NAKAYASU UNIT HYDROGRAPH SYNTHETIC OF BENDUNG WATERSHED

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Abstract. Floods occur during the rainy season has become routine events in several cities in Indonesia. Various reasons to trigger the occurrence of flooding, among other drainage network system capacity is decreased, increasing water flow, or a combination of both. The capacity of the drainage channel has been calculated based on the design criteria to accommodate the flow of water occurs so that the area is not experiencing inundation or flooding. The reduced system capacity due to, among others, many precipitates, physical damage or their network systems and illegal buildings on the system network. While the cause of the discharge increases, among others, high rainfall out of habit, changes in land use, environmental damage to the watershed in a region. Cases like mentioned above also occur in Bendung watershed, so it is necessary to study the drainage network performance evaluation system based on the concept of sustainable drainage based on community participation. Good and bad, high and low of the drainage network system performance is large determined by community participation in management, especially with the lack or absence of funds from Palembang city government for the management of drainage network system

Keywords**:** drainage networks system, sustainable drainage, community participation

I. INTRODUCTION

The flood disaster became a regular phenomenon in the rainy season which is spread in different watersheds (DAS) in most parts of Indonesia. Total incidence of flooding in the rainy season over the last 3 years as well as the increasing number of human casualties and loss of property and facilities from public / social, transport infrastructure and infrastructure for agriculture / irrigation (Soenarno, 2014).

In addition to the problem of precipitation as factors, the incidence of disasters cannot be separated from environmental damages to ecosystems that occur in the watershed and poor management of water resources. Their land damage leading to increased surface runoff coefficient greater. The area upstream watershed is an area of a particle will be increasingly vulnerable to drought, precisely the opposite downstream areas prone to flooding (Nugroho, 2004).

Flooding is a flow / puddle that caused economic losses or even cause loss of life (Asdak, 1995). Flow / puddles can occur because of the outburst in the area in the right or left of the river due to river channel does not have enough capacity for the flow rates through (Sudjarwadi, 1987).

Puddles / flooding is not only experienced by urban area located in the lowlands, even experienced area located in the highlands. Flooding or inundation in a region occurs when the system that serves to accommodate the inundation was not able to accommodate the discharge flow, it is the result of three possibilities occur: the capacity of the system to decrease the flow rate of water increases, or a combination of both. Understanding the system here is a system of drainage network in a region. While the drainage system can be generally defined as a series of waterworks that serve to reduce and / or remove excess water (flooding) of a region or land, so the land can function optimally, so the drainage system is an engineering infrastructure of the region to cope with the inundation floods (Suripin, 2004).

Drainage network system in a region already properly designed to accommodate normal flow rates, especially during the rainy season. This means that the capacity of the drainage channel is already taken into account to accommodate the flow of water occurs so that the area is not experiencing inundation or flooding. If the capacity of a drainage channel system decreases due to various reasons, the normal discharge even cannot be accommodated by the existing system. While declining because drainage capacity, among others, there are many deposition, physical damage tissue system, the other buildings on top of the network system. At certain times during the rainy season is often an increase in the flow rate, or there has been increased discharge caused by various reasons, the capacity of the existing system can no longer accommodate the flow rates, resulting in flooding in a region. While the cause of the increased discharge include high rainfall out of habit, changes in land use, environmental damage to the watershed in a region. Then if an urban or regional decrease system capacity at the same time an increase in the flow rate, the flooding is increasing, both the frequency, extent, depth and duration.

II. METHODS

A. Research location

The location of this study is Bendung watershed. The research location as in figure 1.

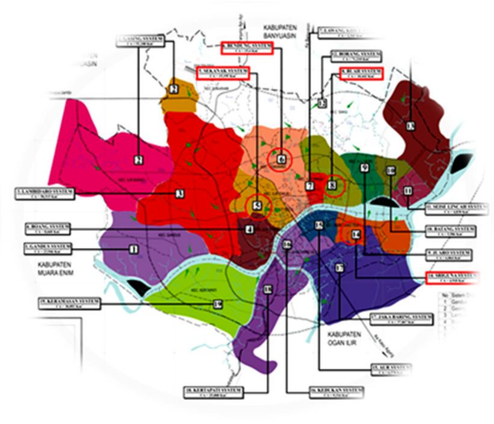

Fig 1. Map Location Research

B. Tools and materials

To support research activities required some research tools. The tools will be used in this research are as shown in Table I.

No.	Tool name	Amount	Be used
1	Stationery	1 box	Write the results of data recording
2	Computer (RAM 2 GB)	1 unit	To perfom of general modeling
3	Printer	1 unit	Displays of reort form
4	Software GIS, Arc-View, MS-Excel	1 piece	To perfom modelling and data processing
5	Laptop dan Printer	1 piece	Assist in preparing reports

The data used in the analysis as shown in Table II based on the type, nature, source and unit of data.

TABLE II
TYPE AND SOURCES OF DATA REQUIRED

No.	Data types	P	S	Sources	Unit
1.	Tidal	√		Field	m
2.	Bathymetry		√	Bakorsurtanal /Pelindo II	m
3.	The height and Flood Inundation pattern		√	BBWSS-VIII	m
4.	River Hydrometry	√		Field	m^3/s
5.	Precipitation (rainfall depth, time of concentration and intensity of rainfall)		√	BMG	mm, hours and (mm/hr)
6.	Land (soil texture, organic matter content, soil structure, and ground conditions, and the type of soil	√		Field	
7.	Land use		√	PUBM&WR	
8.	Geomorphology (Geometry & Morphometry)		√	BPDAS	

Source: author's propose, 2014

III. RESULTS AND DISCUSSION

A. Drainage System Bendung Watershed

Central Sekip is located in the Ilir Timur II district. Using gravity drainage system that depends on the topography. Drainage condition can be described as follows:

1. Location of main drain drainage is the Musi River,
2. Channel is the primary drainage Bendung river that empties into the Musi River,
3. The secondary drainage channels on the drainage channel that empties into the Bendung river.

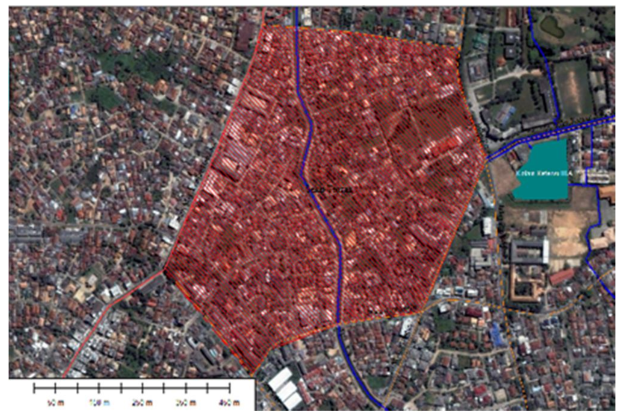

Fig 2. Location central of Sekip

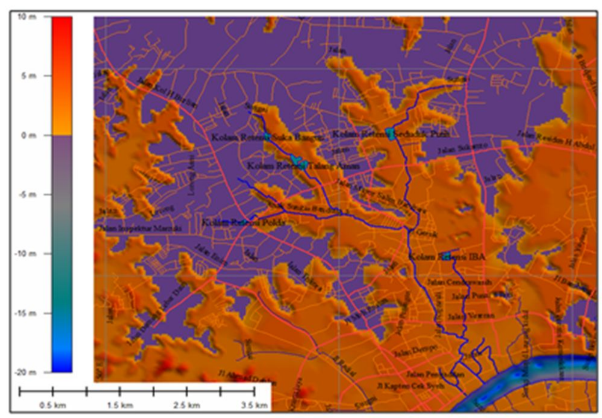

Fig 3.Topographic maps

B. Intensity of Rainfall

The intensity of rainfall that is used is the rainfall intensity data from the calculation of the Normal Distribution.

TABLE IIII
INTENSITY OF RAINFALL

R (year)	X_T (mm/hour)
2	72.18
5	83.66
10	89.67
20	94.59

50	100.19
100	104.01

Period re-elected for further calculations that the return period of 2 years.

C. Runoff coefficient

Runoff coefficient reflects the state of the surface flow area. Drainage coefficient, C is the ratio of the volume of water that reached the mouth of the river basin with the volume of water that fell on the watershed.

Value for drainage coefficient, C and the data obtained from Bappeda office, extensive land use for residential areas are:

Size high density = 7.09 square km
Extensive catchment area = 7.37 square km
Comprehensive trade area = 4.73 square km

Based on the flow coefficient for residential areas with a high density area and retrieved 0.70 to 0.20 wide catchment areas taken as well as to extensive trade area taken 0.90. Then the value Cw:

$$C_w = \frac{A_1C_1 + A_2C_2 + A_nC_n}{A_1 + A_2 + A_n} \qquad \text{.........................} (1)$$

$$C_w = \frac{(7.09 \times 0.7) + (7.37 \times 0.2) + (4.73 \times 0.9)}{7.09 + 7.37 + 4.73} = 0.56$$

runoff coefficient values obtained, C_w = 0.56 and in the calculation taken C_w = 0.60.

TABLE IV
RUN-OFF COEFFICIENT C

Region	Land use	C
Urban	Rural settlement region:	
	- Low density	0,25-0,40
	- High density	0,40-0,70
	- Wells	0,70-0,80
	Trade zone	0,20-0,30
	Industrial area	0,90-0,95
	Park, green lines, gardens, etc	0,80-0,90
		0,20-0,30
Rural	Hills, slope < 20%	0,40-0,60
	Canyons region, slope > 20%	0,50-0,60
	Land with terrasing	0,25-0,35
	Rice fields	0,45-0,55

D. Design Capasity

Determination of flood discharge plan to do with Nakayasu Synthetic Unit Hydrograph method. Before entering in the calculation of the discharge plan using Synthetic Unit Hydrograph of Nakayasu method are necessary length of the Bendung river data and Bendung watershed area. Bendung watershed is divided into sub-watershed with the help of Global Mapper program. Bendung watershed division can be seen in figure 4 and table VI.

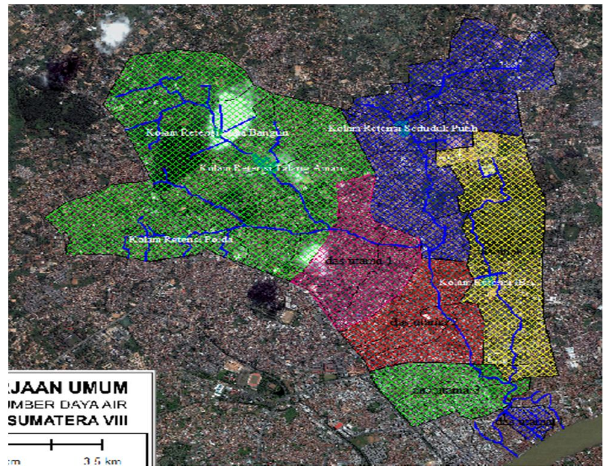

Fig 4 Distribution of Bendung watersheed with Global Mapper program

TABLE V
SIZE AND LENGTH OF THE BENDUNG RIVER

No	River	Large (km^2)	Length (km)
1	Secondary 1	6.07	12.04
2	Secondary 2	3.29	4.24
3	Secondary 3	2.38	4.90
4	Primary 1	1.36	1.22
5	Primary 2	1.36	1.56
6	Primary 3	0.91	0.99
7	Primary 4	0.17	0.99

Once of the entire price discharge curve for each interval time is unknown, enter these prices in the table below to get the price of runoff that occurs on an hourly basis with certain variations in rainfall.

TABLE VI
AMOUNT OF RUN-OFF CAUSED BY RAINFALL WITHIN 24 HOURS

t	U(t,1)	Akibat Hujan (mm/jam)						Jumlah
jam	(m^3/s)	28.25	17.66	14.13	5.65	3.53	1.41	(m^3/s)
0	0.00	0.000						0.000
1	0.05	1.482	0.000					1.482
2	0.28	7.822	0.926	0.000				8.749
3	0. 22	16.789	4.889	0.741	0.000			22.419
4	0. 13	10.16	10.49	3.91	0.29	0.00		24.86
5	0. 08	6.15	6.35	8.39	1.56	0.18	0.00	22.64
6	0. 06	3.72	3.84	5.08	3.35	0.97	0.07	17.05
7	0. 04	3.39	2.32	3.07	2.03	2.09	0.39	13.31
8	0. 03	2.42	2.12	1.86	1.23	1.27	0.83	9.74
9	0. 02	1.73	1.51	1.69	0.74	0.76	0.50	6.97
10	0. 01	1.24	1.08	1.21	0.67	0.46	0.30	4.99
11	0. 01	0.88	0.77	0.86	0.48	0.42	0.18	3.62
12	0. 01	0.87	0.55	0.62	0.34	0.30	0.17	2.87
13	0. 00	0.68	0.54	0.44	0.24	0.21	0.12	2.26
14	0. 00	0.53	042	0.43	0.17	0.15	0.08	1.81

15	0. 00	0.41	0.33	0.34	0.17	0.11	0.06	1.43
16	0. 00	0.32	0.25	0.26	0.13	0.11	0.04	1.13
17	0. 00	0.25	0.20	0.20	0.10	0.08	0.04	0.89
18	0. 00	0.19	0.15	0.16	0.08	0.06	0.03	0.69
19	0. 00	0.15	0.12	0.12	0.06	0.05	0.02	0.54
20	0. 00	0.11	0.09	0.09	0.05	0.04	0.02	0.42
21	0. 00	0.09	0.07	0.07	0.03	0.03	0.01	0.32
22	0. 00	0.07	0.05	0.05	0.03	0.02	0.01	0.25
23	0.00	0.05	0.04	0.04	0.02	0.01	0.01	0.19
24	0.00	0.04	0.03	0.03	0.01	0.01	0.00	0.15

Source: analysis result, 2014

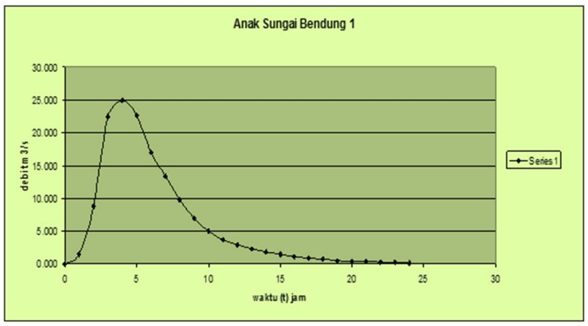

Fig 5. Synthetic hydrograph unit of Bendung watershed

IV. CONCLUSIONS

Based on the results of the previous analysis, we can conclude the following matters:

1. Most of the people around Bendung basin understand that the drainage canal/river should be maintained regularly to keep it functioning properly synergy between the cities of Palembang and society.
2. The involvement of the community in terms of drainage network system river is still very low as well as public awareness for contributions in the form of WTP (Willingness To Pay) or the ability of society to pay for maintenance and repair of tissue damage drainage/river.
3. Performance of the drainage network system/river of Palembang cities in this research study is technically no problem. This is in accordance with the analysis and empirical approach in river flood control systems in urban areas. Pattern priorities are in accordance with the policy direction of the handling of drainage/river in the form of integrated and systematic pattern of handling and sustainable, especially in Bendung watershed.

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