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STUDY ON FLOOD REDUCTION FROM URBAN DRAINAGE AND RIVERS THROUGH RETENTION POND IN LANGSA CITY – ACEH PROVINCE

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Abstract

Flooding Langsa City is caused by the weakening of a river and urban drainage in accommodating excess discharge due to extreme rain events. due to this flood every year several villages in Langsa City experience flood inundation. partly sourced from rivers and urban drainage. this is an important task in overcoming flooding in Langsa Cityto reduce peak flood discharge during the high rainy season in the future. The aim of this study was to find out the magnitude of the planned Q100 annual peak flood discharges in urban drainage and the Langsa river by simulating 1-D and 2-D runoff flows that are able to determine the distribution of land that has the potential to flood hazard risk. find out the location of the appropriate retention pond. to reduce flood peaks from urban and river drainage in order to be able to store water as raw water supply in urban areas. There are several methods used for analysis in this study. namely the method of maximum rainfall frequency. Nakayashu Synthetic Unit Hydrograph (SUH) and rational method used for peak river discharge and urban drainage analysis with the aid of integrity between HECRAS 5.01 and GIS. The results indicated that good locations for retention ponds were located in Pondok Keumuning Village, Meurandeh Dayah Village, lengkong village, Pondok Kelapa village, and Sungai Pauh village resulted in a 24.64% reduction in flooding on the Langsa river. but to increase the reduction of flood discharge. normalization of the river needs to beundertaken.

Keywords: Water Level, Flood Risk, Retention Pond Location, And Flood Discharge.

I. INTRODUCTION

The most destructive natural disasters for humans are floods [1] it is also as a result of extreme climate change where floods throughout the world have an impact on human life and endanger the economy of many regions. Indonesia is currently one of the one country that has an effect on climate change as the cause of one of the natural disasters that often occurs is flooding [2] a phenomenon that often occurs repeatedly as a result of destroying urban facilities and even loss of human life [3] other than that as a An archipelagic country has many coastal areas that are very vulnerable to flooding due to higher tidal sea levels than the coastal plains along with a decrease in infiltration capacity due to increased urban growth [4]. the city of Langsa is in Aceh province as a densely populated coastal area has With an area of 262.41 km^2. there is a main river that passes. namely the Langsa River [5]. as a connector for the final discharge of the river. Urban drainage during extreme rains [6] will experience an increase in discharge from rivers and weakened urban drainage causing flood inundation in several locations due to overflows from minor and major drainages due to high tides [7]. [8].

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Factors causing the weakening of a drainage to accommodate discharge is population growth that causes changes in land cover from agricultural/plantation areas to settlement areas so that infiltration is reduced and increases runoff flow [9]. high tide events at the disposal end point simultaneously increase discharge so it can have an impact the obstruction of the flow of discharge causes the drainage discharge to be unable to be completely discharged. so that the water discharge overflows from the cliff in the drainage construction causing flood inundation along with the increase in the expansion of protected land cover in urban areas.[10] asserted that efforts to reduce inundation in an urban area have offered many solutions both structurally and non-structurally.

while structural actions refer to infrastructure changes including the construction of new drainage facilities and rehabilitation or replacement of sewer networks. while non-structural actions refer to a technological innovation that does not require infrastructure investment such as maximum flood predictions. good rainfall forecasts. and operating procedures for drainage facilities. this non-structural action is much cheaper than structural measures but its ability to prevent and reduce flooding for example improving drainage facilities such as pump stations . rainwater storage tanks do little to reduce flooding even though the facility is designed to withstand 100 years of rainfall.

Many previous studies have succeeded in visualizing the level of flood hazard in analyzing flood maps describing the estimation of flood damage and flood risk through geographic information systems (GIS) [11]. This GIS needs to be combined with hydraulic methods in generating flood profiles with a certain return period [12]. [13]. software used for hydrological models capable of describing one-dimensional flow in rivers and channels. River Analysis System (RAS) created by Hydrologic Engineering Center (HEC) is a division within the Institute for Water Resources (IWR). under the US Army Corps of Engineers (USACE) widely used in European and American countries. The GIS and HEC-RAS models have successfully mapped the flood hazard and risk of several countries. [14]. [15] to the 100th anniversary.

Reducing flood inundation in urban areas has been widely proposed both structurally and non-structurally. Structural actions to reduce the impact of flood inundation by investigating the potential capacity of retention ponds or reservoirs. design of rainwater tank facilities. increasing the capacity of canal storage. and the use of pumps connected to retention ponds and reservoirs. and non-structural actions that have been carried out are the operation of urban drainage systems. with clear rules. application of green zones commensurate with rivers. and prediction of flood events in a watershed. Flood control by increasing river capacity and urban drainage has been carried out but this application not optimal. because the runoff flow will be greater and the cross section of the river will return due to sedimentation [16].

To the researcher’s knowledge there has been no use of GIS and HEC-RAS to estimate the distribution of floods in Langsa city and to determine the location of retention ponds in Langsa City. reduction of flood discharge. so the aim of the study was to estimate the distribution of potential flood hazards originating from rivers and urban drainage at the 50 and 100 year returns. determining the priority of retention pond locations as flood discharge reductions. estimating flood discharge reductions with retention ponds in the 100 year return discharge

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period. The method used in this study used maximum rainfall frequency method (normal distribution. normal log. log person III. and Gumbel). Nakayashu HSS method for periodic design discharge analysis on the Langsa river. rational method for design flood discharge analysis on urban drainage. The AHP method is used to make a decision on the location of a good retention pond. then the volume of pond discharge will affect the reduction of 100-year flood discharge with the help of integrity between HECRAS 5.01 and GIS. So that it can provide information in determining the flood control of Langsa City in the future that is safe from floods and droughts.

II. THE MATERIALS AND METHOD

The method of this study was quantitative and qualitative exploratory. where primary and secondary research data were analyzed with relevant equations to obtain quantitative results and then qualitative statements were created to obtain inductive conclusions in The method of this study was quantitative and qualitative exploratory. where primary and secondary research data were analyzed with relevant equations to obtain quantitative results and then qualitative statements were created to obtain inductive conclusions in generating flood inundation from urban and river drainages as a basis for evaluating the dimensions of primary and secondary drainage networks. where the selection of the location of the reservoir that was able to reduce flooding from rivers and drainage in Langsa city with 11 parameters was carried out with the importance of criteria through the analysis hierarchy process (AHP) through experts in the field of hydrology and the selection of retention pond locations was visualized through GIS. the incidence of flood drainage through The maximum rainfall resulting in a 100-year return discharge on the drainage was modeled with the help of HECRAS 5.01 software to obtain the effect of the flood water level. Furthermore. the results of determining the location of the retention pond were applied in flood reduction in Langsa City.

The data used in this study consisted of primary data including primary and secondary urban drainage dimension data. elevation of drainage profile. and soil type. while secondary data included data of maximum daily rainfall for 10 years from PT Perkebunan Nusantara I (PTPN I). land elevation with DEM SRTM from DEMNAS with DEMNAS spatial resolution of 0.27-arcsecond or equivalent to 8 meters (http://tides.big.go.id/DEMNAS/). population from the Central Statistics Agency (BPS) of Langsa City. land status map and an administrative map of Langsa City from BAPPEDA of Langsa City. and other related agencies. Geographically. the research location is located at 97048'50.4" to 98001'44.4" East Longitude and 04026'6" to 04026'49.20" South Latitude as shown in Figure 1.

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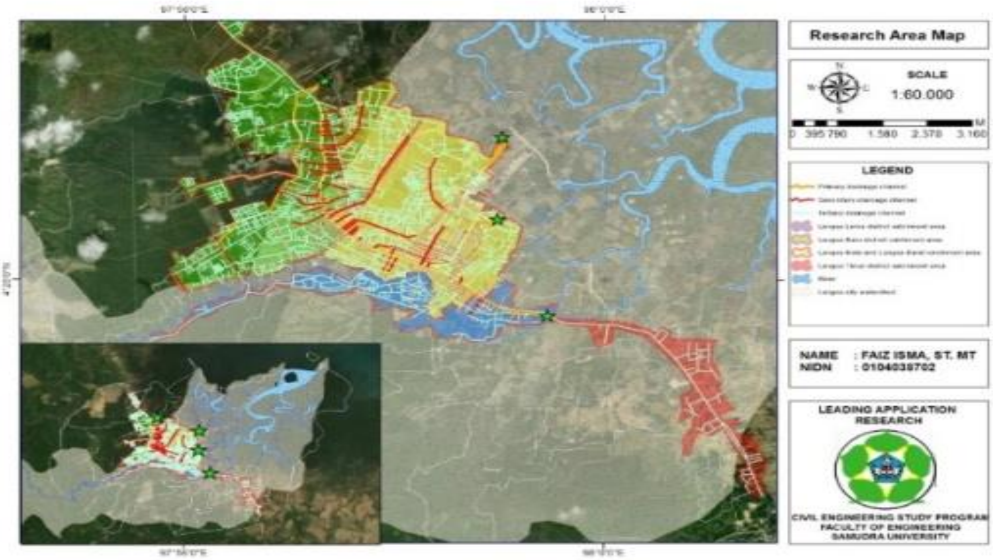

Figure 1: Research Location

Rain intensity is the amount of rain expressed in rain height or rain volume per unit time. the Intensity-Duration-frequency (IDF) curve can be derived from the Mononobe equation. recording of previous rain data so that in designing the design of the building the discharge plan used can be adjusted according to the planned rain for the return period. In determining the discharge. it is carried out using a rational formula that is made empirically which can explain the relationship between rain and runoff. including [9]:

$$Q_{ah} = 0.278\ x\ C\ x\ C_s\ x\ I\ x\ A \quad (1)$$

Where: Q_{ah} : Flood discharge due to planned return period rain (m3/second); C : Flow coefficient; Cs : Coefficient of storage; I : Rain intensity during concentration time (mm/hour); A : The area of the watershed (km^2) The design flood discharge of a drainage is the combined discharge influenced by the rainfall runoff discharge with the following gross domestic waste discharge:

$$Qr = Qah + Qak \quad (2)$$

Where: Qr : design flood discharge (m^3/s); Qah : rainwater discharge (m^3/sec); Qak = dirty water discharge (m^3/sec)

The amount of water needs of the average population is 150 liters / person / day. While the discharge of dirty water that must be disposed of in the canal is 70% of the need for clean water so that the amount of waste water is = 150 x 70% = 105 liters / person / day = 0.00121 liters / sec / person[17]

$$Q_{ak} = \frac{p_n\ x\ q}{A} \quad (3)$$

Where: P_n: Total population (people); q : amount of waste water (liter/second/person); and A : Area (km^2)

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Determining the flood discharge for the river using Nakayasu Synthetic Unit Hydrograph (SUH) requires some DAS parameter characteristics such as a) pause time from the rain occurrence until the hydrograph peak; b) interval time of the rainfall occurrence until the discharge of flood peak; c) the hydrograph peak time for flood; d) watershed; e) the length of Nakayasu main river in Japan. The Nakayasu SUH is showed as follows: [18]

$$Q_P = \frac{AR_e}{3.6(0.3T_p + T_{0.3})} \quad (4)$$

Where: Q_P : peak discharge (m3/s/mm) R_0 : unit of rainfall (mm); T_P : time lag from the beginning of rainfall to flood peak (hour); $T_{0.3}$: duration time which is needed for decreasing discharge until 30% of flood peak (hour); CA : watershed area (km^2) Tp and $T_{0.3}$ is determined by the formula as follow:

Tp = tg + 0.8 tr ; T0.3 = α tg ; Tr = 0.5 tg until tg

tg is analyzed due to the condition as follow:

- For the river length: L > 15 km. so tg = 0.4 + 0.058 L
- For the river length: L < 15 km. so tg = 0.21 L 0.7

Determination of a good retention pond location to reduce flood discharge with agreed criteria in terms of technical aspects including topographic conditions (vegetation area and elevation situation). geological conditions (soil type). hydrological conditions (reservoir volume. volume of water availability. buffer distance to inundation). flooding. and land infiltration distance). and non-technical aspects including social conditions (number of residents around the barn. land status. and community responses related to barn construction). and environmental conditions can be seen in Table 1 and the structure of the AHP criteria in Figure 2.

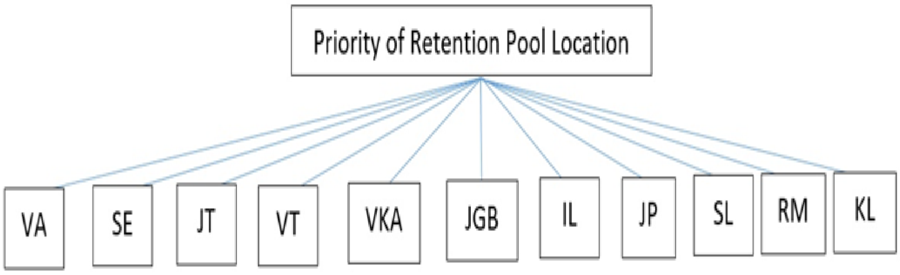

Figure 2: Structure of AHP Criteria for Determining the Location of Retention Ponds

The criteria that are formed will then be given a weighted value so that calculations can be carried out with AHP. but the assessment of importance between parameters involves experts from the PUPR service, Bappeda, BPBD, and academics who obtained a questionnaire by looking at the comparison of the level of importance between the criteria. The basic scale of assessment is divided into nine based on Saaty (2008) [19]

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Table 1: Intensity of Interest Between Criteria

Interest Intensity	Description	Interest Intensity	Description
1	Equally Important	6	Higher Importance
2	Less Important	7	Very Important
3	Important Enough	8	Strongly Pivotal
4	Sufficiently More Important	9	Most Important
5	High Importance		

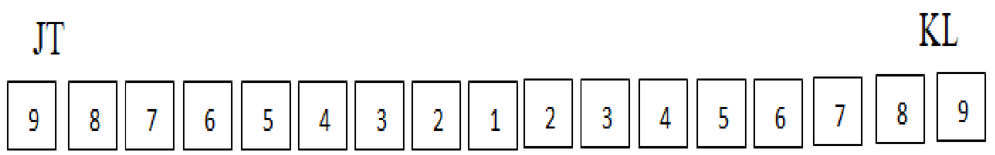

Figure 3: Questionnaire Level of Interest Between Criteria (JT and KL)

The comparison value between the agreed criteria is arranged in the form of a matrix table. then the criteria weight estimation is carried out with AHP. the arrangement stages according to the summary [19] and conduct the normalization value by dividing the value of each criterion by the total value of each column. Then add up each row of normalized values so that the priority vector value will be obtained as in Table 3. Next. calculate the weight per criterion (W) by dividing the value per priority vector by the total number of priority vectors. according to Table 2. and finally perform the AHP consistency test. The successive stages of the consistency test are: calculating the matrix multiplication between the weights (W) and the criterion score (A). the result of the matrix multiplication divided by the weight (W) of the criteria. calculating the value of max. with Equation (1). then determining the random value consistency. After forming the matrix. the next step is to estimate the relative weight of the parameters in 3 stages. namely the first step is to add values for each column in the parameter comparison matrix as shown in Table 3 below.

Table 2: Number of Pairs Comparison Matrix

Parameter	VA	EL	JBG	JT	IL	VKA	VT	RM	SL	JP	KL
VA	1	6	9	7	6	7	8	7	6	9	8
EL	0.17	1	5	6	7	9	6	8	7	7	6
JBG	0.11	0.20	1	9	7	4	6	4	5	5	7
JT	0.14	0.17	0.11	1	9	7	8	5	6	7	5
IL	0.17	0.14	0.14	0.11	1	5	7	8	5	8	5
VKA	0.14	0.11	0.25	0.14	0.20	1	9	4	6	9	9
VT	0.13	0.17	0.17	0.13	0.14	0.11	1	4	7	7	6
RM	0.14	0.13	0.25	0.20	0.13	0.25	0.25	1	6	4	7
SL	0.17	0.14	0.20	0.17	0.20	0.17	0.14	0.17	1	8	5
JP	0.11	0.14	0.20	0.14	0.13	0.11	0.14	0.25	0.13	1	8
KL	0.13	0.17	0.14	0.20	0.20	0.11	0.17	0.14	0.20	0.13	1
Total	2.40	8.37	16.46	24.08	30.99	33.75	45.70	41.56	49.33	65.13	67

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Table 3: Priority Vector Value For Each Criteria

Parameter	Average Normalized Matrix Line	Priority Vector
VA	(0.417 + 0.717 + 0.547 + 0.291 + 0.194 + 0.207 + 0.175 + 0.168 + 0.122 + 0.138 + 0.119) / 11	0.281
EL	(0.069 + 0.120 + 0.304 + 0.249 + 0.226 + 0.267 + 0.131 + 0.192 + 0.142 + 0.107 + 0.090) / 11	0.172
JBG	(0.046 + 0.024 + 0.061 + 0.374 + 0.226 + 0.119 + 0.131 + 0.096 + 0.101 + 0.077 + 0.104) / 11	0.124
JT	(0.060 + 0.020 + 0.007 + 0.042 + 0.290 + 0.207 + 0.175 + 0.120 + 0.122 + 0.107 + 0.075) / 11	0.111
IL	(0.069 + 0.017 + 0.009 + 0.005 + 0.032 + 0.148 + 0.153 + 0.192 + 0.101 + 0.123 + 0.075) / 11	0.084
VKA	(0.060 + 0.013 + 0.015 + 0.006 + 0.006 + 0.030 + 0.197 + 0.096 + 0.122 + 0.138 + 0.134) / 11	0.074
VT	(0.052 + 0.020 + 0.010 + 0.005 + 0.005 + 0.003 + 0.022 + 0.096 + 0.142 + 0.107 + 0.090) / 11	0.050
RM	(0.060 + 0.015 + 0.015 + 0.008 + 0.004 + 0.007 + 0.005 + 0.024 + 0.122 + 0.061 + 0.104) / 11	0.039
SL	(0.069 + 0.017 + 0.012 + 0.007 + 0.006 + 0.005 + 0.003 + 0.004 + 0.020 + 0.123 + 0.075) / 11	0.031
JP	(0.046 + 0.017 + 0.012 + 0.006 + 0.004 + 0.003 + 0.003 + 0.006 + 0.003 + 0.015 + 0.119) / 11	0.021
KL	(0.052 + 0.020 + 0.009 + 0.008 + 0.006 + 0.003 + 0.004 + 0.003 + 0.004 + 0.002 + 0.015) / 11	0.012
Total		1.000

After obtaining the weight values of all criteria. the AHP consistency test is carried out with the following stages:

1. The results of the matrix multiplication of each criterion are divided again by the weight of the criteria divided by the weight of the criteria. namely:

   2.975 : 0.281 = 10.574; 1.387 : 0.172 = 8.043; 1.198 : 0.124 = 9.696; 0.165 : 0.111 = 1.482

   0.141 : 0.084 = 1.677; 0.094 : 0.074 = 1.265; 0.030 : 0.050 = 0.598; 0.972 : 0.039 = 25.072

   0.654 : 0.031 = 21.045; 0.532 : 0.021 = 24.881; 8.469 : 0.012 = 27.869

2. Calculate of λ_{max} by adding up all the results of equation 1 and dividing by the number of parameters. namely

   $$\lambda max = \frac{132.203}{11} = 12.018$$

3. Calculate the value of the index consistency index (CI) in the following way:

   CI = (λ - n) / (n – 1) = (12.018 – 11) / (11 – 1)= 0.102

4. Determine the value of random consistency (RI) based on the number of parameters. because this study used 11 parameters. the RI was determined to be 1.51

5. Calculate the value of the consistency ratio (CR) with the formula:

   CR = CI / CR = 0.102 / 1.51 R = 0.067

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Based on the calculation of the concentration ratio. it is known that the pair comparison process shows a fairly rational level of consistency with a concentration ratio (CR) value of 0.067 or less than the standard of 0.100. So that the weight values for the eleven parameters can be used. A summary of the classification of each parameter and its weight can be seen in the table below.

Table 4: Classification of Each Criterion and Its Weight Criteria

TECHNICAL ASPECT						
No	**Condition**	**Variable**	**Description**	**Value**	**Source**	**Weight**
1.	Topography Condition	Vegetation Area	Forest	1	[20]	0.281
			Bush	2		
			Field/Land	3		
			Rainfed Rice Field	4		
			Residence	5		
2.		Elevation Situation	> 40% (Very Steep)	1		0.172
			>15% - 40% (Steep)	2		
			>2% - 15% (Wavy)	3		
			0% - 2% (Flat)	4		
3.	Geological Condition	Soil Type	Igneous rock. granite. andesite. basalt	1		0.111
			Sand. gravel	2		
			Clay	3		
4.	Hydrological Condition	Storage Volume	> 10 Million m^3 (Big)	1		0.050
			1 Million m^3 – 10 Million m^3 (Medium)	2		
			< 1 Million m^3 (Kecil)	3		
5.		Water Availability Volume	> 20 m^3/second (Besar)	1		0.074
			5 m^3/second – 10 m^3/second (Medium)	2		
			< 1 m^3/second (kecil)	3		
6.		Flood Inundation Distance	0 – 25 meter	1		0.124
			25 – 50 meter	2		
			50 – 100 meter	3		
			100 – 250 meter	4		
			> 250 meter	5		
7.		Land Infiltration	> 250 mm/hour	1		0.084
			> 125 – 250 mm/hour	2		
			> 65 – 125 mm/hour	3		
			> 20 – 65 mm/hour	4		
			> 1 – 20 mm/hour	5		
			< 1 mm/hour	6		
NON TECHNICAL ASPECT						
No	**Condition**	**Variable**	**Description**	**Value**	**Source**	**Weight**
8.	Social Condition	Total Population	None	1	[20]	0.021
			10 KK – 50 KK (Few)	2		
			50 KK – 150 KK (Medium)	3		

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			150 KK – 250 KK (Many)	4		
			> 250 KK (Huge Amount)	5		
9.		Land Status	Belongs to the community who is willing to be released without replacement	1		0.031
			Belongs to the community who is willing to be released (change profit)	2		
			Belongs to the village apparatus	3		
			Belongs to the local government	4		
10.		The community response related to development	Strongly supporting or enthusiastic	1		0.039
			Supporting	2		
			Pro dan Conts	3		
			Rejecting	4		
11.	Environmental Condition		Positive Impact	1		0.012
			Not causing any impact	2		
			Negative Impact	3		

III. RESULTS AND DISCUSSION

The steps to calculate the volume of water availability in the Krueng Langsa watershed used the FJ Mock method can be seen in the example calculation in January as follows. Meteorological data shows that monthly rainfall (R) = 50.985 mm/month. Number of rainy days (n) = 9 days. Number of days 1 month = 31 days . For Actual Evapotranspiration (Ea) data. it is known that Potential Evapotranspiration (ETo) = 138.616 mm/month. Open land surface (m) = 20%. Eto/Ea = 9%. Limited Evapotranspiration (Ee) = ETo x (m/20) x (18-n)/100 = 12.475 mm/month

Ea = Eto – Ee = 138.601 – 12.474 = 126.140 mm/month. Water Balance (a) S = R – Ea = 50.985 – 126.127 = - 75.155 mm/month (b) Storm Runoff (PF =5%). If S > 0. then PF = 0. If S < 0. then PF = R x 0.05 So. the PF used is 2.549 (c) Groundwater Content (SS). If R > Ea. then SS = 0. If R < Ea. then SS = S – PF. So. the SS used is -77.705. (d) Groundwater Moisture Capacity (SMC). If SS = 0. then soil moisture = 200. If SS 0. then soil moisture capacity = soil water content. So. SS 0. then soil moisture = - 77.705. Direct Runoff (DRo) DRo = WS – I + PF = 2.549 – 1.020 + 2.549 = 4.079 mm/month

Total Runoff (Ron) Ron = BF + DRo = 40.204 + 4.078 = 44.283 mm/month. Water Discharge (Q) Q = (Ron x A)/n = Ron x A x 1000/(number of days 1 month x 24 hours x 3600 seconds) = 44.282 x 239.895 x 1000 / (31 x 24 x 3600) = 3.966 m^3 /second.

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A. Result of Research Questionnaires Related to Parameters of Social Conditions

The results of the parameters of social conditions were obtained by distributing research questionnaires which were then answered by the surrounding community as respondents with 19 male respondents and 26 female respondents. With various backgrounds such as age. education and marital status. It emerged the respondents' answers regarding the statements given regarding the creation of a retention pool as follows:

1. Respondent's perception of the statement "The area you live in was built to reduce the potential for flooding." Agree = 45 people. Disagree = None

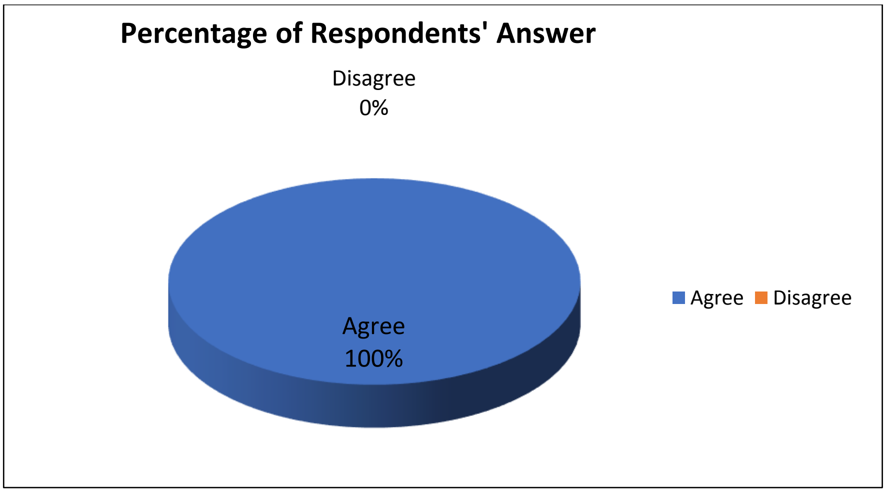

Figure 4: Answers to Statement 1

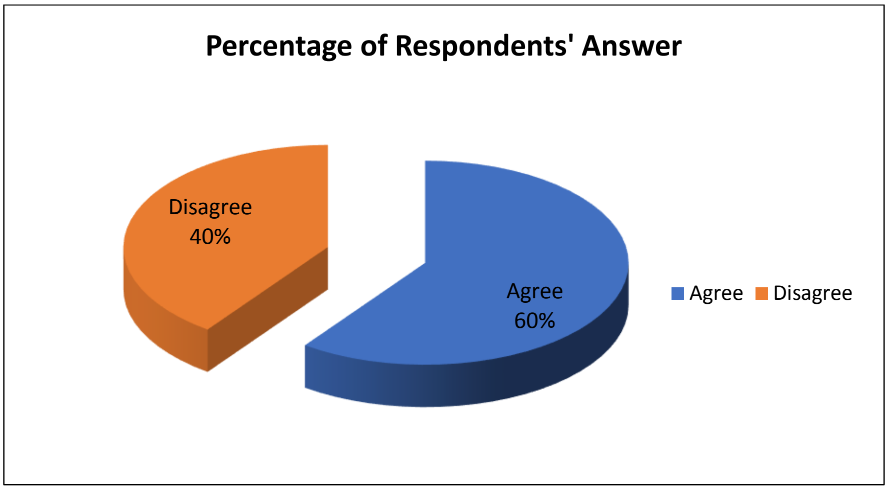

Figure 5: Answers to Statement 2

3. Respondents' perception of the statement "Development of the reservoir was carried out voluntarily by the local community." Agree = 27 people. Disagree = 18 people

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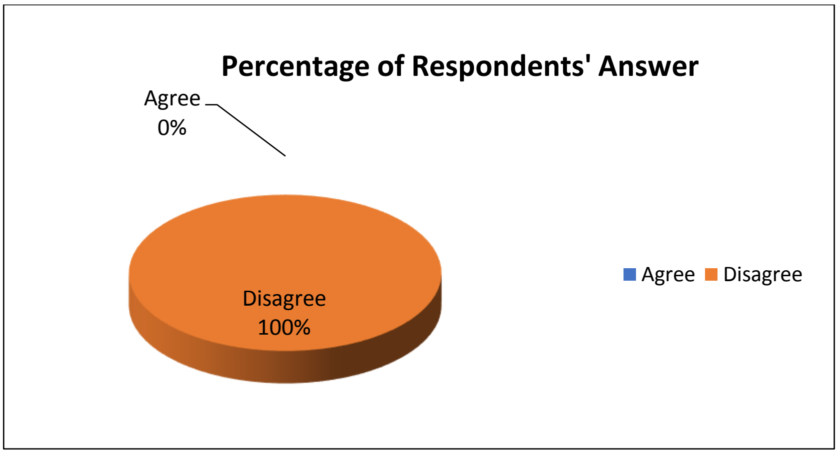

Figure 6: Answers to Statement 3

B. Parameter Map for Determining Retention Pond Location

The following will display a map of each parameter determining the retention pool. the results of which are shown in table 4 below.

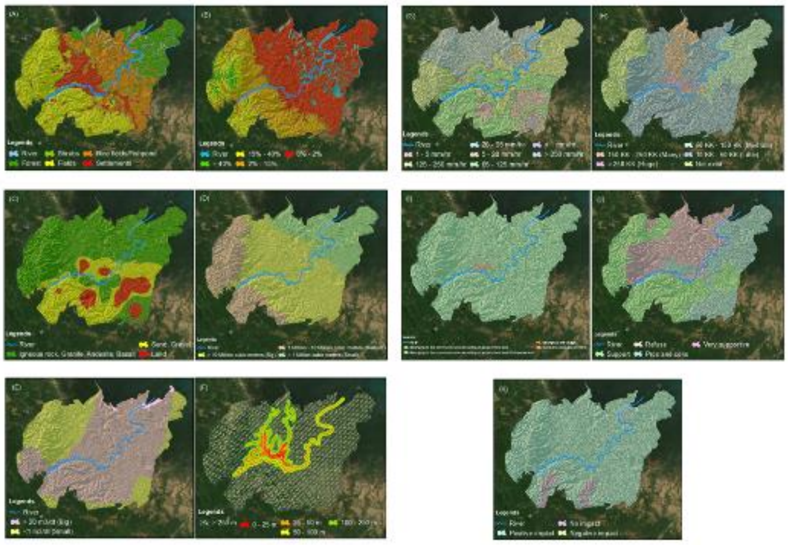

Figure 7: Parameter Map of Retention Pond Determination

Parameters for determining retention ponds in Table 4. Figure 7 explain the distribution of parameters to the area in Langsa City. the distribution of the largest area of vegetation in the description of fields/plantations covering an area of 92.546 km^2 or 41.173% (score 3). while the smallest area in the description of shrubs (score 2) covering an area of 1.110 km^2 or 0.494%. the distribution parameter of land elevation has the largest area in the elevation description of 0% - 2% in the flat land category (Score 4) covering an area of 121.070 km^2 or 53.863%. the smallest area description in the elevation description > 40% very category steep area of 13.971 km^2 or 6.216%. Parameter distribution of soil type with the widest description

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in Igneous Rock. Granite. Andesite. Basalt cover an area of 139.569 km^2 or 62.093%. The smallest description of the land area of 20.780 km_2 or 9.245%. Parameters The storage volume has the widest description in volume > 10 million m^3 in the large category of 113.012 km^2 or 50.278%. the smallest area description in the volume of 1 million m^3 – 10 million m^3 medium category with an area of 51.261 km^2 or 22.806%.

C. Analysis of Location Point Determination

The recap data in the explanation of table 4 is then processed with the help of the ArcGIS application. so that the determination of the location of the retention pool is made in the form of a map as follows:

Figure 8: The Location of Retention Pond

Dealing with the results of data processing using the ArcGis application. there are 5 retention pool locations located in Pondok Kemuning Village. Meurandeh Dayah Village. Lengkong Village. Pondok Kelapa Village and Sungai Pauh Village. Details on the area and coordinates for each retention pond point are described in the table below.

Table 5 explains the area and coordinates of each retention pond point where the largest area is Sungai Pauh village covering an area of 43460.368 m^2. followed by Pondok Kelapa village and it is an area of 36161.964 $m^{2.}$ Meurandeh Dayah Village covering an area of 15696.030 m^2. Pondok Kemuning Village with an area of 10425.553 m^2 and finally Lengkong village with an area of 10071.747 m^2

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Table 5: Retention Pool location Point Data

No	Retention Pool Area	Coordinate		Large of Retention Pool Area (m²)
		X	Y	
1	Pondok Kemuning	97˚56'2.887"E	4˚27'38.897"N	10.425.553
2	Meurandeh Dayah	97˚58'46.324"E	4˚27'11.297"N	15.696.03
3	Lengkong	97˚56'14.998"E	4˚28'30.69"N	10.071.747
4	Pondok Kelapa	97˚56'44.203"E	4˚29'18.032"N	36.161.964
5	Sungai Pauh	97˚58'56.661"E	4˚29'20.331"N	43.460.368

D. Model of Water Level and Inundation Flood Drainage

The formation of the layout of the Langsa River in Figure 9 Model of flood height on the Langsa River due to a Q_{100} discharge of 564.65 m^3/second according to the estimation of HSS Nakayasu.

Peak flood discharge Q100 plan with Nakayasu SUH is 655.376 m^3/s caused by the capacity of retention pool in the amount of 2.185 m^3 which can reduce the flood discharge around 24.64% as presented in Figure 9.

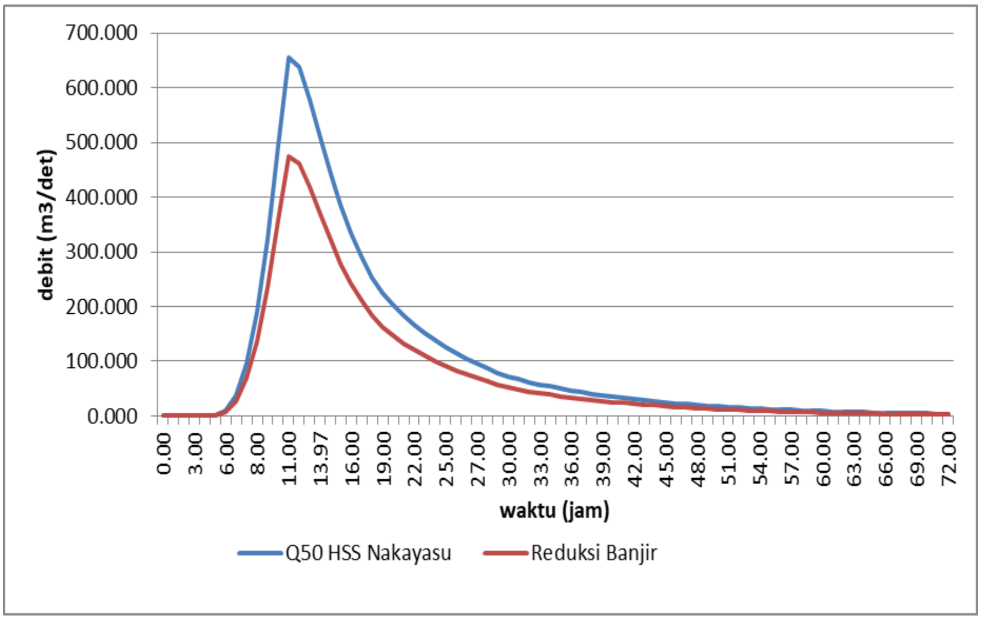

Figure 9: Flood Discharge of Nakayasu SUH Reduction

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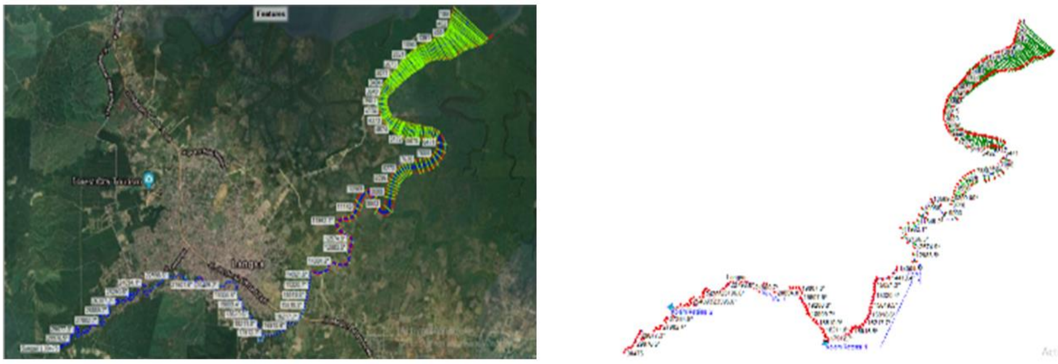
The variation of flood height from upstream to downstream of the Langsa River is shown in Figure 10.



(a) (b)

Figure 10: Layout of the Langsa river profile from upstream to downstream

The condition of Figure 9 b) shows the placement of the retention pond in the Langsa river. the planned rain condition is 180.67 mm/hour for 100 years. the flood height is 3.6 m in the upstream. 1.5 meters in the middle. and the downstream is 3.6 m. 1.5 meters as shown in Figure 12.

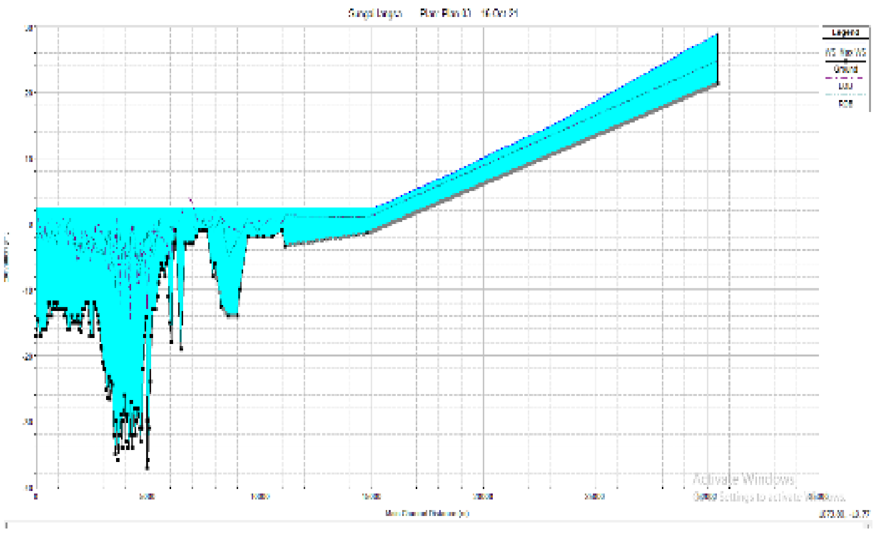


Figure 11: Longitudinal profile of the Langsa river in the event of a 100 year flood front

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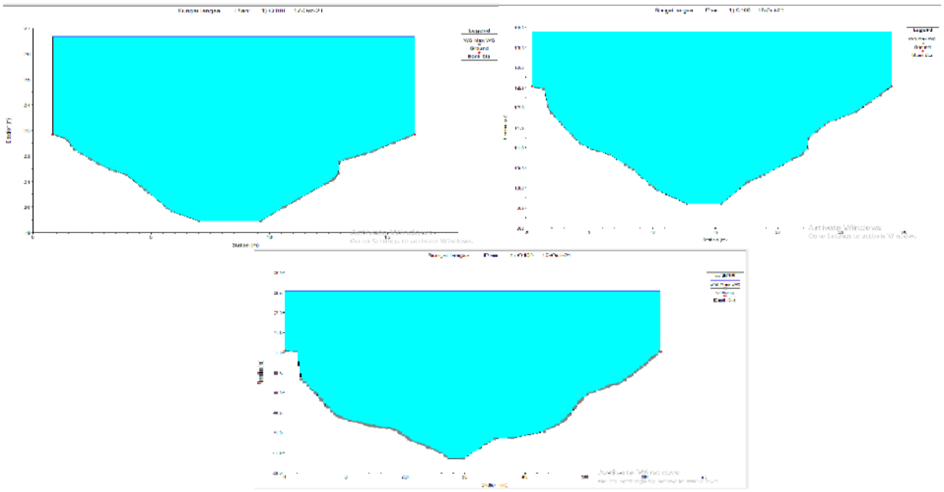
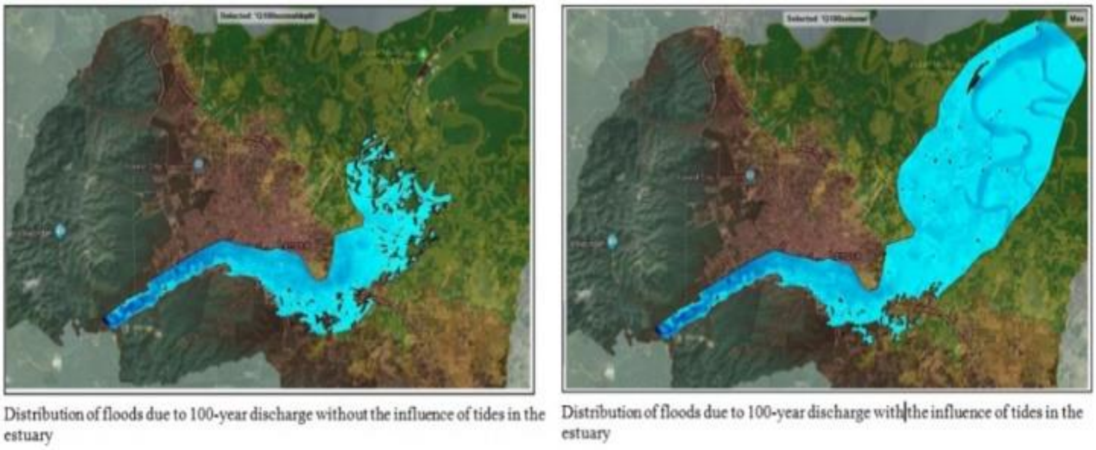


Figure 12: Flood level height on the river profile in a) upstream; b) middle; and c) downstream

Where can be seen the 2D distribution during tidal events and without the influence of tides and tides that occur in the langsa estuary can be seen in figure 13. As a result of this flood incident will have an impact on how many 12 villages. It is necessary to take flood control measures using a retention pond in the langsa River located in pondok Keumuning village at coordinate 97˚56'2.887"E and 4˚27'38.897"N with an area a pond of 10,425.553 m2 and the village of Meurandeh Dayah at coordinates 97˚58'46.324"E and 4˚27'11.297"N with an area of 15.696.03 m^2. The placement of the retention pond in the Langsa River is shown in Figure 10 and Distribution of flooding due to discharge 100 years in figure 13.



(a) (b)

Figure 13: Distribution of flooding due to discharge 100 years

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This flood water level also experienced an increase in urban drainage in the Langsa Baro sub-district was obtained discharge design in the 100 years and it consisted 33.37 m^3/sec. The longitudinal profile condition is shown in Figure 14. the urban drainage condition in Langsa Lama sub-district with a planned Q_{100} discharge of 45 $m^{3.}$ /second layout conditions are shown in Figure 16 and urban drainage conditions in the sub-districts of West Langsa and Langsa Kota with a Q_{100} design discharge of 41.51 m^3/sec. The layout conditions are shown in Figure 12.

Figure 14: Longitudinal profile conditions and retention ponds in West Langsa District and City

As a result of the discharge from the rain plan in the 100 years. the flood level in the primary channel in the urban drainage of Langsa Baro resulted in an average flood height of 3.3 meters. the urban drainage of West Langsa and Langsa Kota of 1.4 meters and Langsa Lama of 3 meters. .5 meters as shown in Figure 17.

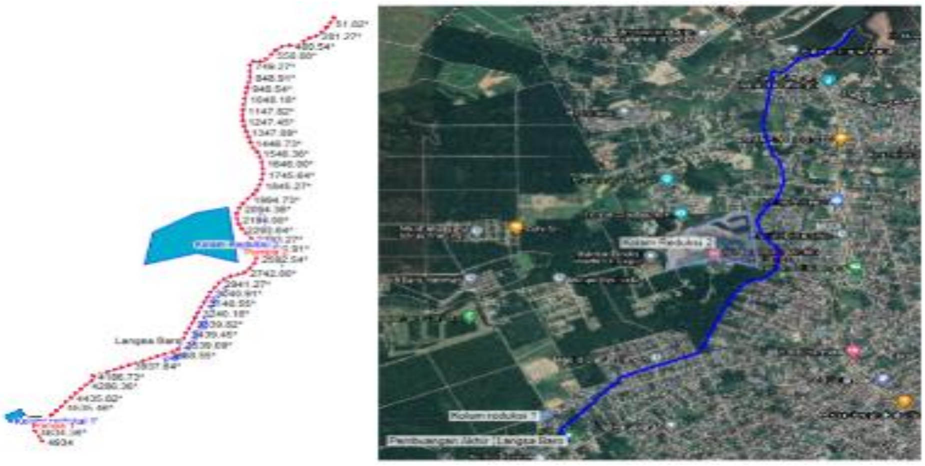

Figure 15: Condition of longitudinal profile and retention pond in sub-district of langsa baro

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The process of reducing flood discharge with a retention pond that uses a pump and a door in accordance with the location of a good pool selection shows that the ability of the pool to reduce flood discharge by 48% results in a reduction in flood water level when the retention pond is applied in Langsa City.

Figure: 16 Longitudinal profile and retention pond conditions in Langsa Lama sub-district

Estimated flood discharge events that can be reduced in urban drainage on average get a flood reduction in Langsa Baro sub-district 40% of flood discharge can be transferred to retention ponds.

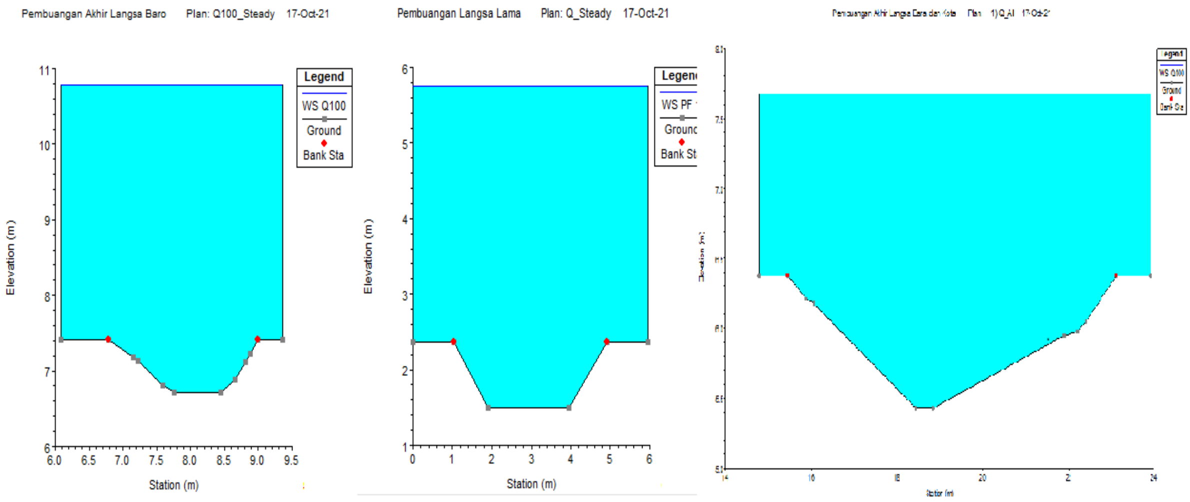

Figure 17: The mean flood level of the primary urban drainage channel

Retention ponds in Langsa Barat and Langsa Kota combined are able to reduce flood discharge 28%. this needs to be increased capacity the retention pond but is blocked by the land requirement. it can be diverted by evaluating the dimensions of the drainage channel.

IV. CONCLUTION

Based on the analysis result conducted, it could be concluded that a good retention pool location in order to decrease flood with AHP for Langsa river and the city drainage at Pondok keumining village is ($97^0$56’2.88”; $4^0$27’38.90”), Meurandeh Dayah (97^0 58’46.32”; $4^0$27’11.29”) to reduce the discharge of flood peak of Langsa river, Lengkong village ($97^0$56’4.99”;$4^0$28’30.69”), Pondok Kelapa ($97^0$56’44.20”; $4^0$29’18.03”) and Langsa River (97^0 58’56.66”; $4^0$29’20.33”) to reduce the flood discharge from city drainage until the retention pool location can decrease the discharge of flood peak in the amount of 24.64% and the retention pool can decrease discharge of flood peak from the primary drainage channel of Langsa Baro sub-district 40%, retention ponds can reduce the peak flood discharge of the Langsa Baro sub-district primary drainage channel 40%, the combination of Langsa Kota and West Langsa primary channels can reduce flood discharge by 28%

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