinda Ulu District. In contrast, the least open space is required for the total population in Samarinda City District, which is 33,165 people covering an area of 0.066 Km².

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