Banger Retention Pool As Alternative Control Flood

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Abstract. Semarang Utara is a lowland where the water level is approximately 2m above sea level so that if the weather is bad, waves or tidal waves occur, sea water will intrude onto the land . This happens almost every day, so a barrier is needed to prevent sea water intrusion into land . Before there was handling then It would be best to create an alternative retention pool simulation in the Banger *chatment area* . The method used uses primary data and secondary data taken from rainfall data closest to the B anger location, namely BMKG Mariti m. Retention pool simulation results and alternative pump capacities 1 with a pond area of 3.8 ha, input volume 1,199,070 m3 and output volume 432,000 m3, alternative 2 with a pond area of 4.7 ha, input volume 1,198,800 m3 and output volume 432,000 m3, alternative 3 with extensive 5 ha pond, input volume 1,199,070 m3 and output volume 432,000 m3 .

Keyword : Pool Retention, Pumps, Channels

1. Introduction

Floods are a natural event that is often found in parts of Indonesia. In some areas, floods can occur during the rainy season or dry season. Naturally, floods are caused by rainfall, river physiography, erosion, sedimentation, inadequate river capacity and the influence of tides. [1] Meanwhile, human factors that cause it are changes in the condition of river basins, slum areas, garbage, land drainage, weirs and water structures, damage to flood control structures and improper flood control system planning.

Semarang is one of the cities in Indonesia that still experiences frequent flooding, especially during the rainy season. With quite high rainfall, the location of the city of Semarang which is very close to the sea coupled with land subsidence *in* several areas in the city of Semarang makes flooding inevitable. To overcome the flooding problem, an integrated system is needed with the areas around the flood location. One of the measures to overcome urban flooding carried out by the government is to build polders.

1.1. Retention pond

A retention pond is a basin or pond that can temporarily hold or absorb the water contained in it. The function of retention ponds is to replace the role of infiltration land which is used as closed/residential/office land, so the absorption function can be replaced with retention ponds. The function of this pond is to collect direct rainwater and flow from the system to be absorbed into the ground. However, this retention pond needs to be placed in the lowest part of the land. The number, volume, area and depth of these pools really depend on how much land is converted into residential areas.

1.2. System Polder

The polder system is a system that hydrologically separates its area from its surroundings, either naturally or artificially, and is equipped with embankments, internal drainage systems, pumps and/or reservoirs and sluice gates. The polder system is a system that allows the original land elevation, and the water is lowered by control using a pump and embankments or other management. [2]

System polder is system handling drainage urban with method isolate that area served (*catchment area*) against water inflow from the sea system, both in the form of runoff (*overflow*) and flow below the ground surface (culverts and seepage), as well as control height advance water flood in in system in accordance with planned needs. [3]

The Kali Banger Polder is a small polder system covering an area of around 600 hectares. This polder area is an area prone to flooding caused by high tides and heavy rain. Based on previous research, this area also has land subsidence problems , with subsidence rates ranging from 9 to 15 cm per year. [4]

2. Methods

Study location is within *the Catchment Area* (CA) of the Banger Watershed. Primary data was obtained by making observations and direct measurements in the field. The primary data used consists of Polder area data, existing drainage channel capacity (dimensions, flow direction) and Pump Capacity. Secondary data is data obtained or sourced from related agencies and which have carried out measurements. Secondary data used in this research is data bulk rain, flood discharge and use land .

2.1. Hydrological Analysis

The first step is to find out the correlation model between *catchment area, water storage*, pump capacity in the polder system data collection - the rainfall data obtained, hydrological analysis is carried out which produces the planned flood discharge, which is then processed again For look for big *flood routing* which the result used For determined elevation embankment. Analysis hydrology For Retention pond planning includes four things, namely:

a. Flow enter (inflow) Which fill in pool retention.
b. Flood plan For determine capacity and dimensions embankment
c. Storage pool retention.
d. Flow go out (outflow) For determine lots of water Which go out.

Hydrological analysis is used to obtain the magnitude of the planned flood discharge in a planning Correlation Model of Catchment Area, Water Storage, Pump Capacity in the Polder System in Semarang. As for steps For get debit plan is as following :

a. Determine Area Flow River (watershed) along with its area.
b. Determine wide influence area rain stations .
c. Determine bulk Rain maximum daily average watershed from bulk data the rain There is.
d. Analyze planned rainfall with period repeat T years.
e. Calculate the planned flood discharge based on the planned rainfall over a return period of T years.

2.2. Simulation Method

Simulation is conducted after hydrological analysis is carried out according to the rainfall station data obtained so that it can be known how much water can be accommodated in the retention pond. Flood discharge evaluation is carried out by comparing channel capacity and flood discharge due to 5, 10 and 15 annual maximum rainfall. The results of this evaluation will be known channel sections that experience runoff. This event will provide an overview of the existing conditions of the channels within the polder system.

3. Results and Discussion

3.1. Distribution Bulk Rain Region (Area watershed)

Daily rain data comes from the station the closest rainfall around the Banger watershed viz Tanjung Mas Maritime Rainfall Station Semarang . Distribution section and area influence The rain station is based on 2 other nearby stations, namely Karangroto and Pucanggading using the Thiessen method with the help of ArcGIS 10.5 software as follows :

Table 1. Wide Influence Station Rain to watershed Bangers

Catchment Areas	Wide Catchment Areas (m^2)	Thiessen coefficient
CA Maritime	2,494.42	1.00
Wide watershed Bangers	6,724.23	1.00

Source : Results Analysis, 2019

Table 2. Bulk Rain Maximum Area On Station Rain Maritin

No	Year	Date	Bulk Maximum Rain
1	2006	January 28	156.50
2	2007	November 6	78.40
3	2008	February 19	96.10
4	2009	December 25	104.50
5	2010	December 11	168.60
6	2011	January 2	89.00
7	2012	February 4	96.00
8	2013	February 23	135.30
9	2014	January 23	120.50
10	2015	February 13	119.00
11	2016	April 11	74.00

Source : Results Analysis, 2019

3.2. Frequency Analysis

Following is steps in analysis frequency using A Prob software version 4.1:

a. Inputs program is Rain watershed Bangers in accordance on **Table 3** in below

Table 3. Banger Watershed Rainfall

No	Year	Rain watershed
1	2006	156.50
2	2007	78.40

No	Year	Rain watershed
3	2008	96.10
4	2009	104.50
5	2010	168.60
6	2011	89.00
7	2012	96.00
8	2013	135.30
9	2014	120.50
10	2015	119.00
11	2016	74.00

Source : Results Analysis, 2019

b. The DAS rainfall data is then automatically identified by A Prop as statistical data in the form of average (Xrt), Standard Deviation (SD), Kurtosis Curve, and Skewness Curve. Table 4 is normal data statistics, and Table 5 is logarithmic data statistics.

Table 4. Statistics Data Normal

No	Statistics Normal Data		
1	amount data	:	11.00
2	minimum	:	74.00
3	maximum	:	168.60
4	average	:	107.60
5	deviation standard	:	15.95
6	kurtosis	:	3.20
7	excess kurtosis	:	0.20
8	skewness	:	- 0.30

Table 5. Statistics Data Logarithmic

No	Statistics Logarithmic Data		
1	amount data	:	11.00
2	minimum	:	1.90
3	maximum	:	2.13
4	average	:	2.02
5	deviation standard	:	0.07
6	kurtosis	:	3.30
7	excess kurtosis	:	0.30
8	skewness	:	- 0.67

c. To guarantee that empirical approach can really be represented by a theoretical curve, it is necessary to carry out a distribution suitability test, commonly known as *testing of goodness of fit* . There are two types of alignment tests, namely the chi-square and Smirnov alignment tests Kolmogorof. On test This Which observed is results calculation Which expected. A Prob has accommodated this alignment test with a confidence level of 0.90. Data from the distribution alignment test results are summarized again in **Table 6.**

Table 6. Test Compatibility Data

Test Compatibility To Spread Data				
Method	**Gumbel**	**Normal Logs**	**Logs Person III**	**Normal**
Smirnov-Kolmogorov	Passed	Passed	Passed	Passed
Maximum difference	0.100	0.094	0.090	0.120
Chi-square	Passed	Passed	Passed	Passed
Chi-2 maximum	4,696	6,522	6,522	5,304

Source : Results Analysis, 2019

In the table above, it can be concluded that the rain data alignment test meets the requirements for the distribution of Log Pearson III with the smallest maximum difference, namely 0.090. Proven by the Smirnov-Kolmogorof and Chi-Square tests, data distribution Pearson III log passed.

d. Next, the inflow and rain data are plotted on *Probability Paper* to see whether the data *is outlayer* or not. Based on the output of the A Prob model, no deviant watershed rainfall data was found. A Prob automatically generates plotting data on probability paper usually drawn in a way manually. Picture plotting data on *Probability Paper* can be seen in **Figure 1.**

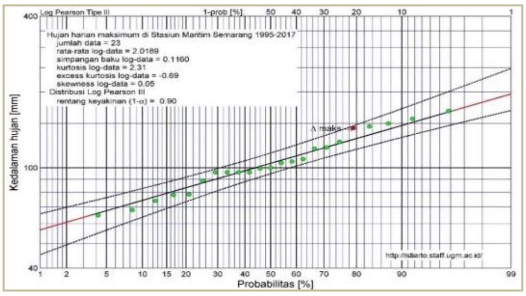

Figure 1. Plotting Logs Person III Probability Paper

e. Based on determining the distribution of data in point 3 above, the quantity can be known rain return period as in **Table 7.**

Table 7. Kala Repeat Rain Banger Watershed Based on Sta. Maritime Rain

Return Time	**Logs Pearson III**
2	104
5	131
10	147
20	163
50	182
100	196
200	211
500	229
1000	243

Source : Results Analysis, 2019

3.3. Analysis Intensity Bulk Rain

This rainfall intensity analysis can be processed from rainfall data that has occurred on period past. Analysis intensity bulk Rain related with time concentration (tc). Formula Which used For look for time concentration use equality *Kirpich* , as following :

$$tc = \frac{0{,}87\ x\ L^{2^{0,385}}}{(1000\ \mathrm{X}\ S)}$$

t_c : time concentration (hour)
L : long trajectory water from point farthest until point which reviewed (km)
S : average slope of the water passage area

Based on results analysis obtained time concentration during 1 hour, so that *hyetograph* Which used is *hyetograph* Rain 1 hour. The planned rainfall data is used as a basis for calculations to determine the amount of rainfall intensity. This is done by taking an approach through the hourly rain *hyetograph diagram.* DAS rainfall with a 50 year return period of 182 mm is plotted on a *hyetograph graph* . The following is *a hyetograph* of the rainy days of the Banger watershed.

3.4. Analysis Debit Flood with E.P.A SWMM 5.1.

In planning the Banger drainage system, it is planned using the Polder system, namely by utilizing channel drainage become pool shelter or normal called *long storage*. By adding a pump station that was built to remove water from *long storage* .

The storage characteristic curve has been identified and is used as input The planned database of retention ponds in this analysis is displayed in the following tables.

Table 8. Characteristics Storage Pool alternative 1

Depth (m)	Elevation (m)	Wide (Ha)	Volume (1000 m3)	Vol Comm (1000 m3)
3	1	5.0	5.0	15.0
2	0	5.0	5.0	10.0
1	- 1	5.0	5.0	5.0
0	- 2	5.0	0.0	0.0

Table 9. Characteristics Storage Pool Alternative 2

Depth (m)	Elevation (m)	Wide (Ha)	Volume (1000m3)	Vol Comm (1000m3)
3	1	3.8	3.8	11.4
2	0	3.8	3.8	7.6
1	- 1	3.8	3.8	3.8
0	- 2	3.8	0.0	0.0

Table 10. Characteristics Storage Pool Alternative 3

Depth (m)	Elevation (m)	Wide (Ha)	Volume (1000m3)	Vol Comm (1000m3)
3	1	4.7	4.7	14.2
2	0	4.7	4.7	9.5
1	- 1	4.7	4.7	4.7
0	- 2	4.7	0.0	0.0

3.5. Planning System Pump

Selection refers to the development of river water levels or flood water discharge and the manufacturer's capacity with a certain capacity. [5] Following This is analysis pump operation using EPA SWMM 5.1.

a. Simulation Capacity Pump in use on alternatives Pool 1 with Wide Pool 3.8 HA

Table 11. Simulation Capacity Pump

Time (t)	Δt (minute)	Debit Inputs (m3/s)	Volume Input (m3)	Capacity Pump (m3/s)	Volume Outputs (m3)	ΔStorage	Volume Pool (m3)
0:00:00	15	0	0	0.00	0.00	0.00	114,000.00
0:15:00	15	0	0	0.00	0.00	0.00	114,000.00
0:30:00	15	0	0	0.00	0.00	0.00	114,000.00
0:45:00	15	0.74	19,980	4.00	108,000.00	-88,020.00	25,980.00
1:00:00	15	10.47	302,670	4.00	216,000.00	86,670.00	112,650.00
1:15:00	15	19.23	801,900	8.00	324,000.00	477,900.00	590,550.00
1:30:00	15	21.2	1,091,610	8.00	432,000.00	659,610.00	1,250,160.00
1:45:00	15	23.21	1,199,070	8.00	432,000.00	767,070.00	2,017,230.00
2:00:00	15	12.87	974,160	8.00	432,000.00	542,160.00	2,559,390.00
2:15:00	15	9.25	597,240	8.00	432,000.00	165,240.00	2,724,630.00
2:30:00	15	7.91	463,320	8.00	432,000.00	31,320.00	2,755,950.00
2:45:00	15	5.76	369,090	8.00	432,000.00	-62,910.00	2,693,040.00
3:00:00	15	4.28	271,080	4.00	324,000.00	-52,920.00	2,640,120.00
3:15:00	15	3.24	203,040	4.00	216,000.00	-12,960.00	2,627,160.00
3:30:00	15	2.49	154,710	4.00	216,000.00	-61,290.00	2,565,870.00
3:45:00	15	1.94	119,610	4.00	216,000.00	-96,390.00	2,469,480.00
4:00:00	15	1.11	82,350	0.00	108,000.00	-25,650.00	2,443,830.00
4:15:00	15	0.96	55,890	0.00	0.00	55,890.00	2,499,720.00
4:30:00	15	0.8	47,520	0.00	0.00	47,520.00	2,547,240.00
4:45:00	15	0.69	40,230	0.00	0.00	40,230.00	2,587,470.00
5:00:00	15	0.57	34,020	0.00	0.00	34,020.00	2,621,490.00
5:15:00	15	0.5	28,890	0.00	0.00	28,890.00	2,650,380.00
5:30:00	15	0.44	25,380	0.00	0.00	25,380.00	2,675,760.00
5:45:00	15	0.38	22,140	0.00	0.00	22,140.00	2,697,900.00
6:00:00	15	0.34	5.40	0.00	0.00	5.40	2,697,905.40
6:15:00	15	0.31	4.88	0.00	0.00	4.88	2,697,910.28
6:30:00	15	0.28	4.43	0.00	0.00	4.43	2,697,914.70
6:45:00	15	0.26	4.05	0.00	0.00	4.05	2,697,918.75
7:00:00	15	0.23	3.68	0.00	0.00	3.68	2,697,922.43
7:15:00	15	0.22	3.38	0.00	0.00	3.38	2,697,925.80
7:30:00	15	0.2	3.15	0.00	0.00	3.15	2,697,928.95

Pump capacity used is 4m3/sec with a quantity of 2 pieces. Pump operation is carried out at the 45th minute, pump 1 turns on for 1 hour then the second pump turns on with a total pump capacity of 8 m3/sec.

b. Simulation Capacity Pump in use on alternatives Pool 1 with Wide Pool 4.7 HA

Table 12. Simulation Capacity Pump

Time (t)	Δt (minute)	Debit Inputs (m3/s)	Volume Input (m3)	Capacity Pump (m3/s)	Volume Outputs (m3)	ΔStorage	Volume Pool (m3)
0:00:00	15	0	0	0.00	0.00	0.00	141,000.00
0:15:00	15	0	0	0.00	0.00	0.00	141,000.00
0:30:00	15	0	0	0.00	0.00	0.00	141,000.00
0:45:00	15	0.74	19,980	0.00	0.00	19,980.00	160,980.00
1:00:00	15	10.47	302,670	4.00	108,000.00	194,670.00	355,650.00
1:15:00	15	19.23	801,900	8.00	324,000.00	477,900.00	833,550.00
1:30:00	15	21.21	1,091,880	8.00	432,000.00	659,880.00	1,493,430.00
1:45:00	15	23.19	1,198,800	8.00	432,000.00	766,800.00	2,260,230.00
2:00:00	15	12.87	973,620	8.00	432,000.00	541,620.00	2,801,850.00
2:15:00	15	9.24	596,970	8.00	432,000.00	164,970.00	2,966,820.00
2:30:00	15	7.92	463,320	8.00	432,000.00	31,320.00	2,998,140.00
2:45:00	15	5.75	369,090	4.00	324,000.00	45,090.00	3,043,230.00
3:00:00	15	4.28	270,810	4.00	216,000.00	54,810.00	3,098,040.00
3:15:00	15	3.24	203,040	0.00	108,000.00	95,040.00	3,193,080.00
3:30:00	15	2.49	154,710	0.00	0.00	154,710.00	3,347,790.00
3:45:00	15	1.95	119,880	0.00	0.00	119,880.00	3,467,670.00
4:00:00	15	1.11	82,620	0.00	0.00	82,620.00	3,550,290.00
4:15:00	15	0.97	56,160	0.00	0.00	56,160.00	3,606,450.00
4:30:00	15	0.81	48,060	0.00	0.00	48,060.00	3,654,510.00
4:45:00	15	0.69	40,500	0.00	0.00	40,500.00	3,695,010.00
5:00:00	15	0.6	34,830	0.00	0.00	34,830.00	3,729,840.00
5:15:00	15	0.51	29,970	0.00	0.00	29,970.00	3,759,810.00
5:30:00	15	0.44	25,650	0.00	0.00	25,650.00	3,785,460.00
5:45:00	15	0.39	22,410	0.00	0.00	22,410.00	3,807,870.00
6:00:00	15	0.34	5.48	0.00	0.00	5.48	3,807,875.48
6:15:00	15	0.28	4.65	0.00	0.00	4.65	3,807,880.13
6:30:00	15	0.23	3.83	0.00	0.00	3.83	3,807,883.95
6:45:00	15	0.24	3.53	0.00	0.00	3.53	3,807,887.48
7:00:00	15	0.22	3.45	0.00	0.00	3.45	3,807,890.93
7:15:00	15	0.2	3.15	0.00	0.00	3.15	3,807,905.63

Pump capacity used is 4m3/sec with a quantity of 2 pieces. Pump operation is carried out when the flow rate is 10.47 m3/s in the first hour pump 1 is on with a capacity of 4 m3/s. On 15 minute next pump to two turned on until debit 7.92 m3/sec. In minute to 15 next pump lowered with only operate 1 pump for 15 minutes.

c. Pump Capacity Simulation is used in alternative Pond 1 with a Pond Area of 5 Ha

Table 13. Simulation Capacity Pump

Time (t)	Δt (minute)	Debit Inputs (m3/s)	Volume Input (m3)	Capacity Pump (m3/s)	Volume Outputs (m3)	ΔStorage	Volume Pool (m3)
0:00:00	15	0	0	0.00	0.00	0.00	50,000.00
0:15:00	15	0	0	0.00	0.00	0.00	50,000.00
0:30:00	15	0	0	0.00	0.00	0.00	50,000.00
0:45:00	15	0.74	19,980	0.00	0.00	19,980.00	69,980.00
1:00:00	15	10.47	302,670	4.00	108,000.00	194,670.00	264,650.00
1:15:00	15	19.23	801,900	4.00	216,000.00	585,900.00	850,550.00
1:30:00	15	21.2	1,091,610	8.00	324,000.00	767,610.00	1,618,160.00
1:45:00	15	23.21	1,199,070	8.00	432,000.00	767,070.00	2,385,230.00
2:00:00	15	12.87	974,160	8.00	432,000.00	542,160.00	2,927,390.00
2:15:00	15	9.25	597,240	8.00	432,000.00	165,240.00	3,092,630.00
2:30:00	15	7.91	463,320	8.00	432,000.00	31,320.00	3,123,950.00
2:45:00	15	5.76	369,090	8.00	432,000.00	- 62,910.00	3,061,040.00
3:00:00	15	4.28	271,080	4.00	324,000.00	- 52,920.00	3,008,120.00
3:15:00	15	3.24	203,040	4.00	216,000.00	- 12,960.00	2,995,160.00
3:30:00	15	2.49	154,710	4.00	216,000.00	- 61,290.00	2,933,870.00
3:45:00	15	1.94	119,610	4.00	216,000.00	- 96,390.00	2,837,480.00
4:00:00	15	1.11	82,350	0.00	108,000.00	- 25,650.00	2,811,830.00
4:15:00	15	0.96	55,890	0.00	0.00	55,890.00	2,867,720.00
4:30:00	15	0.8	47,520	0.00	0.00	47,520.00	2,915,240.00
4:45:00	15	0.69	40,230	0.00	0.00	40,230.00	2,955,470.00
5:00:00	15	0.57	34,020	0.00	0.00	34,020.00	2,989,490.00
5:15:00	15	0.5	28,890	0.00	0.00	28,890.00	3,018,380.00
5:30:00	15	0.44	25,380	0.00	0.00	25,380.00	3,043,760.00
5:45:00	15	0.38	22,140	0.00	0.00	22,140.00	3,065,900.00
6:00:00	15	0.34	5.40	0.00	0.00	5.40	3,065,905.40
6:15:00	15	0.31	4.88	0.00	0.00	4.88	3,065,910.28
6:30:00	15	0.28	4.43	0.00	0.00	4.43	3,065,914.70
6:45:00	15	0.26	4.05	0.00	0.00	4.05	3,065,918.75
7:00:00	15	0.23	3.68	0.00	0.00	3.68	3,065,922.43
7:15:00	15	0.22	3.38	0.00	0.00	3.38	3,065,925.80
7:30:00	15	0.2	3.15	0.00	0.00	3.15	3,065,928.95
7:45:00	15	0.19	2.93	0.00	0.00	2.93	3,065,931.88

Time (t)	Δt (minute)	Debit Inputs (m3/s)	Volume Input (m3)	Capacity Pump (m3/s)	Volume Outputs (m3)	ΔStorage	Volume Pool (m3)
8:00:00	15	0.18	2.78	0.00	0.00	2.78	3,065,934.65
8:15:00	15	0.19	2.78	0.00	0.00	2.78	3,065,937.43
8:30:00	15	0.17	2.70	0.00	0.00	2.70	3,065,940.13
8:45:00	15	0.16	2.48	0.00	0.00	2.48	3,065,942.60

The pump capacity used is 4 m3/s with 2 units. Operation pumping is carried out at a flow rate of 10.47 m3/s in the first hour pump 1 is on with a capacity of 4 m3/s. In the next 30 minutes the second pump was turned on with a capacity of 4m3/sec. The first pump was turned off at 3 hours and operated for 45 minutes.

4. Conclusion

Flood management is not only a structural method, which involves technical matters such as infrastructure development, but also a non-structural method that deals with societal and socio-cultural aspects. Semarang city's flood management efforts must be conducted in a comprehensive and integrated manner starting from the planning, implementation, evaluation, reconstruction and revitalisation stages.

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