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Implementation of Retention Ponds in Flood Management in Sorong Regency – Southwest Papua

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A B S T R A C T

Mariat Subdistrict is one of the villages affected by the floods in Klasuluk Village, with an area of 0.7995 km^2, and Klamalu Village, with an area of 1.0479 km^2. This research uses experimental, descriptive, qualitative, and quantitative analysis methods. The results of the analysis and simulation, after being run at intervals of 10 years in the future, there are three flood points in the Klamalu village canal, where the most significant total flood volume is at JN64 146,687 m^3/s, the smallest is at JN15 21,232 m^3/s, and there are 56 flood points in the Klasuluk village canal, where the largest total flood volume was at JN91 1,863 m^3/s and the smallest at JN9 and JN37 0.008 m^3/s. The volume of wastewater discharge that enters the drainage is only 1%, so it has no effect. From the data on the dimensions of the retention pond, it is obtained that the wet cross-sectional area is about 145.05 m^2, the wet perimeter of the retention pond is 101.69 meters, the hydraulic radius is 1.43 m, the flow velocity is 3.168 m/s, the guard height is 1.22 meters, the water discharge that comes out is 459.51 m^3/second.

1. Introduction

Several areas are classified as prone to flooding in the Mariat District, namely the Klamalu, Klasuluk, and Mariyai Sub-Districts. On June 8, ˈ2019, and on August 24, ˈ2022 the Mariat River, which is located in the Mariat District, Sorong Regency, overflowed again due to high and long-lasting rain intensity, causing hundreds of residential units and hundreds of hectares of plantation land along the banks of the river to be submerged and flooding as high as 0.5 meters – 1 meter. This disaster resulted in the death of 1 person, a 3-year-old toddler in the Blibis SP 1 Klamalu, and also resulted in losses due to the paralysis of community activities and the cut off of road access in several sub-districts of the Mariat District, including the Klasuluk sub-district to the Klamalu sub-district. This is due to inadequate drainage channels, the presence of waste, especially plastic waste, and sedimentation that often occurs in the Klasuluk River channel, causing the drainage to overflow when it rains with great intensity and for a long time, causing inundation with a depth of between 20 - 50 cm [1].

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There are several journals in terms of previous studies related to research results, the first with the theme Water infiltration rates in various types of soil and straw weight by applying pure biotechnology in Medan Amplas District using an experimental method by testing three types of soil with straw weight treatment, the results his research found out the rate of water infiltration of the three types of soil from the treatment of each strawweight [2]. The second research with the theme Study of the Application of Ecodrain in Urban Drainage Systems in Sawojajar Housing, Malang City, used the Storm Water Management Model (SWMM) instrument by comparing the conditions of the drainage network before and after the application of infiltration wells and permeable pavements. The research results know the model calibration by showing the RMSE value between the modeling discharge and the measured discharge [3]. Third research with the theme Analysis of the Volume of the Deli Watershed Retention Pond as One of the Efforts to Control Floods in Medan City. The purpose of this study is to analyze the volume of the retention pond storage due to the return period flood discharge of the Deli DAS with the cross-sectional capacity of the river; the research results show the retention pond discharge with capacity design [4]. Fourth research with the theme Identification of Infiltration Lands (Retention Ponds) in handling Floods in the Johar-Yasmin Simpang Area, the methods used to determine the design of flood discharge are rational, basin characteristics, and mathematical simulations. The technical design uses the trial and error method, the results of his research determine the length of time for the inlet discharge and the volume of the retention pond as well as the construction of the pond using cobblestone retaining walls [5] .

Fifth research with the theme Application of Ecodrainage Systems in reducing the potential for flooding Using two methods, namely retention ponds and infiltration wells, from a technical, environmental, and financial perspective [6]. Sixth research with the theme Retention Pond Study as an Effort to Control Floods in the Way Simpur River, Palapa Village, Tanjung Karang Pusat District. Using three methods, namely, the arithmetic means method, the Thiessen method, and the Isohyet method, geotechnical analysis of the infiltration rate using the Horton model, from the research results, it is known that the planned rainfall discharge for the 5-year return period at the pool capacity also calculates the planned budget costs [7]. The seventh research is the theme Analysis of the effectiveness of the Retention Poll as Flood Control. They are using the comparative causal method. The research results calculate the volume of the retention pond storage and how many pumps are needed [8]. The eighth research with the theme Study of Artificial Ground Water Filling in Irrigated Land Using the Mood Flow Model. Using hydrogeochemical aspects, from the results of problem-solving research, groundwater recharge from infiltration ponds under irrigation conditions to solve water supply problems using mudflow [9]. The ninth research, with the theme Treatment of Sewage Using a Constructed Soil Rapid Infiltration System Combined with Pre-Denitrification, Uses the constructed rapid soil infiltration system (CSRI) method, a new waste biofilm processing technology. The results of this experiment, the CSRI system with a two-stage A/O process combined with pre-denitrification and circulation, fully combines the advantages of aerobic and anoxic denitrification for wastewater treatment [10]. Tenth research with the theme Hydrology of the HAPEX-Sahel Central Super Site: Surface Water Drainage and Aquifer Recharge Through the Pool System. Using the Sahelian hydrology method characterized by drainage network degradation, a typology in three endorheic systems (valley bottom, sink, upland) was proposed. The behavior of one representative pond in each category was analyzed, showing that the partition between evaporation and deep infiltration depends on the fill level of the ponds [11].

The eleventh study, with the theme of infiltration wells to anticipate stagnant water in Permata, recognizes housing for flood prevention; this research aims to predict flooding with the infiltration well program in each resident's housing [12]. Twelfth study with the theme of

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planning an environmentally sound drainage system (Ecodrainage) in Jatisari Village, Mijen District, Semarang City. This project aims to determine rainfall, water capacity, existing drainage system, drainage system, and environmental planning (Ecodrainage) in the study area. The results of this study are the application of the eco-drainage system at the study site and comparison with the existing drainage system, especially in terms of capacity [13]. Thirteenth study the theme of studying the effect of changes in land use on discharge in the Citepus Watershed in Bandung City. The conservation method discussed in this final project is utilizing pure biological technology, infiltration wells, storage ponds, and increasing the Green Open Space (RTH) area. The research results are to determine the percentage of the effect of changes in land use on runoff discharge in the Citepus watershed and conservation efforts on land changes that occur [14]—fourteenth study with the theme of an eco-drainage system by harvesting rainwater. The methodology used by the author is to make observations using data collection methods consisting of interviews, observation, participation, and literature study for analysis and discussion using descriptive and interpretive methods. The results of observational research on rainwater harvesting at UGM consist of bio pores, infiltration wells, and storage tanks. The author also designed a rainwater harvester filter combination so that the rainwater harvester can function in two seasons [15].

Fifteenth study with the theme of analysis of conservation strategies in the upstream watershed: a case study in the Cimandiri watershed, the results of research to determine the calibration of the Tank Model in the Cumucang-Cimandiri DTA SPAS using rainfall, evapotranspiration, and land cover data and showing the coefficient of determination at the model output debit and existing debit [16]. The sixteenth research theme Is the development of an environmentally sound urban drainage system, a case study of the magersari drainage system in Mojokerto city. This study aims to determine the drainage system's condition, evaluate the drainage channel's capacity, and environmentally sound drainage methods that can be applied. The research results calculate and analyze the ratio of catchment areas in the Magersari Drainage sub-system [17]. Seventeenth research with the theme Evaluation and re-planning of drainage channels in the Sawojajar housing area, Kedungkandang sub-district, Malang city. This research aims to plan drainage channels and can also be considered and entered for system planning drainage along with the development of Malang city [18]. The eighteenth research, the theme of analyzing the performance of the drainage system for flood and inundation management based on water conservation in Bojonegoro District, requires the evaluation of a good and adequate drainage system for the capacity of existing canals and water conservation-based handling. To analyze it, modeling of rain runoff with a 5-year return period was carried out using the Sewergems Connect software by comparing the condition of the existing drainage network with the state of the drainage network after the implementation of the construction of retention ponds, infiltration wells, and channel modifications [19]. Nineteenth study with the theme Study of retention and infiltration wells due to resettlement of the upstream Batang Kuranji watershed, this research aims to determine changes in discharge that occur due to changes in land cover and to analyze whether the use of infiltration wells and retention ponds can reduce flood volume [20].

2. Methodology

This stage uses qualitative and quantitative descriptive analysis methods. The activities carried out were field observations, reference studies from previous research, data collection, and primary and secondary data processing.

The research location is at the inundation site, precisely in the Klasuluk and Klamalu Villages, Mariat District, Sorong Regency. Geographically, the area in the study location is part of the Mariat District location plan, with an area of 542.19 km^2. The preparation of this research was carried out from July 2022 to October 2022.

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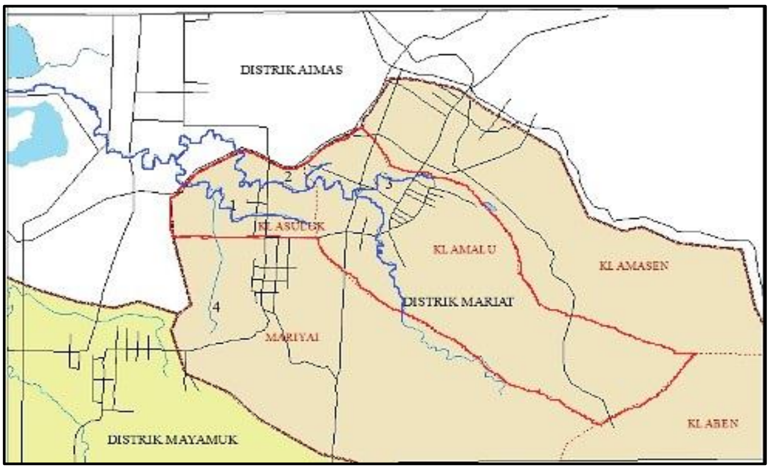

Source: Google Earth, 2022
Figure 1. Research Locations

The data used are primary data, including the field's current conditions, elevation, canal dimensions, and clean water usage data per household. The methods used include the normal distribution, the normal log distribution, the Gumbel distribution, and the Pearson log Type III distribution [21]

$$X_{Tr} = X + K_T . S \quad (1)$$

Normal Log Method

$$Log\ X_{Tr} = \overline{Log\ X} + K_T . S \quad (2)$$

Log Person Method III

$$Log\ \bar{x} = \frac{\sum (Log\ Xi)}{n} \quad (3)$$

$$(^{S}Log\ X)^{½} = (\frac{\sum (Log\ Xi - Log\ X)2}{n-1})^{½} \quad (4)$$

$$Log\ X_{Tr} = Log\ X + k\ (\ sLogX\ ) \quad (5)$$

Two alternatives are used to test the sample frequency distribution, including the chi-square and Kolmogorov-Smirnov tests. In the Chi-Square Test using the formula:

$$X^2 = \sum_{i=0}^{n} \frac{(O_f . E_f)^2}{Ef} \quad (6)$$

In the Kolmogorov-Smirnov Test, it is done by sorting the data (from large to small or vice versa), then determining the probability of each data, sorting the value of each theoretical opportunity from the results of the data depiction, after that, determining the largest pedigree between the observation opportunities and the theoretical opportunities Dmax = P(Xn) - P'(Xn); determine the value of D_o, with a note that if the value of $D_{max} < D_o$ means that the theoretical distribution used to determine the distribution equation is acceptable. [6] Otherwise, theoretically, the distribution used is unacceptable. [6] Analisa Intensitas hujan menggunakan rumus mononobe:

$$I = \frac{R_{24}}{24} \left[\frac{24}{t}\right]^{2/3} \quad (7)$$

Environmentally Friendly Drainage (Ecodrainage) Retention ponds use the necessary data, namely average rainfall intensity data. In addition to these data, dirty water discharge must also be planned to ensure the amount of water entering the retention pond. The types of ponds are the type beside the river body, inside the river body, and elongated storage. There are many types of pump stations, including archimedean, rotodynamic, and mixed flow pumps. [22] The benefits of retention ponds include being a location for water tourism as a water conservation

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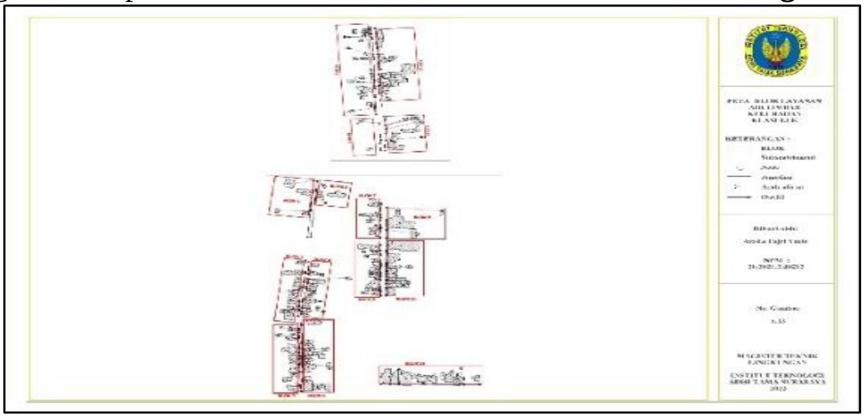
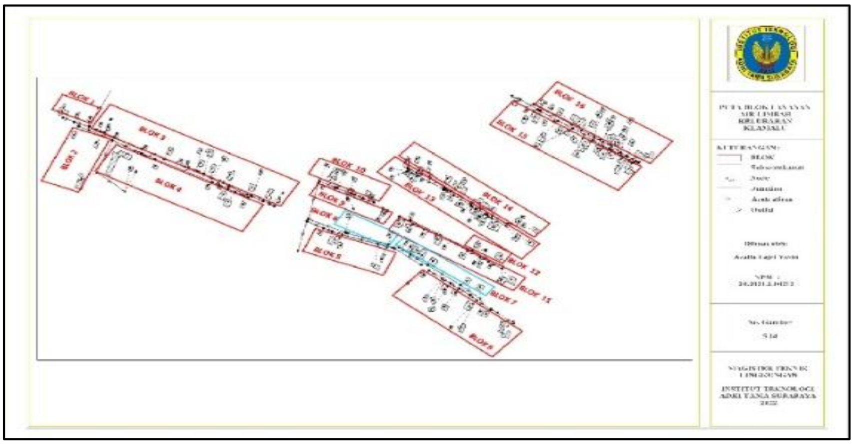
area. Another function of the Retention pool is as flood controller and water distributor; for Sewage treatment, a retention pond is built to accommodate and treat waste before disposal; supporters reservoirs/dams and retention ponds are constructed to facilitate maintenance and reservoir water purification. Because it is much easier and cheaper to clean the water in the pool with small retention before being discharged into the reservoir than draining/clearing the water in the reservoir itself. [23]

Different drainage systems are widely used solutions to this phenomenon. Comparison between horizontal and vertical drainage systems, including pipe drainage, open trench drainage, and pump wells in anisotropic soils studied by Valipour (2012a, 2013). Knowledge of the effect of changes in drainage parameters on drainage discharge is essential in subsurface drainage systems. [9]. Groundwater recharge is generally divided into deep recharge and shallow infiltration. For shallow infiltration, the water is accumulated in the pits, ponds, and pools, and then it slowly penetrates the aquifer [24]

The software used in this study is the EPA-SWMM Program to analyze and evaluate the dimensions of drainage capacity; GIS (Geographical Information System) is used for digitizing maps and calculating the area of land use that will be used to input data into EPA-SWMM. The number of known population data at the Research Location; Calculating the discharge of the need for Clean Water (Qam) per person/day; The average wastewater discharge (liters/day) obtained is then calculated using the peak factor calculation method, the daily peak discharge value (liters/day) is obtained. [25]. The division of service blocks is done to simplify calculations, in which each service block burdens each collector channel. Conditions that need to be considered in the distribution of service blocks are topography and road networks. [26] The following block is planned from the two alternatives can be seen in **Figure 2.**



Source: Author (EPA-Swmm), 2022
Figure 2. Klasuluk Village Wastewater Service Block



Source: Author (EPA-Swmm), 2022
Figure 3. Klamalu Urban Village Wastewater Service Block

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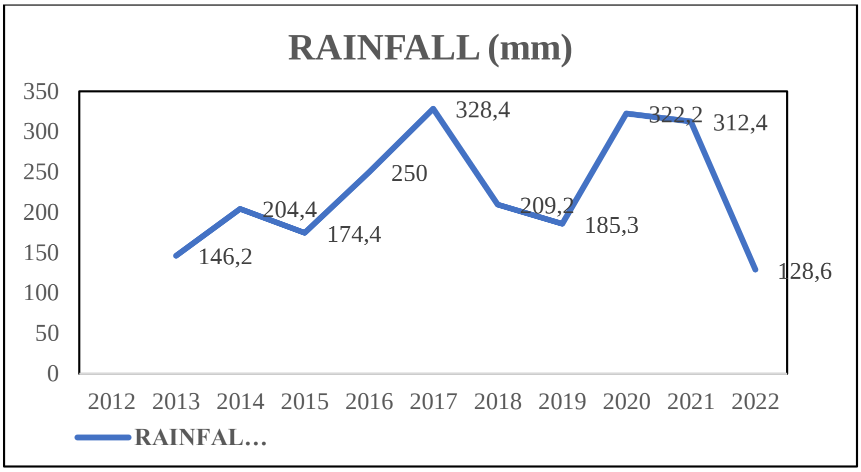
3. Results and Discussions

3.1 Hydrological Analysis

Rainfall data used for the last ten years, namely between 2013 (June) – 2022 (May) [27]



Source: JAXA, 2022

Figure 4. Graph of 10-Year Return Rain Intensity

3.2 Frequency Analysis

There are types of statistical methods that can be used to analyze the frequency of data. In this case, the frequency distributions commonly used are the Normal Distribution, the Log-normal distribution, the Gumbel distribution, and the Pearson III Log distribution. The reuse period is 2, 5, and 10 years. The return period calculation results using normal, log-normal, Gumbel, and Pearson III log distribution methods are presented in **table 1.**

Table 1. Rain Plan Period T year

Kata Ulang T (tahun)	Normal Xt (mm)	Log Normal Xt (mm)	Log Person III Xt (mm)
2	226.110	216.163	215.954
5	287.903	303.980	284.836
10	320.271	362.127	328.662

Source: Calculation Result Data, 2022

The results obtained in carrying out the Chi-Square test and the Smirnov-Kolmogorof test, namely the calculated Chi-Square parameter value for the Normal distribution is 0,4, while the degree of freedom (DK) is one and the 5% degree of confidence is obtained from the critical Chi-Square parameter of 3,841. Thus, (X2 hits < critical X2 → 0,4 < 3,841), which means that the normal distribution satisfies the Chi-Square test. As for the Smirnov-Kolmogorof results, namely the value of $\alpha = 5\%$, so that the critical $\Delta = 0{,}38$. It can be seen from the results of the comparison above that:

Δ max < Δ critical (0,20 < 0,38), which means it meets.

With a value of $\alpha = 1\%$ that the critical $\Delta = 0{,}48$, it can be seen from the comparison results above that: Δ max < Δ critical (0,20 < 0,48).

3.3 Rain Intensity Analysis

The following is a picture of the analysis of rain intensity

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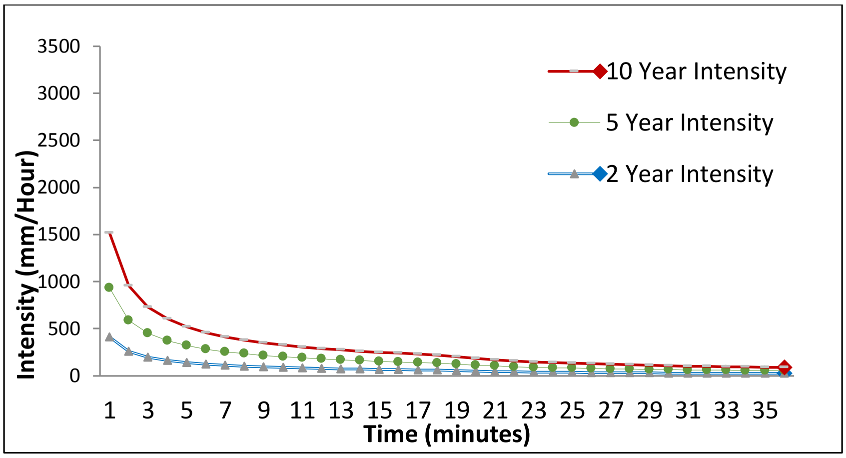


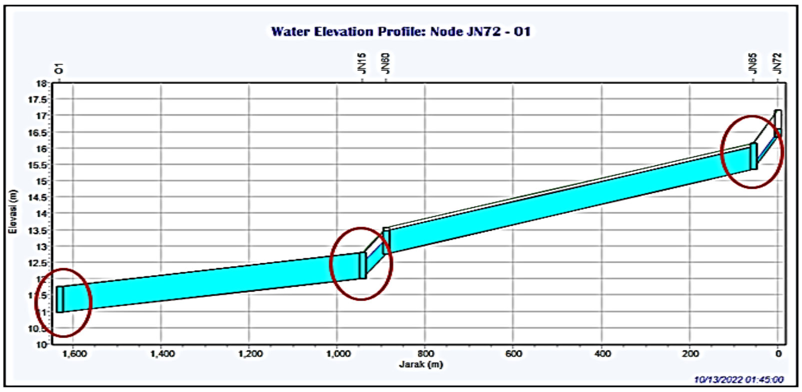
Source: Result Data, 2022

Figure 5. Graph of 2, 5, and 10-Year Return Rain Intensity

The graphic above indicates that the time starts from 5 minutes, that the intensity for the 2-year return period is 410.87 mm/hour, the 5-year return period is 523.15 mm/hour, while the 10-year return period is 581.97, and so on. Up to the 360th minute, the rainfall intensity gets smaller. Namely, the 2-year return period is 23.74 mm/hour, the 5-year return period is 30.23 mm/hour, and the 10-year return period is 33.63 mm/hour.

3.4 Drainage Evaluation

Several drainages cannot accommodate the overflow that occurs in the SWMM simulation. The following is the result of running SWMM under existing conditions. The SWMM simulation results take research at the largest return period, namely the 10-year return period. Because every time you repeat the picture is the same, but the volume is different. The results of running SWMM with a 10-year return period, there are 3 flood points in the Klamalu sub-district canal, where the largest total flood volume is at JN64 146,687 m3/s, and the smallest is at JN15 21,232 m3/s. Figure 6 shows that the JN15 channel is full due to sedimentation and weeds blocking the flow of water; this occurs between JN60 and O1. At JN65, it seems that it has exceeded the canal's capacity due to the same problem so that in the reservoir at O1, there is a large enough overflow to receive the confluence of flows from street Blibis well as flows from street Kasuari.



Source: Results of Running SWMM, 2022

Figure 6. Cross section of JN72 – O1 flow

In **Figure 7,** it can be seen that the J64 channel contains water discharge whose channel discharge exceeds the channel's capacity. Because there has been no channel construction, natural channels made by the local community are blocked by wild plants. Based on figure 8, the results of running SWMM at ten-year intervals, there are 56 flood points in the Klasuluk

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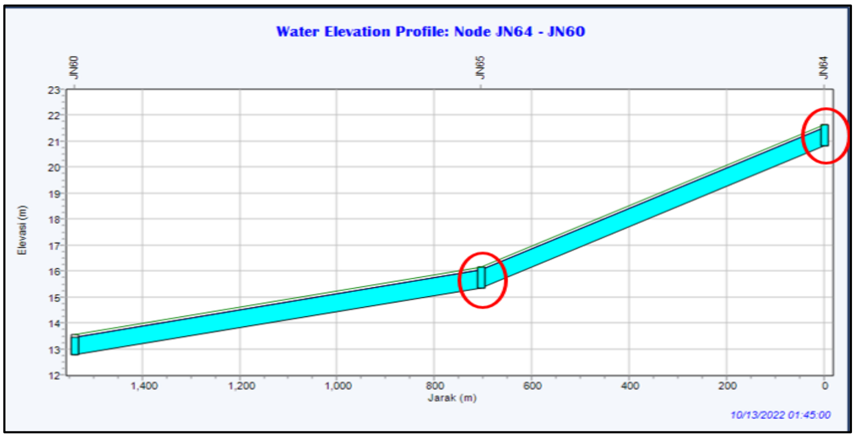
sub-district drainage, where the largest total flood volume is at JN91 1,863 m^3/s and the smallest at JN9 and JN37 0,008 m^3/s, here will explain the results of flooding with only the largest value.



Source: Results of Running SWMM, 2022
Figure 7. Cross section of the JN64 – JN60 flow

Topic: Node Flooding — Click a column header to sort the column.

Node	Hours Flooded	Maximum Rate CMS	Day of Maximum Flooding	Hour of Maximum Flooding	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
JN47	4.91	0.859	0	01:21	10.105	0.000
JN48	0.09	0.078	0	01:15	0.011	0.000
JN49	0.06	0.078	0	01:14	0.006	0.000
JN50	2.76	0.625	0	01:11	1.581	0.000
JN51	2.00	0.216	0	01:09	0.677	0.000
JN52	4.86	0.781	0	01:24	6.523	0.000
JN53	0.02	0.070	0	01:09	0.004	0.000
JN55	0.04	0.156	0	01:09	0.010	0.000
JN56	1.90	0.475	0	01:16	1.785	0.000
JN59	4.78	0.732	0	01:13	5.555	0.000
JN76	4.88	0.136	0	01:07	1.306	0.000
JN77	4.93	0.517	0	02:00	4.316	0.000
JN78	4.91	0.110	0	02:00	1.194	0.000
JN79	4.89	0.442	0	01:28	3.190	0.000
JN8	0.01	0.016	0	01:14	0.000	0.000
JN82	1.87	0.333	0	01:24	1.146	0.000
JN84	1.72	0.026	0	01:24	0.059	0.000
JN86	1.75	0.215	0	01:25	0.712	0.000
JN88	4.86	0.765	0	01:20	10.014	0.000
JN9	0.02	0.069	0	01:12	0.001	0.000
JN90	0.74	0.034	0	01:19	0.073	0.000
JN91	2.94	1.863	0	02:00	7.996	0.000

Source: Results of Running SWMM, 2022
Figure 8. Flood Node Results of Running SWMM with an interval of 10 years

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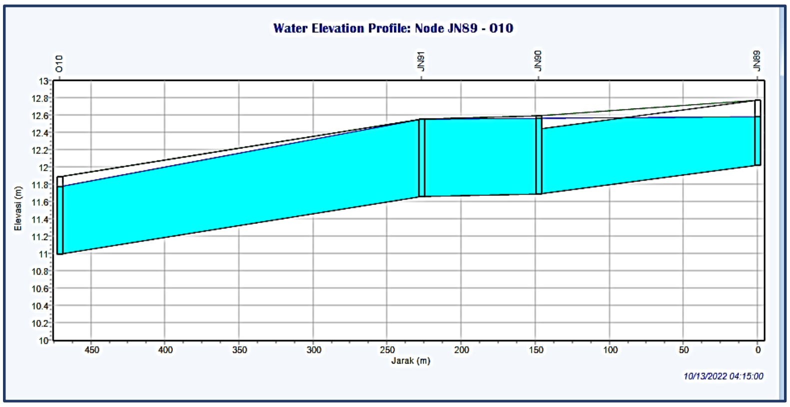
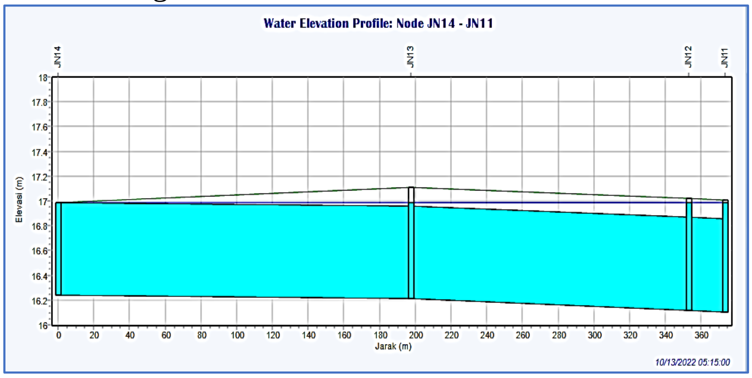


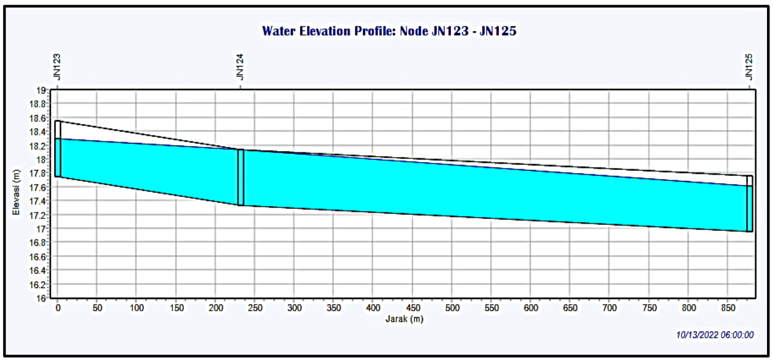
Source: Results of Running SWMM, 2022
Figure 9. Cross section of JN89 – O10 flow

Based on **figure 9** shows that JN91 looks full with an interval of 4 hours. This is because there has not been any drainage construction, only natural channels made by residents located on Jalan Menur so that the water goes directly to O10, where swamps and rivers are around the outlet of the confluence of the streams from the direction of Jalan Flamboyan 2.

In **Figure 10**, it can be seen that the JN14 channel has exceeded its capacity due to the environmental conditions of the drainage that were not paid enough attention to; the drainage was buried in sedimentation so that the water flow was blocked, there were only a few points on Menur Street where drainage was built.



Source: Results of Running SWMM, 2022
Figure 10. Cross section of the JN14 – JN11 flow



Source: Results of Running SWMM, 2022
Figure 11. Cross section of JN123 – JN125 flow

In **Figure 11,** it can be seen that runoff occurs at the JN124 channel point. This is due to the low contour of the canal and the closure of the canal from sedimentation so that water fills the canal. From **Figure 12** below, it can be seen that there are three flood channel points in Klamalu

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Village, which are on Street Kasuari and Blibis, while in Klasuluk Village, there are 56 channel points which are on on-street Menur, Flamboyan, and Nusa Indah.

3.5 Changing Channel Dimensions

The results of running with existing canal data for intervals of 2, 5, and 10 years when compared, the results have similarities that cannot accommodate overflows that occur in the same conduits. Even though it occurs at the same channel point, the intensity data differs. Based on the table below shows the change in the dimensions of the channel which was initially flooded; after the Running SWMM experiment was carried out repeatedly on the cross-section of the channel, it was seen that the difference in the channel could accommodate the maximum discharge. This change in dimensions was also adjusted because it collided with land acquisition. Thus, changes are specific to the depth of the channel.

10 Tahun					
Junction	Conduit	b (m)	h (m)	Bentuk Saluran	Keadaan Saluran
JN15	CN15	0.4	0.8	IRREGULAR	sedimentasi dan tumbuhan liar
JN64	CN69	0.3	0.5	IRREGULAR	sedimentasi dan tumbuhan liar
JN65	CN70	0.3	0.3	IRREGULAR	Saluran alami terhalang tumbuhan liar
JN5	CN11	0.8	0.75	OPEN TRAPEZOIDAL	Sedimentasi dan tumbuhan liar
JN6	CN10	0.8	0.75	GOTHIC	Sedimentasi dan sampah plastik
JN7	CN9	0.8	0.65	OPEN TRAPEZOIDAL	Sedimentasi dan tumbuhan liar
JN8	CN8	0.8	0.5	GOTHIC	Sedimentasi dan sampah plastik
JN9	CN7	0.8	0.3	OPEN TRAPEZOIDAL	Tertutup aliran oleh timbunan tanah dan tumbuhan liar
JN10	CN6	0.8	0.75	GOTHIC	Sedimentasi dan tumbuhan liar
JN11	CN5	0.8	0.4	GOTHIC	Tertutup aliran oleh timbunan tanah dan tumbuhan liar
JN12	CN4	0.8	0.5	OPEN TRAPEZOIDAL	Tertutup aliran oleh timbunan tanah dan tumbuhan liar
JN12	CN4	0.8	0.5	OPEN TRAPEZOIDAL	Tertutup aliran oleh timbunan tanah dan tumbuhan liar
JN13	CN3	0.8	0.3	GOTHIC	Tertutup aliran oleh timbunan tanah dan tumbuhan liar
JN14	CN2	0.8	0.2	OPEN TRAPEZOIDAL	Tertutup saluran oleh timbunan tanah dan tumbuhan liar

Source: Results of Running SWMM, 2022

Figure 12. An example of a partial recapitulation of the Flooded Canal Dimensions in Klamalu and Klasuluk Villages

3.6 Wastewater Discharge in the Primary Channel Distribution of Wastewater Service Blocks

The Klamalu sub-district has 16 blocks, while the Klaluluk sub-district has 15 wastewater service blocks. The planned blocks of the two alternatives can be seen in **Figure 2** and **Figure 3**.

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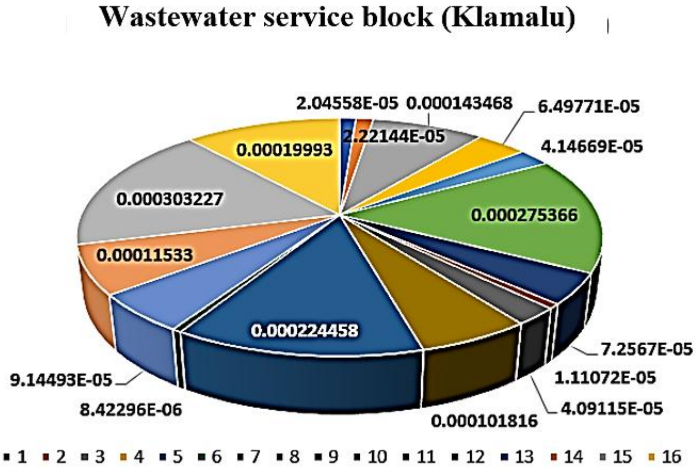
3.6.1 Volume of Domestic Wastewater

The following is the result of the volume of domestic wastewater generated from the research location for the Klasuluk Sub-District and the Klamalu Sub-District, as seen in **Figure 13**. Based on the figure below, the Klamalu sub-district is divided into 16 blocks; in block one, the wastewater discharge is 0.0000021 m^3/s, as follows:

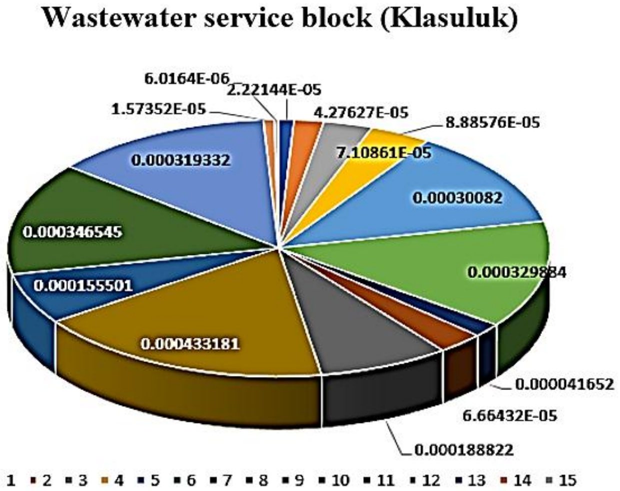
Block 1, Total Population (F) = 17 people
Q ab = 130 liters/person/day

Q al = 80% Q ab

Q_L = Q ab × P × 80 = 0.0000021 m^3/s



Source: Field Data Calculation Results, 2022
Figure 13. The Klamalu Village Wastewater Service Block (BPAL)



Source: Field Data Calculation Results, 2022
Figure 13. Wastewater Service Block (BPAL) of Klasuluk Village

Based on the picture above, the Klasuluk sub-district is divided into 15 blocks; in block one the wastewater discharge is 0.0000020 m^3/s, as follows:

Block 1, Total Population (F) = 16 people
Q ab = 150 liters/person/day
Q al = 80% Q ab
Q_L = 0.0000020 m^3/s

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3.6.2 Volume of Non-Domestic Wastewater

3.6.2.1 Volume of non-domestic wastewater in Klamalu Village:

Q Educational facilities
= Σ Facilities × Σ Total Students × Q clean water = 0.0000139 m^3/second
Q Worship facilities = Σ Facilities × Q clean water = 2 units × 500 liters/day = 0.0000116 m^3/s
Q total = 0.0000139 m^3/s + 0.0000116 m^3/s = 0.000025 m^3/s
Q ave total (Klamalu) = 0.000025 m^3/s + 0.0000020 m^3/s = 0.0000045 m^3/s

The following is the calculation of the discharge of the Klasuluk sub-district channel;
Σ Educational Facilities = 1 Unit (Klasuluk)
Σ Total students = 233 souls
Σ Religious Facilities = 4 units
Q ab Educational facilities = 30 liters/day
Q ab worship facilities = 1000 liters/day

3.6.2.2 Volume of non-domestic wastewater in Klasuluk Village:

Q Educational facilities = Σ Facilities × Σ Total Students × Q clean water
= 1 unit × 233 souls × 30 liters/day = 0.0000809 m^3/s
Q worship facilities = Σ Facilities × Q clean water
= 4 units × 1000 liters/day
= 0.0000463 m^3/s
Q total = 0.0000809 m3/s + 0.0000463 m^3/s = 0.0001272 m^3/s
Q ave total (Klasuluk) = 0.0001272 m^3/s + 0.0000022 m^3/s = 0.0001494 m^3/s
Thus, domestic and non-domestic wastewater that flows into the drainage for the Klasuluk and Klamalu sub-districts is 1%, and most of it seeps into the ground.

3.7 The capacity of the Retention Pond

Extensive *Catchment Area* (A) = 602 Ha
Koef. Flow (C) = 0,10
The first time (t_o) =10 minutes
Channel length (L) = 1130 meters
Average speed (v) =1,5 meters/second
The design rainfall interval of 10 years (R_t) = 362,13 mm/hour

1. Time flows along channels $t_d = \frac{L}{60V} = \frac{1130}{90}$ = 12,6 minutes
2. Time of concentration $t_c = t_o + t_d$ = 22,56 minutes
3. Deviation coefficient $C_s = \frac{2t_c}{2t_c+t_d}$ = 0,7823
4. Rain Intensity $I_t = \frac{R_t(24)}{24\,(t)}\,{}^{2}/_{3} = \frac{362{,}13\,(24)}{24\,(22{,}56/60)}\,{}^{2}/_{3}$ = 241,02 mm/hour
5. Intake water volume $Q_{in} = 0{,}00278.C.C_s.I.A$ = 0,00278 × 0,1 × 0.78 × 241,02 × 601,9
   = 31,55 m^3/second

Analysis of calculation of Retention Pond capacity and Pump Capacity with planning data:
Required data:
Flow time along the channel (t_d) = 12,6 mnt
Time of concentration (t_c) = 22,56 mnt
Rain plan interval 10 years (R_t)= 362,13 mm/day

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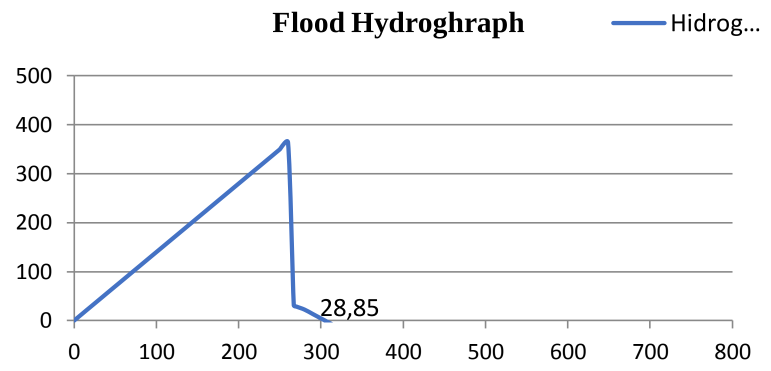
Rain intensity (I) = 241,02 mm/hours
Incoming water discharge (Q_{in}) = 31,55 m^3/sc
The following is a flow hydrograph in the plan area as shown below:



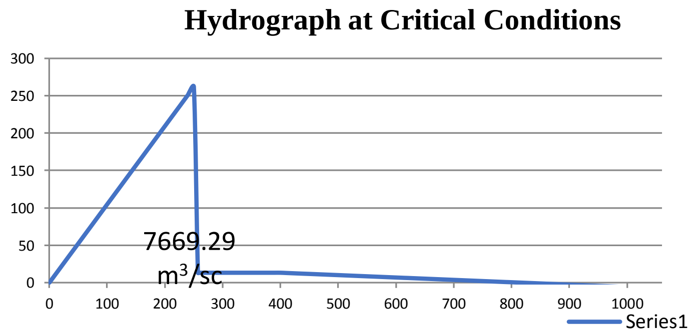
Source: Field Data Calculation Results, 2022
Figure 14. Flow Hydrograph Graph

At the inflow capacity tested (*trial and error*), the critical hydrograph model tc > t, an interval of 10 years with the following data:
tc = 400 min

Deviation coefficient $C_s = \frac{2t_c}{2t_c+t_d} = 0.9845$

Rain Intensity $I_t = \frac{R_t(24)}{24\,(t)}\,{}^{2}/_{3} = \frac{362{,}13\,(24)}{24\,(400/60)}\,{}^{2}/_{3}$ = 35,44 mm/hours

Incoming water volume:
Q_{in} = 0,00278.C.C_s.I.A
= 0,00278 × 0,1 × 0.985 × 35,4 × 601,9
= 5,84 m^3/sc



Source: Field Data Calculation Results, 2022
Figure 15. Inflow Hydrograph Graph

Dimensional analysis of the retention pond using the data:
Incoming water discharge = 31,55 m^3/sec
Storage Length = 219,94 meters
Storage area = 6763,06 m^2
Retention pool width = 92,22 meters
Water depth = 3 meters
The slope of the embankment = 1,5 meters
The slope of the channel permit = 0,0025
Manning roughness coefficient = 0,02

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1. Wet cross-section area
   A = (b+(m×h))×h
   A = (92,22+(1,5 × 3))× 1,5
   A = 145,05 m^2
2. Wet around **(**P) = b + 2h $(m+1)^{0,5}$ = 101,69 meters
3. Hydraulic spokes **(**R) = $\frac{A}{P} = \frac{145,05}{101,69}$ = 1,43 meters
4. Flow speed
   V = $\frac{1}{n} R^{2/3} . I^{1/2} = \frac{1}{0,02}$ (1,267) × (0,050)
   = 3,168 m/sec
5. Guard high **(**W) = $\sqrt{0,5H} = \sqrt{0,5(3)}$ = 1,22 meters
6. Water discharge **(**Q_{out}) = v × A = 3,168 × 145,05 = 459,51 m^3/sec
7. Check
   $R_{em} = \frac{Qin}{Qout} = \frac{70,95}{459,51}$ = 0,154 OK (0,154 < 70,95)

5. Conclusion and Suggestion

5.1 Conclusion

One effort to overcome this problem is to conserve water resources to prevent flooding or inundation. The aim is to maintain the existence of carrying capacity and carrying capacity by conducting technical research on constructing an environmentally sound drainage network system located in two sub-districts, namely Klamalu and Klasuluk sub-districts by taking into account the amount of rain intensity over a 10-year interval. Based on the results of the evaluation of the EPA-SWMM simulation modeling program on drainage capacity in Klamalu Village and Klasuluk Village, In flooded canals, dimensional changes to the drainage capacity are made, including channel height and channel widening. Still, here, only the depth of the channel is prioritized due to land acquisition, so the channel widening remains the same. After running with an interval of 10 years, there were 3 flood points in the Klamalu village canal, where the largest total flood volume was at JN64 146,687 m^3/s, and the smallest was at JN15 21,232 m^3/s. There were 56 flood points in the Klasuluk urban canal, where the total volume of the biggest flood was at JN91 1.863 m^3/s, and the smallest was at JN9 and JN37 0,008 m^3/s. **Table 12** shows the change in the dimensions of the channel which was initially flooded. After the Running SWMM experiment was carried out repeatedly, the cross-section of the channel shows the difference in the channel that can accommodate the maximum discharge. The changes are adjusted due to collisions with land acquisition. So changes are specific to the depth of the channel. There are 16 Wastewater service blocks in the Klamalu Village with a total of 0,001737 m^3/sec, while in the Klaluluk Subdistrict, there are 15 Wastewater service blocks with a total of 0,002429 m^3/sec. The Non-Domestic Wastewater Debit in Klamalu Village is 0,0000045 m^3/sec. Whereas for the Klasuluk Village, it is 0,0001494 m^3/sec. However, only 1% enters the drainage. Some of it flows and absorbs into the soil. So it does not affect the drainage. The area of the retention pond is 6763 m^2, the incoming water discharge data is 31.55 m^3/s with a retention pond width of 92.22 meters, the length of the retention pond is about 219.94 meters with a depth of 3 meters, the slope of the dam is 1.5 meters, the allowable slope of the channel is 0.0025 so that the manning roughness coefficient is 0.02. From the data above, it is obtained that the wet cross-sectional area is about 145.05 m^2, the wet circumference

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of the retention pond is 101.69 meters, the hydraulic radius is 1.43 m, the flow velocity is 3.168 m/s, the guard height is 1.22 meters, the discharge of water that comes out is 459.51 m^3/sec.

5.2 Suggestion

There needs to be further planning related to drainage, which includes wastewater and rainwater in one channel with the latest data, so that scientific work on planning can be used as a reference for future implementation, especially in the Sorong Regency area.

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