International Journal of Engineering and Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 12 Issue 5 May 2023 || PP 45-52

Hydrological Analysis of the Impact of Black Water Polder Revitalization in Samarinda City

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ABSTRACT
Air Hitam Polder has an area of 6,012 ha with a catchment area of 230. 4 ha, built to reduce the problem of flooding or waterlogging in Jalan A.W Syahranie and surrounding roads. Over time the location became one of the places used by the community for sports, travel and recreation. With the addition of this function, it impacts environmental problems, which are one of the focuses of the Samarinda City Government to carry out revitalization. The impact of the revitalization requires an analysis of the existing hydrology so that the condition of the Polder can be known and recommended in further stages of treatment. The results of hydrological analysis using hydrological calculation methods resulted in the Polder apparatus being unable to accommodate the cumulative volume of rainwater for 12 hours fully. Polder capacity can only accommodate the cumulative volume of rainwater for 7.33 hours. Polder capacity with an area of 6,012 can only accommodate the cumulative volume of rainwater, amounting to 83.3% of the total volume capacity that must be accommodated. The hydrological analysis recommends dredging on the Polder to restore the initial planning function by strengthening the Polder cliff structure. If not strengthened, it will impact the stability of the polder slope.
Keywords: *Hydrological Analysis, Black Water Polder, Samarinda City*

Date of Submission: 01-05-2023 Date of Acceptance: 21-05-2023

I. INTRODUCTION

The folder is designed in such a way and limited by dikes so that water runoff originating from outside the area cannot enter. Thus only surface flow or excess water coming from the area will be managed by the polder system. The polder system is a way of handling tidal floods with complete physical facilities of an inseparable water management unit, which includes: regional drainage systems, retention ponds, dikes around the area, pumps and sluices.

Samarinda's black water polder area has an area of 6,012 ha with a catchment area of 230.4 ha. It has become a place that is quite crowded with the people of Samarinda; the initial purpose of making polders is to reduce flooding or puddles on A.W Syahranie Road and surrounding roads. Over time, the Samarinda polder area, which was initially only a place to collect rainwater, gradually developed into an alternative green open space (RTH) that is often crowded for sports activities such as jogging and cycling, recreational activities such as enjoying the scenery in the polder area and can also be a place for micro, small and medium enterprises (MSMEs) to market their wares.

The polder area can build a better image within the city of Samarinda. However, there needs to be an improvement in the governance system of facilities that do not support it. The polder area still looks irregular, and no previously arranged order exists. For this reason, it is necessary to revitalize the existing infrastructure at the location of the Black Water Polder. This arrangement certainly does not eliminate the primary function of the Polder as a retention pool area.

With the Black Water Polder revitalization plan, of course, a study is needed on the condition of the Black Water Polder in terms of hydrological analysis so that the existence of the Polder can still function properly. The Black Water Polder is needed to overcome flooding problems around the AW Road area. Syahranie, Jalan Kadrie Oening and Jalan Ir. H. Juanda in Samarinda City.

II. RESEARCH METHODS

A. Time and Place

The research was conducted from July to December 2022. The research location was at the Air Hitam Polder Revitalization, Samarinda City, East Kalimantan Province, Indonesia

B. Stages of Research

The stages of the research activities carried out are presented in Figure 1

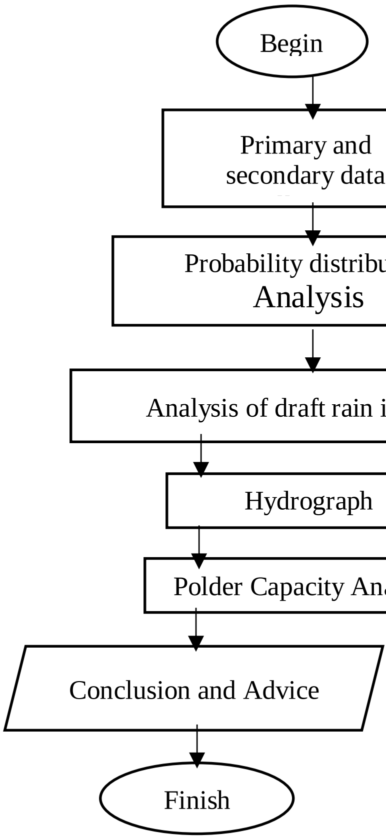

Figure 1. Research Flow Chart

C. Data Collection

Data collection is (1) primary data, namely direct measurements in the field, including topographic data, bathymetric data, and polder area data; and (2) secondary data obtained from related agencies, including rainfall data, inundation area data, other data following the study.

D. Data Analysis

A hydrological analysis of the condition of the Black Water Polder in Samarinda City, there are several stages and methods used as follows:

1. Rainfall Data Analysis
   Analysis of rainfall data includes:
   a. Compilation of rainfall data by Excel method;
   b. Determination of Re-Time by method (NSPM) of the Department of Public Works of the Director General of Copyright;
   c. Analyze rain design with the Normal Distribution method, normal log distribution, Gumbel Distribution and Pearson Type III Log Distribution.
2. Probability Distribution Analysis using methods: Chi-Squared Test Method; normal probability distribution; normal log probability distribution; Pearson Type III Log Probability Distribution;
3. Calculation of rain intensity using the Mononobe Formula method.
4. Calculation of hydrography with synthesis unit (HSS) nakayasu.
5. Calculation of polders by the rational method.

III. RESULTS AND DISCUSSION

A. Rain Data Analysis

Maximum daily rainfall data in a year expressed in mm/day, for the rainfall station closest to the location of the drainage system or Polder, the least amount of rainfall data for ten consecutive years. Rain stations sometimes do not have complete data; if missing data is found, it needs to be completed by filling in data on incomplete or empty stations, with several methods as follows:

- If the difference in average annual rain at the station to be equipped is not more than 10%, to fill the lack of data can fill it with the average price of rain from surrounding stations.
- If the annual rain difference is more than 10%, complete the data with the Normal Ratio method by comparing the annual rain data of stations that lack data with surrounding stations.

The following table shows the maximum daily rainfall data for ten years (2012 to 2021) obtained at the Aji Pangeran Tumenggung Pranoto Samarinda Meteorological Station.

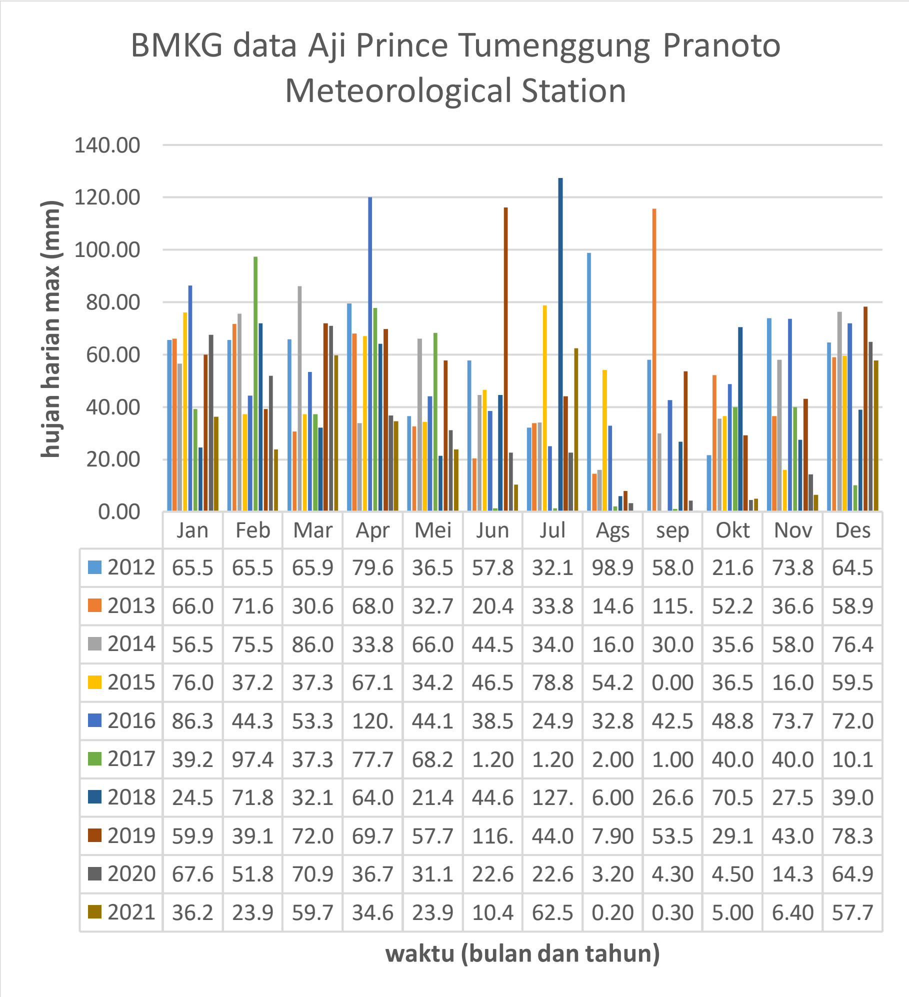

Figure 2. Maximum daily rainfall data from the Meteorological Station Aji Pangeran Tumenggung Pranoto Airport (10 Years Observation)

From the maximum daily rainfall data from the Aji Pangeran Tumenggung Pranoto Meteorological Station (10 Years Observation) maximum daily rainfall data is obtained as follows:

Table 1. Maximum daily rainfall data

Year	(mm/day)
2012	98.90
2013	115.70
2014	86.00
2015	78.80

2016	120.10
2017	97.40
2018	127.30
2019	116.10
2020	70.90
2021	62.50

Source : Aji Pangeran Tumenggung Pranoto Airport Meteorological Station

B. Determination of Rain Reset

Table 2. Maximum daily rainfall data

City Typology	Catchment Area (Ha)			
	< 10	10 - 100	10 - 500	> 500
Metropolitan City	2 Yrs	2 - 5 Yrs	5 - 10 Yrs	10 - 25 Yrs
Major Cities	2 Yrs	2 - 5 Yrs	2 - 5 Yrs	5 - 20 Yrs
Medium / Small Town	2 Yrs	2 - 5 Yrs	2 - 5 Yrs	5 - 10 Yrs

Source: Procedures for Making Retention and Polder Ponds (NSPM) Department of Public Works Director General Create Works

The plan for channels in areas with a catchment area of 230.4 Ha is taken from Table 5 above; the catchment area obtained from Big Cities with catchment areas of 10 - 500 is then taken when resetting the five areas.

C. Analystis Rain Plan

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Table 3. Determination of Distribution Type

No.	Types of Distribution	Condition $C_s \approx 0$
1.	Usual	
		$C_s \approx C_v^3 + 3C_v$ $C_k \approx 3$
2.	Log-Normal	$C_k \approx C_v^8 + 6C_v^6 + 15C_v^4 + 16C_v^2 + 3$
		$C_s \approx 1.14$
3.	Gumbel	$C_k \approx 5.4$
4.	Log Person III	Other than the above values

Source: Suripin, 2004, Sustainable Urban Drainage Systems

From the results of calculations to analysis of rain plans that produce a recapitulation of calculations as follows:

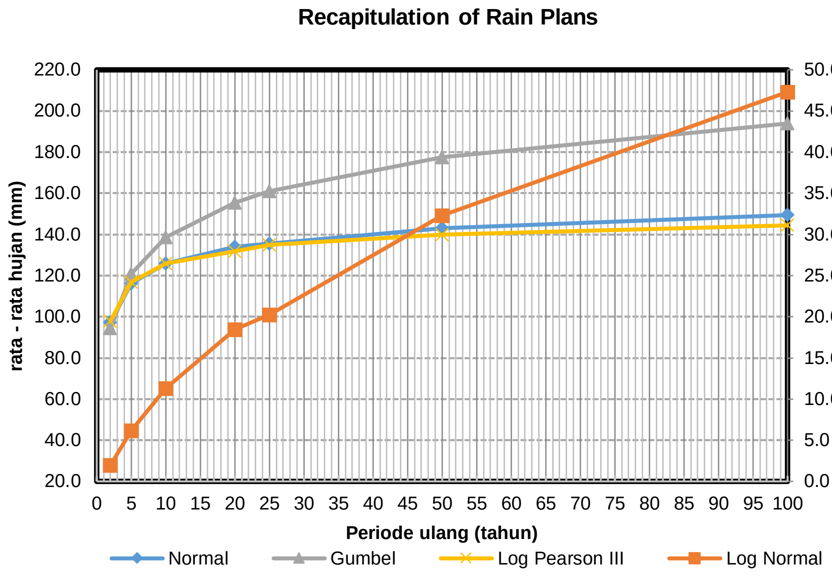

Figure 3. Analyst Recapis Rain Plan (Source: Calculation result)

D. Probability Distribution

The calculation results with various probability distribution methods are presented in Table 4 below :

Table 4. Recapitulation of Probability Distributions

No	Probability Distribution	x^2	X_{cr}^2	Information
1	Gumbel	1.00	5.991	Accepted
2	Usual	2.00	5.991	Accepted
3	Log-Normal	2.00	5.991	Accepted
4	Pearson Type III logs	4.00	5.991	Accepted

Source: Calculation result

The data in Table 4 shows that the values in the recapitulation of all probability distributions have x^2 < X_cr^2, so it can be stated that all distributions are acceptable. However, the Gumbel Probability Distribution is the best way to analyze the rain data series.

E. Rain Intensity Plan

Rain intensity is the height or depth of rainwater unity time. The intensity of rain depends on the length and magnitude of the rain. The longer the rain lasts, the intensity will tend to be higher, and vice versa. The shorter the duration of the rain, the smaller the intensity. Rain Intensity Plan using Mononobe Formula. The results of the analysis of the rain intensity plan are presented in Figure 4 below:

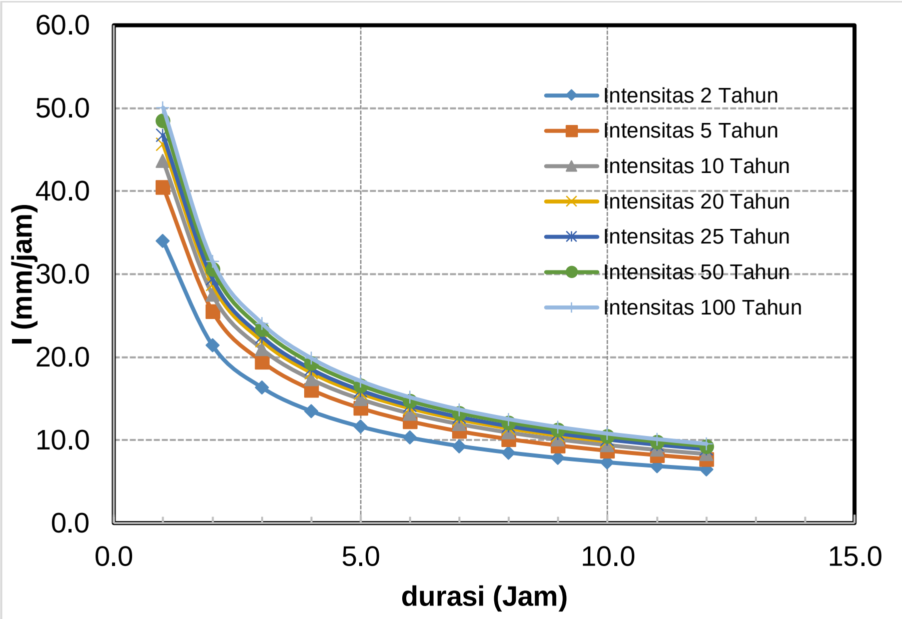

Figure 4. Mononobe Method Plan Rain Intensity Recapitulation
(Source: Calculation Result)

F. Nakayasu Unit of Synthesis Hydrograph (HSS)

Nakayasu (1950) investigated unit hydrographs in Japan and gave a set of equations to form a unit hydrograph as follows (Figure 5):

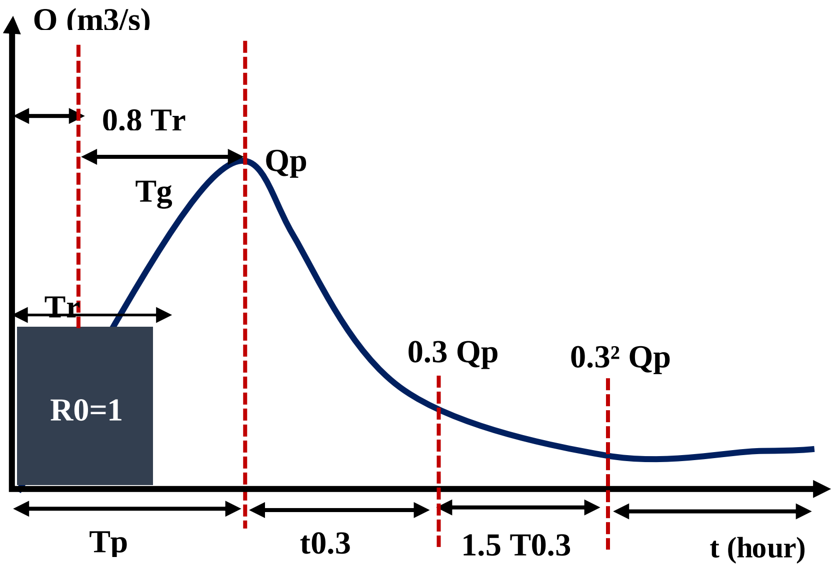

Figure 5. Hydrograph Section of Nakayasu Synthesis Unit
(Source : Nakayasu, 1950)

The results of the Nakayatsu synthetic unit hydrograph calculation can be seen in Gamber 6 below:

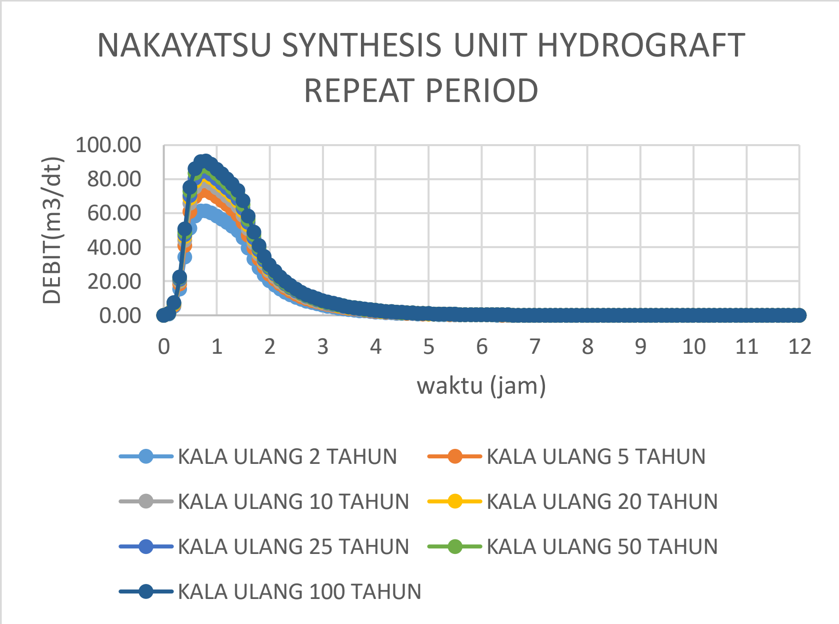

Figure 6. Re-period Nakayasu Synthesis Unit Hydrograph
(Source: Calculation Results)

G. Analysis Polder Capacity

Analysts are flooded discharge drainage channels rain period five years can be seen in Gamber 7 below:

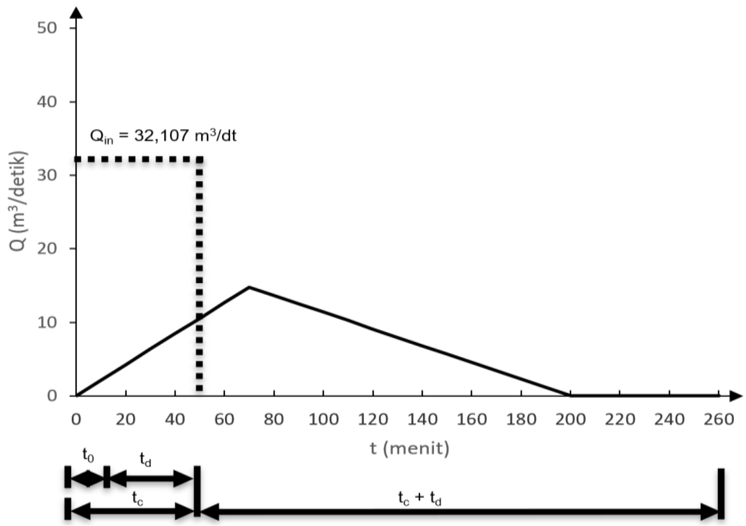

Figure 7. Hydrograph Debit A liran Air yang Masuk
(Source: Calculation Results)

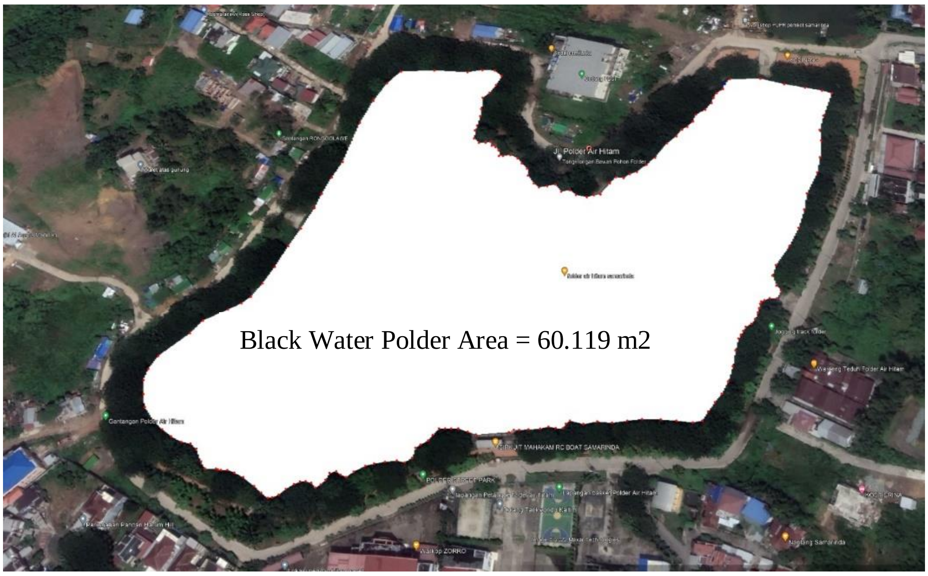

Figure 8. Black Water Polder
(Source: Field Measurement Results)

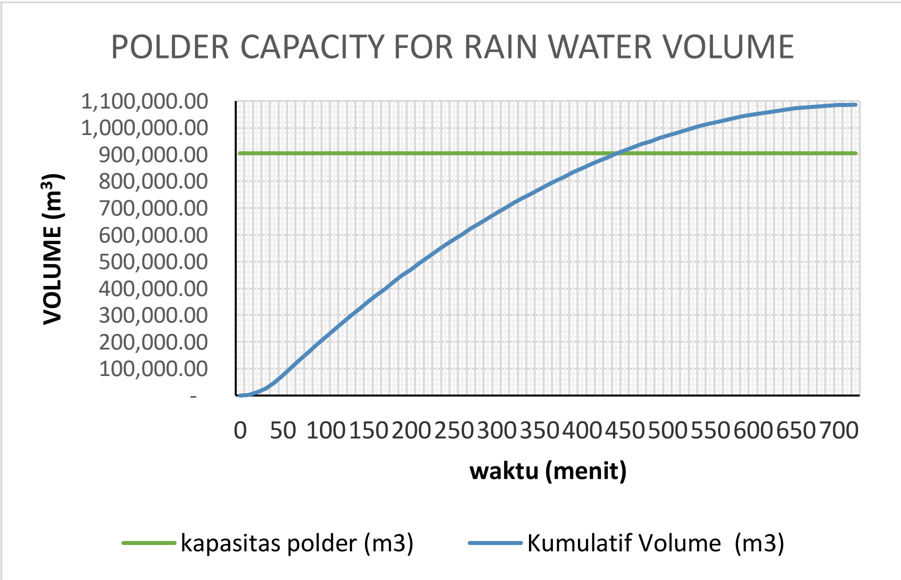

Figure 9. Black Water Polder Capacity Analysis
(Source: Calculation Results)

The analysis shows that the capacity of the Black Water Polder has not been able to accommodate the cumulative volume of rainwater for 12 hours fully. Polder capacity can only accommodate the cumulative volume of rainwater for 7.33 hours. Polder capacity with an area of 6,012 can accommodate the cumulative volume of rainwater by 83.3%.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

1. Air Hitam Polder has an area of 6,012 ha with a catchment area of 230.4 ha, built to reduce flooding problems or puddles on A.W Syahranie Road and surrounding roads. Over time the location became one of the places used by the community for sports, travel and recreation. With the addition of this function, it impacts environmental problems, which are one of the focuses of the Samarinda City Government to carry out revitalization.
2. The impact of the revitalization requires an analysis of the existing hydrology so that the condition of the Polder can be known and recommended in further stages of treatment. The results of hydrological analysis using hydrological calculation methods resulted in the capacity of the Polder being unable to accommodate the cumulative volume of rainwater for 12 hours fully. Polder capacity can only accommodate the cumulative

volume of rainwater for 7.33 hours. Polder capacity with an area of 6,012 can only accommodate the cumulative volume of rainwater, amounting to 83.3% of the total volume capacity that must be accommodated.

B. Recommendations

The hydrological analysis recommends dredging on the Polder to restore the initial planning function by strengthening the Polder cliff structure. If not strengthened, the stability of the polder slope will be disrupted.

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