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Design of Irrigation Channel Network Connectivity and Tertiary Channels in Menten Village, Rambutan District South Sumatra to Optimize Agricultural Land

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A B S T R A C T

South Sumatra Province is a province that is flowed by many rivers, including the Musi River, the longest river on the island of Sumatra. The condition of inadequate irrigation infrastructure means that farmers in Menten Village can only plant one crop per year. This study aimed to determine the irrigation water needs of tertiary canals and design the dimensions of connectivity and tertiary channels. Repairing the irrigation network in the village is planned to increase the productivity of agricultural land to two plantings in one year with a cropping pattern of rice and crops. This research was conducted following the following stages Calculation of Irrigation Water Needs, Calculation of Surface Runoff Discharge, Calculation of Channels Design Discharge, Calculation and determination of the dimensions of Connectivity and Tertiary Irrigation Channels. The study results obtained a Need Field Requirement (NFR) value of 1.572 l/s/ha with a maximum irrigation water requirement of 2.418 l/s.ha. To increase menten agricultural yields, a planting pattern of 2 times is planned. The planned channel is an open trapezoidal channel that functions as a carrier channel and a discharge channel namely rice and crops. There are three connectivity irrigation channels. While there are 25 tertiary irrigation canals. The results of this research can be used reference to improve irrigation systems that are still not optimal.

1. Introduction

South Sumatra Province is a province that is flowed by many rivers, including the Musi River, the longest river on the island of Sumatra [1]. This province consists of 11 districts and 4 municipalities, with the agricultural sector evenly distributed in each region. The existence of the river has a positive impact on agriculture through irrigation, drainage, and soil

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fertility. One of the districts that have this agricul has al sector is Banyuasin Regency, where the district is fed by the Musi River, which can support agricultural productivity in every village in Banyuasin Regency. One of the villages in Banyuasin Regency where the agricultural land is in the form of leak swamp land is Menten Village, Rambutan District. The agricultural area in Menten village is already a large expanse of paddy fields, but the availability of water for the needs of crops in the fields is insufficient for farmers to produce two harvests in a year. This has an impact on the amount of production produced [2].

In increasing agricultural production to achieve national food, the Irrigation network plays an important role [3]. An irrigation network is a unit that includes channels, buildings, and complementary buildings that regulate water, including supply, distribution, collection, use, and disposal of irrigation water [4]. Research related to the performance of irrigation networks in Central Lampung shows That a good irrigation network can provide maximum service distribution water to meet plant water needs. When water is lost due to irrigation networks not working properly well, it can be ascertained that the discharge produced is not optimal [5].

Irrigation canals are important in providing water for irrigation areas [6]. Many countries have experienced crisis problems in food production, lack of energy availability, and weak air irrigation management [7],[8]. One of the irrigation management networks is the improvement of facilities and irrigation infrastructure. Improvement of irrigation network facilities and infrastructure is divided into two activities, viz development and management [9]. Damage to infrastructure has an impact on less than optimal performance of irrigation networks [10]. Irrigation approach areas are located in the hydrological area starting from the primary channel of the main river, secondary canals to tertiary canals in farmers' fields [11]. Research conducted in Boyolali shows water sources for irrigating rice fields in Boyolali include weirs, ditches, and springs, namely collected in the form of a pond, and a small portion is a reservoir. Within 2 years after surgery, pond water was used for irrigation to accelerate the increase in crop yields [12].

Currently, the paddy fields in Menten village only have existing canals or secondary canals, which are only part of the agricultural land. The irrigation system for the irrigation canals comes from a rain-fed system, which until now has not been sufficient to meet the water needs of the paddy fields. In addition, the paddy fields in Menten Village do not yet have a network of tertiary irrigation channels that flow to each paddy field to meet the plant's water needs. However, the canal is only half functional because it does not have a water gate and has experienced erosion and sedimentation at several points. In order to implement a harvest system

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at least twice a year, it is necessary to increase the construction of connecting irrigation networks and tertiary irrigation networks in the paddy fields of this village. Each paddy field functions as a carrier and place of release so that the level of drought and frequent flooding/overflow occur can be overcome so that the results of rice productivity can be maximized.

This research aims to analyze the need for irrigation water, which is large with 2 plantings in one year, and plan effective irrigation channels. Design of connecting networks and tertiary irrigation channels for each rice field in Menten Village, Rambutan District, so that water can be spread evenly in every Menten Village land. So that it is expected to be able to improve irrigation systems that are not yet optimal, which have an impact on agricultural production

2. Research Method

In this study, the quantitative research method is based on empirical experience that collects data in numbers that can be counted and in numerical form. This type of research can be used to design connectivity and tertiary irrigation canals on the agricultural land of Menten Village, Rambutan District, to calculate the dimensions of the tertiary canal. The stages in planning channels begin with planning tertiary plots and designing irrigation canal networks. Furthermore, a hydrological analysis is carried out, which aims to determine the irrigation water needs and the planned discharge. The design location for connectivity and tertiary irrigation channels is carried out in Menten Village, Rambutan District, Banyuasin Regency, South Sumatra Province, which is located at coordinates 3° 01' 39.8" S - 3° 05' 48.1" S and 104° 51' 18.9" E - 104 ° 55' 25.9" E. The agricultural land in this village has a land area of 189.11 Ha, with the type of leak swamp land for which tertiary irrigation channels will be designed.

2.1 Primary Data Collection

Primary data was collected from the questionnaires obtained directly from interviews with each farmer group in Menten Village, Rambutan District. The purpose of this questionnaire is to collect data that is expected to assist in designing connectivity and tertiary irrigation channels in Menten Village. The primary data obtained from the results of the questionnaire are; Cropping pattern data, Data on the area of paddy fields, Water source, Infrastructure needs, and High - long inundation. In the agricultural land of Menten Village, Rambutan District, there is a canal that works as a carrier channel and a discharge channel which is a secondary channel, so that the results of field measurements obtained the length of the existing channel and the width of the existing channel, as well as field documentation.

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2.2 Secondary Data Collection

This study's secondary data came from the BMKG Kenten station. Secondary data collection aims to be used in analyzing hydrology [4]. The secondary data needed for this research are; Rainfall data was used to analyze the need for irrigation water in Menten Village and disposal in flood discharge. Climatological data is used to calculate evapotranspiration which is then used to calculate the need for irrigation water. The network map is used to determine the location of the irrigation network in Menten Village, Rambutan District.

2.3 Tertiary Plot Planning

Tertiary plot planning is carried out based on the network map as outlined on an overview map with a scale of 1: 25000. To plan tertiary plot boundaries, the area of the planned tertiary plots ranges from 10 to.d. 20 Ha [13]. The results of research in batimurung show that; planting age, paddy field area, and distance between paddy fields, paddy fields, and irrigation canals are factors that have a significant relationship with the level of participation of farmers in the management of irrigation canals [14].

2.4 Hydrological Analysis

A hydrological analysis was carried out to determine the water demand for agricultural land and the planned discharge. The following are some of the data analyzed in hydrological analysis.

- **Evapotranspiration**

this study, the evapotranspiration equation uses the Penman-Monteith method [15], [16]. The amount of potential evapotranspiration is formulated as follows:

$$ET_0 = \frac{0{,}408\,\Delta R_n + \gamma \frac{900}{(T+273)} U_2 (e_s - e_{a)}}{\Delta + \gamma(1 + 0{,}34 U_2)} \quad (1)$$

Where ET_o is reference evapotranspiration rate (mm d-1); T is mean air temperature (°C) o; U_2 is wind speed (m s-1); e_a is mean daily ambient vapor pressure (kPa); e_s is mean saturated vapor pressure (kPa)

- **Effective rainfall**

The effective rainfall data used is monthly rainfall data, where rainfall data is obtained from Kenten Station. Effective rainfall for irrigation of rice plants is taken 70% of the mid-monthly average rainfall with a 20% probability of not being fulfilled or reliable rainfall R_{80} [17], [18].

$$R_e \text{ padi} = \frac{R_{80} x 0{,}7}{number\ of\ observation\ days} \quad (2)$$

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Where Re is effective rainfall (mm/day); R 80 is semi-monthly minimum rainfall with a return period of 5 years/mm; n is the Number of data.

- **Need Field Requirement (NFR)**

Analysis of irrigation water needs aims to obtain predictions of the value of maximum and minimum irrigation water needs on agricultural land in Menten Village, Rambutan District [19]. Some of the factors that are determined for rice field water needs are explained as follows:

a. Land preparation is intended to determine water needs during land preparation. The calculation used is the Van de Goor and Zijlsha method.
b. Plant Coefficient
c. Consumptive Use to determine the amount of water used by plants.
d. Percolation is intended to determine percolation power in irrigated areas based on soil type.
e. Replacement of the Water Layer 2 times, each 50 mm (or 3.3 mm/day for 1/2 month) for one month and two months after transplantation. The cropping pattern used is paddy-rice-plants.
f. Plant Water Needs In this study, plants' water needs were divided into two, namely, the net water requirement in paddy fields (NFR) and the irrigation water requirement for rice and secondary crops [20].

The amount of water needed by plants in a paddy field is expressed in the following equation:

$$NFR = ETc + P + WLR - Re + IR \quad (3)$$

Where NFR is Need Field Requirement (mm/day); Etc is planted water requirement (mm/day); WLR is water layer replacement (mm/day); P is percolation (mm/day); Re is effective rainfall (mm/day)

- **Drainage Module**

The drainage module or waster coefficient is the amount of excess water that must be removed per unit area per unit of time [21]. Due to the type of swamp land in Menten Village, Rambutan District, it is a swampy area where excess water must be forcibly removed using a pump. In this study, to obtain the dump modulus coefficient, it is necessary to know the surface discharge runoff, which can be calculated using the surface discharge runoff equation. Furthermore, the design discharge modulus can be calculated, and 3 days of rainfall with a return period of 5 years are selected [13]. The drainage modulus is then calculated using the following formula:

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$$D_m = \frac{D_{(n)}}{n x 8{,}64} \quad (4)$$

Where Dm is Drainage modulus for n days (l/s.ha); D(n) is Runoff for n days (mm); n is the number of consecutive days.

- **Discharge**

The irrigation network in Menten Village has a dual function, namely as a carrier channel and a drain channel. So two discharge analyses are carried out for the channel [22]. Discharge calculation for the carrier channel using the following formula:

$$Q = \frac{c.(NFR).A}{E} \quad (5)$$

Where Q is Discharge (l/s); A is the Area of the irrigated area (ha); E is Channel efficiency.

While the discharge calculation for the exhaust can be calculated using the following formula:

$$Qd = 1{,}62 \text{ x } D_m \text{ x } A^{0{,}92} \quad (6)$$

Where Qd is Discharge (l/s); Dm is Drainage module (l/s.ha), and A is an area of drained area (ha)

2.5 Hydraulic Analysis

The hydraulic analysis aims to determine the design dimensions of the (secondary) and tertiary connectivity channels based on the design discharge obtained from the hydrological analysis. Research on the efficiency of irrigation networks and water loss in Merauke is carried out by calculating the discharge channel from the hydrological analysis [23]. In principle, the cross-sectional shape of the channel is planned as an open channel (open channel) in the form of a trapezoid without a protective layer [13], [22]. In planning tertiary irrigation channels, the hydraulic analysis aims to determine the design dimensions of tertiary canals based on the planned discharge obtained from the hydrological analysis [24]. The dimensions of the tertiary canal consist of the dimensions of the carrier canal and the dimensions of the discharging channel [25]. As a result of calculating the canal's dimensions, the largest dimension is chosen to be determined for the planning of tertiary irrigation canals in the agricultural land of Menten Village, Rambutan District.

3. Results and Discussions

3.1 Irrigation Channel Network Design

The survey results in Menten Village, Rambutan District, which has an area of 189.11 Ha, show that there are no tertiary canals that flow to the paddy fields in the village. So a

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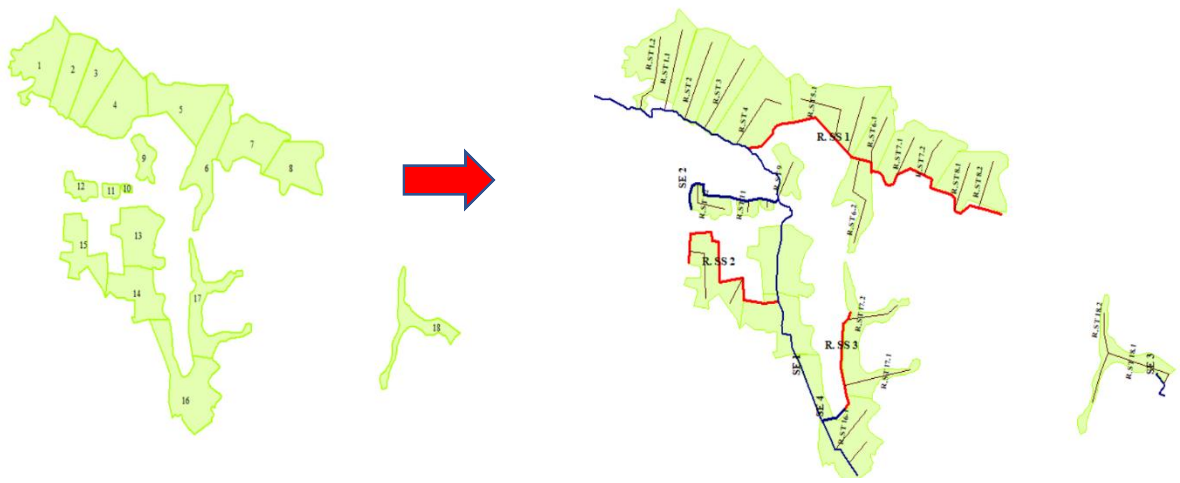
network of tertiary channels and (secondary) connectivity channels are planned in several places as channels that connect tertiary channels in Menten Village agricultural land. Before planning a tertiary irrigation canal network, tertiary plots in paddy fields were first planned, with the area per paddy field ranging from 10 Ha to 20 Ha. The tertiary plot planning for Menten Village, Rambutan District, is shown in Figure 1 (a) below. From the figure, there are 18 planned tertiary plots.



(a) (b)

Source: Author's Analysis.

Figure 1. (a). Menten Village Tertiary Plot **1(b).** Menten Village Irrigation Channel Network

Figure 1. (b) shows that a network of tertiary irrigation canals and connectivity (secondary) is planned, which will function as carrier and discharge channels for tertiary canals. The planned irrigation channel has a dual function, namely, as a carrier channel and a discharge channel. Where the line green (R. ST) is Tertiary Channel, Line red (R. SS) is Secondary Channel, and line black (SE) is Existing Channel

3.2 Evapotranspiration

Calculation of evapotranspiration is carried out using the Penman-Monteith method, which requires climate data and the location of climatological stations so that data processing is carried out according to the criteria for the method unit.

Table 1. Evapotranspiration Calculation Results with the Penman-Monteith Method

Month	Periode	es (Kpa)	ea (Kpa)	ϒ (Kpa/°C)	D	U2 (m/s)	Rn (MJ/m²/day)	Eto (mm/day)
January	I	3,464	2,937	0,068	0,204	1,203	7,901	2,625
	II	3,503	3,018	0,068	0,206	1,242	8,171	2,674
February	I	3,477	3,007	0,068	0,205	1,238	8,348	2,708
	II	3,460	2,973	0,068	0,204	1,105	8,783	2,825

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Month	Periode	es (Kpa)	ea (Kpa)	ϒ (Kpa/°C)	D	U2 (m/s)	Rn (MJ/m²/day)	Eto (mm/day)
March	I	3,561	3,067	0,068	0,209	1,186	8,938	2,896
	II	3,649	3,140	0,068	0,213	1,012	9,326	3,008
April	I	3,659	3,156	0,068	0,214	0,966	9,192	2,962
	II	3,695	3,153	0,068	0,216	0,966	9,200	2,994
May	I	3,372	2,336	0,068	0,199	0,925	8,738	3,141
	II	3,331	2,426	0,068	0,197	0,950	8,335	2,949
June	I	3,690	3,099	0,068	0,216	0,968	8,339	2,778
	II	3,264	2,429	0,068	0,194	0,966	8,042	2,820
July	I	3,600	2,954	0,068	0,211	1,064	8,559	2,889
	II	3,665	2,977	0,068	0,214	1,140	9,492	3,206
August	I	3,721	2,974	0,068	0,217	1,193	9,409	3,245
	II	3,754	2,943	0,068	0,219	1,275	9,814	3,434
September	I	3,665	2,831	0,068	0,214	1,198	9,563	3,354
	II	3,336	2,423	0,068	0,197	1,125	8,791	3,152
October	I	3,650	2,822	0,068	0,213	1,117	8,415	2,998
	II	3,761	3,004	0,068	0,219	1,005	8,497	2,946
November	I	3,637	2,955	0,068	0,213	0,945	8,056	2,745
	II	3,699	3,138	0,068	0,216	0,983	8,084	2,688
December	I	3,581	3,057	0,068	0,210	1,052	7,765	2,573
	II	3,575	3,126	0,068	0,210	1,157	7,584	2,480

Source: Author's Analysis.

Table 1. shows the results of calculating evapotranspiration every month for 2 periods. The calculation results will be used to analyze irrigation water needs, and the largest evapotranspiration occurs in the second period in August at 3.434 mm/day.

3.3 Effective Rainfall

Effective rainfall is taken from 70% of the minimum monthly rainfall in rice plants or R_{80}. Meanwhile, secondary crops are calculated using the USDA method. The results of the effective rainfall calculation can be seen in **Table 2.**

Table 2. Recapitulation of Effective Rainfall for Paddy and Crops Plants.

Month	Periode	R80	Re Paddy	Re Crops
January	I	42.84	2.00	1.37
	II	66.60	2.91	1.37
February	I	63.56	2.97	1.71
	II	53.86	2.90	1.71
March	I	102.28	4.77	1.78
	II	129.20	5.65	1.78
April	I	93.96	4.38	1.85
	II	138.72	6.47	1.85
May	I	36.32	1.69	1.09
	II	58.00	2.54	1.09
June	I	23.22	1.08	1.21
	II	19.42	0.91	1.21
July	I	20.88	0.97	0.42
	II	7.80	0.34	0.42
August	I	1.74	0.08	0.28
	II	0.10	0.00	0.28
September	I	0.00	0.00	0.04
	II	3.60	0.17	0.04
October	I	0.00	0.00	0.21
	II	16.00	0.70	0.21
November	I	50.20	2.34	2.09
	II	101.80	4.75	2.09
December	I	81.98	3.83	2.30
	II	106.94	4.68	2.30

Source: Author's Analysis.

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Table 2. shows the results of calculating the effective rain for rice and crops, which will be used to calculate the irrigation water requirement according to the cropping pattern. The effective rainfall value for rice is higher than for crops, especially from November to April.

3.4 Need Field Requirement (NFR)

In March and April, the results of a survey questionnaire in Menten Village, Rambutan District, experienced stagnant water or floods as high as 2.5 m. 3m, so that in that month, it cannot be planted. In this study, the cropping pattern used was paddy in period 1 and crops in period 2. Period 1 for planting rice starts in October and harvests in February, and Period 2 for planting crops starts from May to August. The crop planters were chosen in May because during that month, the land was not inundated with water, and the planting of crops also did not require much water compared to paddy. **Table 3**. shows an analysis of the need for irrigation water based on a predetermined cropping pattern.

Table 3. Recapitulation of Calculation of Irrigation Water Needs.

Plant type	Month	Periode	Eto	Re	P	WLR	Eo	M	K	IR	Etc	NFR	KAI
Paddy	October	II	2.948	0.70	2	0	3.243	5.243	0.944	8.583	0.000	1.144	1.760
	November	I	2.747	2.34	2	0	3.022	5.022	0.904	8.440	0.000	0.937	1.442
		II	2.690	4.75	2	0	2.959	4.959	0.893	8.399	0.000	0.654	1.006
	December	I	2.575	3.83	2	1.65	2.832	4.832	0.870	8.317	2.789	1.265	1.946
		II	2.481	4.68	2	1.65	2.730	4.730	0.851	8.252	2.647	1.142	1.757
	January	I	2.628	1.37	2	1.65	2.890	4.890	0.880	8.355	2.671	1.540	2.369
		II	2.677	1.37	2	1.65	2.944	4.944	0.890	8.390	1.785	1.441	2.217
	February	I	2.711	1.71	2	0	2.982	4.982	0.897	8.414	0.858	1.107	1.703
		II	2.828	1.71	2	0	3.111	5.111	0.920	8.497	0.000	1.017	1.565
	March	I	2.899	0.00	2	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		II	3.011	0.00	2	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	April	I	2.965	0.00	2	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		II	2.997	0.00	2	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Crops	May	I	3.142	1.09	2	0	3.457	5.457	0.982	8.723	0.524	1.176	1.809
		II	2.950	1.09	2	0	3.245	5.245	0.944	8.585	1.072	1.223	1.882
	June	I	2.780	1.21	2	0	3.058	5.058	0.910	8.463	1.899	1.291	1.986
		II	2.821	1.21	2	0	3.103	5.103	0.919	8.493	2.445	1.358	2.089
	July	I	2.891	0.42	2	0	3.180	5.180	0.932	8.542	2.920	1.510	2.322
		II	3.208	0.42	2	0	3.529	5.529	0.995	8.771	3.230	1.572	2.418
	August	I	3.248	0.28	2	0	3.572	5.572	1.003	8.800	2.133	1.464	2.253
		II	3.437	0.28	2	0	3.780	5.780	1.040	8.938	1.088	1.360	2.092

Source: Author's Analysis.

Table 3. shows the amount of irrigation water needed for the analysis of discharge in the conveyance and disposal channels; the NFR value used is the highest NFR value with a value of 1.572 l/s/ha.

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3.5 Drainage Module

The drainage module or waster coefficient is the amount of excess water that must be removed or drained per paddy field. Maximum daily rainfall data for 3 consecutive days each year, obtained from rainfall data, are then sorted from the largest to the smallest value. The following is Table 4, which shows the maximum daily rainfall data recapitulation after sorting.

Table 4. Maximum Daily Rainfall Recapitulation.

No.	Month												P	Return Period
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
1	106.4	140.6	162.4	154	109.4	105.7	72.5	139.9	174.7	121.9	178	128	9.09	11.00
2	101.2	113	148.9	128	105.6	75.9	72	59.2	92	114.8	160.3	124	18.2	5.50
3	99	102	125.3	123.7	94.8	74.3	47	43	42.2	109.4	128.2	112.3	27.3	3.67
4	95.4	90	124	118.4	86.5	70.2	40.8	38.9	39	104.2	127.4	110.4	36.4	2.75
5	91.8	89	122.4	108.3	73.9	65	40.8	38.4	16	86.5	125.6	101.3	45.5	2.20
6	85.5	80	104.2	107	52	59.1	33.5	33.3	14.5	74.9	120	94.9	54.5	1.83
7	78.3	79.8	94	95.5	50	43.4	32.5	30	14	74.5	88.3	83.9	63.6	1.57
8	52.2	66.5	90.7	92.4	50	41.2	22.5	23.1	13.9	2	77.8	80.2	72.7	1.38
9	29.9	60.1	58	82.9	42.4	40.2	20.4	20.7	1	0.4	57.7	70.5	81.8	1.22
10	27.5	7	50.7	80	41.6	27	19.1	0.5	0	0	33.1	0	90.9	1.10

Source: Author's Analysis.

From **Table 4.** above, the 5-year return period is between the 5.5 and 3.67 return periods. Then the data used for interpolation is using the 2nd and 3rd-order data. Below is an example of an elaboration of calculations to find the planned rainfall value for a 5-year return period. **Table 5**. shows a recapitulation of the planned 5-year return period rainfall each month due to the interpolation.

Table 5. Maximum Daily Rainfall Recapitulation.

Month	R(n)T	Month	R(n)T
Jan	100.6	Jul	65.18
Feb	110	Aug	54.78
Mar	142.5	Sep	78.42
Apr	126.8	Oct	113.3
May	102.7	Nov	151.5
Jun	75.46	Dec	120.8

Source: Author's Analysis.

Table 5. shows the results of the calculation of the planned rainfall for the 5-year return period, the maximum value is sought to obtain the value of R(n)T. The maximum value obtained in November is 151.5 mm/day, which is then used to find runoff discharge. After calculating the maximum 3 daily rainfall data, the value of the waster modulus or waster coefficient of 4.323 l/sec/ha was obtained.

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3.6 Discharge

The analysis of discharge calculations shows that the discharge channel discharge value is greater than that of the carrier channel. Then the irrigation canal design for hydraulic analysis will use the calculation of drainage discharge. **Table 6** and **7** show the results of calculating the design discharge for each secondary and tertiary discharge channel.

Table 6. Calculation of Debit on the Secondary Exhaust Channel.

No.	Channel Name	Field area	Dm	Qd
		ha	lt/dt/ha	m3/dt
1	SSP 11	55.8	4.323	0.283
2	SSP 12	39.3	4.323	0.205
3	SSP 13	25.3	4.323	0.137
4	SSP 2	21.13	4.323	0.116
5	SSP 3	11.9	4.323	0.068

Source: Author's Analysis.

Table 7. Calculation of Discharge on Tertiary Exhaust Channels.

No.	Channel name	Field area	Channel length (m)	Dm	Qd
		ha		lt/dt/ha	m3/dt
1	STP 1-1	8.14	500	4.323	0.048
2	STP 1-2	6.76	480	4.323	0.041
3	STP 2	11	500	4.323	0.064
4	STP 3	11	500	4.323	0.064
5	STP 4	16.2	440	4.323	0.091
6	STP 5-1	10.02	450	4.323	0.058
7	STP 5-2	6.48	350	4.323	0.039
8	STP 6-1	6.5	300	4.323	0.039
9	STP 6-2	7.5	570	4.323	0.045
10	STP 7-1	5.8	250	4.323	0.035
11	STP 7-2	7.2	250	4.323	0.043
12	STP 8-1	6.48	300	4.323	0.039
13	STP 8-2	5.82	300	4.323	0.035
14	STP 9	3.83	230	4.323	0.024
15	STP 10	0.45	50	4.323	0.003
16	STP 11	1.33	70	4.323	0.009
17	STP 12	3.32	300	4.323	0.021
18	STP 15-1	6.93	370	4.323	0.042
19	STP 15-2	2.9	180	4.323	0.019
20	STP 16-1	6.37	320	4.323	0.038
21	STP 16-2	3.8	180	4.323	0.024
22	STP 17-1	6.1	450	4.323	0.037
23	STP 17-2	5.8	350	4.323	0.035
24	STP 18-1	5.84	800	4.323	0.036
25	STP 18-2	2.29	250	4.323	0.015

Source: Author's Analysis.

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3.7 Secondary Channel (Connectivity)

There are 3 planned secondary channels with 5 channel names based on the needs of the water flowing in the flowing plot. **Table 8**. shows the results of calculating the dimensions of the (secondary) channel connectivity.

Table 8. Calculation of Dimensions (Secondary) Connectivity Channels

Channel Name	Field Area	Qd	n	m	w	k	b	h	B	H	A	P	R	V	I
	ha	m3/dt					m	m	m	m	m2	m	m	m/dt	
SSP 11	55.8	0.283	1	1	0.4	35	1	0.60	2.20	1.00	0.960	2.697	0.356	0.30	0.0002818
SSP 12	39.3	0.205	1	1	0.4	35	1	0.45	1.90	0.85	0.653	2.273	0.287	0.31	0.0004262
SSP 13	25.3	0.137	1	1	0.4	35	1	0.35	1.70	0.75	0.473	1.990	0.237	0.3	0.0004656
SSP 2	21.13	0.116	1	1	0.4	35	1	0.30	1.60	0.70	0.390	1.849	0.211	0.3	0.0005743
SSP 3	11.9	0.068	1	1	0.4	35	0.6	0.30	1.20	0.70	0.270	1.449	0.186	0.3	0.0004914

Source: Author's Analysis.

The planned (secondary) connectivity channel has a dual function, namely as a carrier channel and a discharge channel, with the existing slope flat. Because the canal also functions as a drain, the canal must be able to accommodate excess water to prevent flooding.

3.8 Tertiary Channel

There are 25 planned tertiary channels, where in tertiary plots 1, tertiary plots 6, tertiary plots 15, tertiary plots 16, tertiary plots 17, and tertiary plots 18, 2 tertiary channels are planned in each of these plots. **Table 9**. shows the results of calculating the dimensions of the tertiary channel for the exhaust channel.

Table 9. Calculation of Dimensions Tertiary Channels.

Channel name	Field Area	Channel length	Qd	n	m	w	k	b	h	B	H	A	P	R	V	I
	ha	(m)	m3/dt					m	m	m	m	m2	m	m	m/dt	
c	8.14	500	0.048	1	1	0.4	35	0.5	0.25	1.00	0.65	0.188	1.207	0.155	0.3	0.00065
STP 1-2	6.76	480	0.041	1	1	0.4	35	0.5	0.22	0.94	0.62	0.158	1.122	0.141	0.3	0.00073
STP 2	11	500	0.064	1	1	0.4	35	0.5	0.30	1.1	0.70	0.240	1.349	0.178	0.3	0.00057
STP 3	11	500	0.064	1	1	0.4	35	0.5	0.30	1.1	0.70	0.240	1.349	0.178	0.3	0.00057
STP 4	16.2	440	0.091	1	1	0.4	35	0.5	0.40	1.30	0.80	0.360	1.631	0.221	0.3	0.00039
STP 5-1	10	450	0.058	1	1	0.4	35	0.5	0.25	1.00	0.65	0.188	1.207	0.155	0.3	0.00095
STP 5-2	6.48	350	0.039	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00095
STP 6-1	6.5	300	0.039	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00096
STP 6-2	7.5	570	0.045	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00125
STP 7-1	5.8	250	0.035	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00078
STP 7-2	7.2	250	0.043	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00116
STP 8-1	6.48	300	0.039	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00095
STP 8-2	5.82	300	0.035	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00078
STP 9	3.83	230	0.024	1	1	0.4	35	0.4	0.15	0.7	0.55	0.083	0.824	0.100	0.3	0.00150
STP 10	0.45	50	0.003	1	1	0.4	35	0.3	0.04	0.3	0.44	0.012	0.363	0.032	0.3	0.00675
STP 11	1.33	70	0.009	1	1	0.4	35	0.3	0.10	0.5	0.50	0.035	0.533	0.066	0.3	0.00208
STP 12	3.32	300	0.021	1	1	0.4	35	0.5	0.12	0.74	0.52	0.074	0.839	0.089	0.3	0.00166
STP 15-1	6.93	370	0.042	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00108
STP 15-2	2.9	180	0.019	1	1	0.4	35	0.4	0.12	0.6	0.52	0.062	0.739	0.084	0.3	0.00197
STP 16-1	6.37	320	0.038	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00092
STP 16-2	3.8	180	0.024	1	1	0.4	35	0.5	0.14	0.8	0.54	0.090	0.896	0.100	0.3	0.00125
STP 17-1	6.1	450	0.037	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00085
STP 17-2	5.8	350	0.035	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00078
STP 18-1	5.84	800	0.036	1	1	0.4	35	0.5	0.20	0.90	0.60	0.140	1.066	0.131	0.3	0.00079
STP 18-2	2.29	250	0.015	1	1	0.4	35	0.4	0.10	0.60	0.50	0.050	0.683	0.073	0.3	0.00240

Source: Author's Analysis.

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The planned tertiary channel has a double function, namely as a carrier channel and a discharge channel, with the existing slope being flat. Because the tertiary channel also functions as a drain channel, the channel must be able to accommodate excess water so that flooding does not occur. By setting cropping patterns based on wet and dry months and planning irrigation networks, it is expected to increase agricultural production. Rice production in Menten village with one planting currently reaches 4 tons to 5 tons gkp/ha, with planting time between December and March. Meanwhile, April to November in Menten Village is included in the dry season category, making it impossible to plant rice. In this study, the dry season was used to plant crops so that two crops could be planted in one year.

4. Conclusion

To increase menten agricultural yields, a planting pattern of 2 times is planned, namely rice and crops. The results of the hydrological analysis, the need for water and runoff in Menten Village, Rambutan District using the rice-plants cropping pattern, obtained a maximum irrigation water requirement of 2,418 l/sec.ha and a runoff discharge of 112,050 mm. In the hydraulic analysis, the planning of the dimensions of the connecting (secondary) canal and the tertiary canal is planned in the form of a trapezoidal canal with the dimensions of the secondary canal, which is planned based on hydrological analysis and the area of rice fields. The canal's dimensions are designed to increase rice and secondary crop cultivation. The results of this research can be used reference to improve irrigation systems that are still not optimal.

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