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Authors: Abdul Holis Rahmadi, Novitasari Novitasari, Ulfa Fitriati

Keywords: DIR Maluka Baulin, Water Demand, Water Availability

Topic

Water and environmental engineering

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STUDY OF POTENTIAL DEVELOPMENT OF RAINFED LAND IN MALUKA BAULIN SWAMP IRRIGATION AREA

Abdul Holis Rahmadi[1], Novitasari Novitasari[1*], Ulfa Fitriati[1]

[1]Civil Engineering, Faculty of Engineering, Lambung Mangkurat University, Banjarbaru, South Kalimantan, Indonesia

*novitasari@ulm.ac.id

Abstract. Agricultural land in South Borneo has high rice productivity. The supporting factors for rice productivity are irrigation areas, one of which is the Maluka Baulin Swamp Irrigation Area (DIR). It is located in Kurau, Tanah Laut Regency. It has an area of 421 ha (Decree of the Minister PUPR of the Republic Indonesia) now to 286 ha (land function and administrative other villages) with use as agricultural land. It so far has a low average rice production and cropping index of one crop in one year. The purpose of this study was to analyze the availability and demand of water well as the provision of irrigation water based on the water balance for the development of cropping patterns and schedules. This study collects primary and secondary data. Preliminary data are location survey, instantaneous discharge, and questionnaire. Secondary data are climatological data, maps of land types, and data on the discharge Tabanio-Bajuin River. The water requirement is obtained from the calculation of land preparation and consumptive use of water for plants. Water availability is obtained by analyzing rainfall, calculating evapotranspiration, calibrating F.J. Mock Model discharge, and calculating mainstay discharge. The temporary result obtained the water balance is land area is obtained with cropping pattern and schedule that increases to paddy-paddy-palawija, which was previously only paddy-paddy. Then, agricultural production, especially rice and secondary crops, will directly grow.

1. Introduction

Paddy fields in lebak (non-tidal) swamps and tidal swamps that have the potential to be optimized and developed are in the province of South Kalimantan. According to [1], rice productivity in South Kalimantan is the highest compared to 4 other provinces on the island of Kalimantan, which is 4,19 tons/ha. Rice productivity in South Kalimantan is still much lower at 79.42% of the average national rice productivity of 5,34 tons/ha. Agricultural Survey Data Land in 2015 showed that the paddy fields planted with rice were 450,024 ha, consisting of 47,877 ha of irrigated paddy fields, 141,033 ha of rainfed land, 166,317 ha of tidal swamps, and 94,797 ha of lebak swamps. The total paddy field planted with rice once a year is 408,870 ha (90.86%), planted with rice twice a year is 41,014 ha (9.11%), and planted with rice three times a year is 140 ha (0.03%).

The total paddy field, which is a supporting factor for rice productivity in the land, is the irrigation area. According to [2], South Kalimantan Province has 535 Swamp Irrigation Areas (DIR) under the authority of district governments. One of them is the DIR in Tanah Laut Regency, and the name is DIR Maluka Baulin which has an area of 421 ha (Permen-PUPR No. 14/2015). DIR Maluka Baulin is located in Kurau District, Tanah Laut Regency.

The problem that is often faced by the farmers of DIR Maluka Baulin is the lack of water, especially during the dry season, causing several problems, such as reduced yields, vulnerability to pest attacks, and uneven distribution of water which causes competition for water to irrigate paddy fields. According to secondary data obtained from the Agricultural Extension Center (BPP) of Kurau District in 2021, the average rice production in Kurau District is around 3.4 tons/ha, while the average cropping index (IP 100) or one crop per hectare one year. Based on research conducted by [3], rice production in Kurau District can be said to be low, classified below the median or average. One of the causes of low rice production is the uneven water balance in the Maluku Baulin DIR area. Water balance is a balance between water availability and water demand.

Water balance is closely related to water balance. The water balance is a quantitative relationship model between the amount of water available above and in the soil and the amount of rainfall that falls on an area within a certain time [4]. Therefore, it is necessary to use irrigation water optimally by streamlining the distribution and use of irrigation water so that existing agricultural land can be irrigated optimally. In order to make efficient use of irrigation water, it is necessary to conduct research on adjusting the amount of water demand for plants and setting cropping patterns according to the availability of water in the DIR Maluka Baulin.

2. Materials and Methods

2.1 Collection Data

Primary Data

Data collection was obtained directly in the field, namely DIR Maluka Baulin. The primary data in this study are as follows: (i) Research site survey; (ii) Filling out questionnaires (land type, cropping index, pattern, and planting schedule); (iii) Measuring the discharge of DIR Maluka Baulin.

Secondary Data

Data collection was obtained from the relevant agencies. Requests for secondary data for this study include the Department of Agriculture, Horticulture and Plantation, Tanah Laut Regency, Agricultural Extension Center (BPP) in Kurau District, and Class 1 Banjarbaru Climatology Station. The secondary data required are as follows: (i) The geospatial data of Kurau District consists of: Map of land and irrigation network, a map of land area; (ii) Rainfall data consists of Banjarbaru Climatology Data for 20 years (2002-2021); (iii) Climatological data from BMKG Banjarbaru Station.

2.2 Water Availability Analysis

Calculating Planned

Rainfall Planned rainfall is calculated on a monthly basis; a cumulative value of 15 days will be taken. The planned rainfall will get the mainstay of rainfall. The mainstay rainfall obtained is the mainstay rainfall (R_{80}) and (R_{50}). R_{80} means that out of 10 planned rainfall events, eight times will be exceeded. At the same time, R_{50} means that out of 10 planned rainfall events, five times will be exceeded.

Calculating Evapotranspiration

Evapotranspiration is calculated based on the FJ Mock Method. Before calculating the evapotranspiration value, climatological data is needed first. The climatological data will be used to calculate the value of potential evapotranspiration that occurs at the study site; daily evapotranspiration is calculated based on the Penman-Monteith, Thornthwaite, and Hargreaves formulas.

Calculating the Discharge Calibration of the FJ Mock Model

Method *Mock* was developed by Dr. FJ Mock. Method *Mock* is used to estimating the amount of discharge in a watershed based on the concept of water balance. Rainwater (precipitation) that falls will experience evapotranspiration according to the vegetation that covers the catchment area. Evapotranspiration in the *Mock* is evapotranspiration which is influenced by the type of vegetation, soil surface, and the number of rainy days [5].
Discharge data of the Tabanio-Bajuin River is used for the calibration process to obtain the parameters used in the simulation or experiment stage. The parameters obtained include the infiltration coefficient, initial soil moisture, soil moisture capacity, and initial groundwater storage so that the simulation process can be calculated with the reference year 2001-2020; this simulation discharge data will be tested with measured discharge data from field observations at DIR Maluka Baulin.

Calculating Mainstay Discharge

The analysis is continued by calculating the mainstay discharge using the Weibull method to meet water demand at the research site. The mainstay discharge analysis is calculated based on the results of water availability by taking the probabilities of 80% and 50% for the function of irrigation water demand.

2.3 Water Demand Analysis

Calculating Land Preparation

The method developed by [6] to calculate irrigation needs during land preparation was used. The method is based on a constant water rate in lt/s/ha during the land preparation period. According to [7] from several studies, it was found that the Penman-Monteith Model provides accurate estimates, so FAO recommends its use for estimating standard evapotranspiration in estimating water demand for plants.

Calculating Plant Water

Use Consumptive use is the amount of water used by plants for the photosynthesis process of these plants. The calculation of plant water demand is assisted by the CROPWAT 8.0 Application. The main functions of *CROPWAT*, according to [8], are: (i) To calculate evapotranspiration references; (ii) To calculate crop water requirements; (iii) To calculate the need for irrigation water; (iv) to prepare irrigation schedules; (v) to make a pattern of water availability; (vi) to evaluate rainfall; and (vii) to evaluate the efficiency of irrigation practices.

2.4 Maluka Baulin DIR Water Balance Optimizing the Maluka Baulin

DIR is done after getting the water balance between water availability and water demand at the research site. There are two conditions resulting from the water balance; namely, the availability of water is greater than water demand ($Q_{available} > Q_{requirement}$), or water availability is smaller than water demand ($Q_{available} < Q_{requirement}$). Optimization is carried out in 3 ways, namely optimizing land area, optimizing cropping patterns, and optimizing planting schedules.

3. Results and Discussions

3.1 Water Demand Analysis

Explained by [9] that the cropping pattern is the order of the types of plants cultivated on a plot of agricultural land in one year, including the tillage period and the rest period. The cropping pattern in this study uses paddy-paddy-palawija. Calculation of water needs is contained in the calculating irrigation water needs. The calculation of irrigation water needs is based [10]. The results of these calculations are shown in **Table 1**.

Table 1. Water Demand

Month		Water Demand lt/sec/ha	Type Plant	Month		Water Demand lt/sec/ha	Type Plant
Jan	I	0,06	Palawija	Jul	I	5,56	Paddy
	II	0,15			II	0,95	
Feb	I	0,44		Agt	I	1,04	
	II	5,39			II	1,04	
Mar	I	5,26	Paddy	Sep	I	1,09	
	II	5,53			II	0,83	
Apr	I	0,57		Oct	I	7,93	
	II	0,61			II	7,84	
May	I	0,72		Nop	I	6,84	Palawija
	II	0,87			II	0,03	
Jun	I	0,59		Dec	I	0,10	
	II	4,78			II	0,11	

The start planting in **Table 1.** was carried out on the second of March. The maximum water demand in the first October was 7.93 lt/sec/ha, and the minimum water demand in the second November was 0.03 lt/sec/ha.

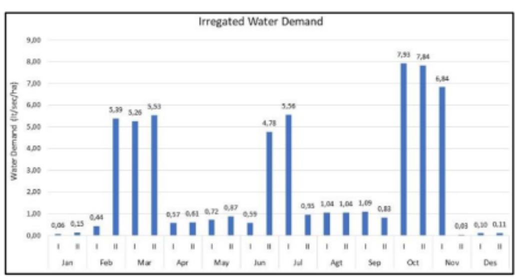

Figure 1. Barchart of Irrigated Water Demand

3.2 Water Availability Analysis

Calibration F.J. Mock Method

The availability of water at DIR Maluka Baulin can be calculated using the FJ Mock Method. The data needed to calculate using the F.J. Mock Method include the following:

1. Potential evapotranspiration
2. Rainfall
3. Measurable discharge data

The obstacle faced in general when calculating water availability is that the available data is very minimal. The discharge data used in this study is the discharge date of the Tabanio-Bajuin River due to the unavailability of discharge data in the rivers closest to the study site. The steps for calculating water availability using the FJ Mock Method are described in detail as follows:

Table 2. Tabanio-Bajuin Semi-Monthly Measured Discharge Data

Month		Average	Month		Average
Jan	I	16,19	Jul	I	4,35
	II	23,27		II	6,63
Feb	I	22,05	Agt	I	3,98
	II	8,87		II	6,60
Mar	I	7,36	Sep	I	5,89
	II	16,23		II	4,43
Apr	I	16,43	Oct	I	4,57
	II	5,74		II	6,57
May	I	5,48	Nop	I	8,95
	II	4,65		II	13,49
Jun	I	14,55	Dec	I	27,28
	II	6,68		II	25,04

The calibration results obtained a *volume error* of 0.048 and a correlation of 0.714, which means that it has a slight error rate and a strong relationship so that the calculation can proceed to the simulation stage. The graph of the calibration results is shown in **Figure 2**.

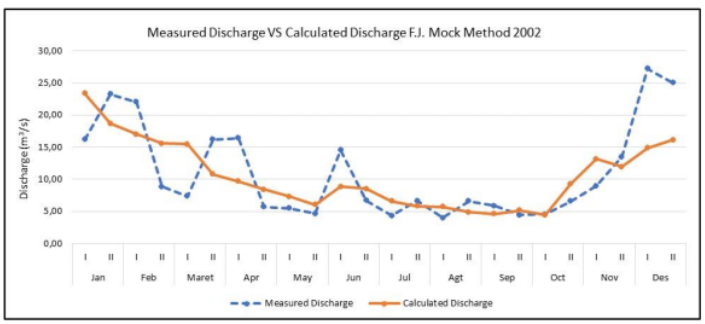

Figure 2. Calibration F.J. Mock Method of Measured Discharge VS Calculated Discharge

It can be concluded that the value of the calibration parameters that will be used in the next stage, namely the simulation stage, is as follows, which is attached in the form of **Table 3**.

Table 3. Parameter of Calibration Result and Specification

Parameter	Calibration Result	Specification
DIC	0,80	$0{,}0001 \leq DIC \leq 0{,}9999$
WIC	0,65	$0{,}0001 \leq WIC \leq 0{,}9999$
ISM	200	$ISM \geq 0{,}0001$
SMC	188	$50 \leq SMC \leq 250$
IGWS	1000	$IGWS \geq 0{,}0001$
k	0,84	$0{,}0001 \leq k \leq 0{,}9999$

The calibration result in the next step of simulation F.J. Mock Method shows in **Figure 3**.

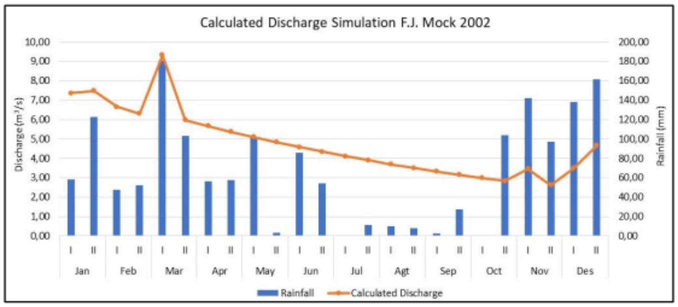

Figure 3. F.J. Mock Calculated Discharge Simulation Resulted in 2002

The amount of the debit value is based on calculations in 2002; the maximum debit value occurred in the first March with a debit value of 9.33 $m^{3/}s$, and the minimum debit occurred in the second November with a debit value of 2.62 $m^{3/}s$.

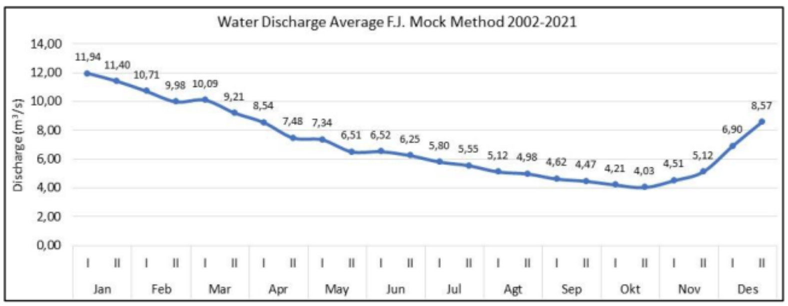

Figure 4. Water Discharge Average F.J. Mock Method 2002-2021

The average monthly discharge value is obtained by averaging the debit data each year in the same month so that the maximum debit value occurs in the first January with a debit value of 11.94 $m^{3/}s$ and the minimum debit value occurs in the second October with a value discharge of 4.03 m^3/s.

Analyze Water Availability

Water Availability with the Weibull method is shown chart shown in **Figure 5**.

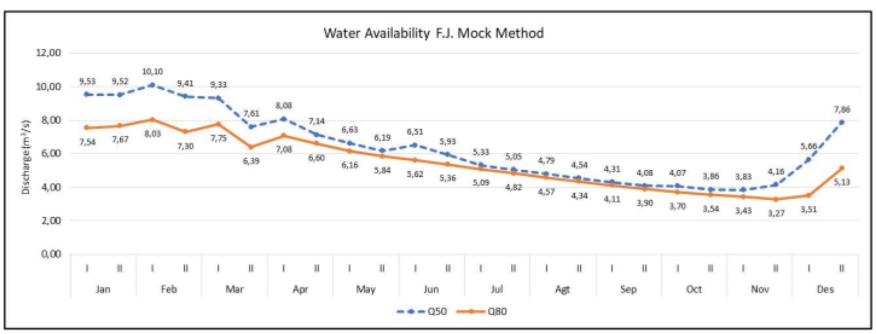

Figure 5. Chart of Water Availability F.J. Mock Method

Discharge of irrigation water needs using the F.J. Mock method; the maximum for secondary crops (Q_{50}) occurred in the first February with a discharge value of 10.10 $m^{3/}s$, and the minimum occurred in the first November with a discharge value of 3.83 m^3/s. The maximum irrigation water demand discharge for rice (Q_{80}) occurred on the first of February with a discharge value of 8.03 m^3/s, and the minimum occurred on the second of November with a discharge value of 3.27 m^3/s. The availability of water in the Maluka Baulin DIR will be used for the service area of the irrigation area, especially for groundwater storage, crop water needs, and water needs in Kurau District, Tanah Laut Regency. The availability of water at DIR Maluka Baulin is expected to be used at the end of each rainy season to be used during the dry season.

3.3 Water Balance

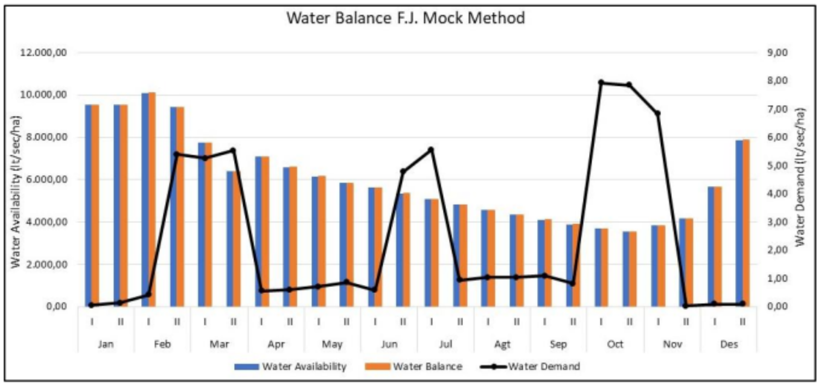

Figure 6. Water Balance F.J. Mock Method

Availability of water in **Figure 6**, the maximum in the first February was 10,100 lt/sec/ha, and the minimum in the second October was 3,540 lt/sec/ha. The maximum water demand on the first October was 7.93 lt/sec/ha, and the minimum water demand in the second November was 0.03 lt/sec/ha. The maximum water balance in the first February was 10,099.56 lt/sec/ha, and the minimum in the second October was 3,532.16 lt/sec/ha during the land preparation period.

4. Conclusions

The maximum water demand in the first October was 7.93 lt/sec/ha, and the minimum water demand in the second November was 0.03 lt/sec/ha. The calibration results obtained a *volume error* of 0.048 and a correlation of 0.714, which means that it has a slight error rate and a strong relationship so that the calculation can proceed to the simulation stage. And then, the water availability maximum in the first February was 10,100 lt/sec/ha, and the minimum in the second October was 3,540 lt/sec/ha. The maximum water requirement on the first October was 7.93 lt/sec/ha, and the minimum water requirement in the second November was 0.03 lt/sec/ha. The maximum water balance in the first February was 10,099.56 lt/sec/ha, and the minimum in the second October was 3,532.16 lt/sec/ha during the land preparation period.

This research needs to be strengthened by rainfall that is close to the location under study, for example, satellite data on rainfall or rain-captive equipment at the research location, so that the results of water availability and water demand are more accurate.

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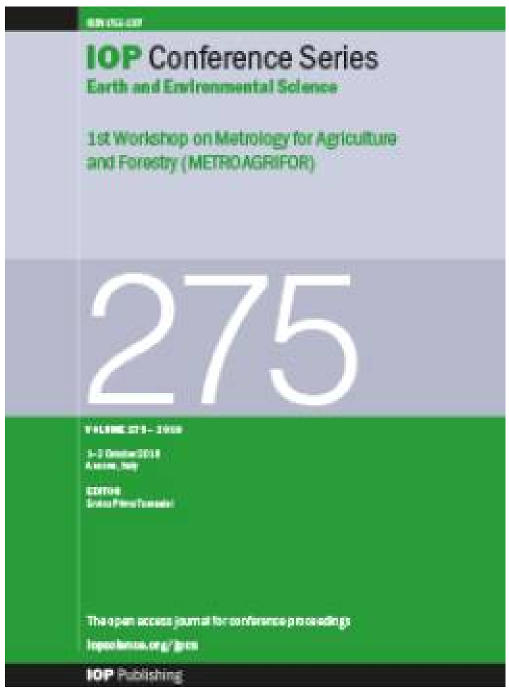
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Abdul Holis Rahmadi[1], Novitasari Novitasari[1*], Ulfa Fitriati[1]

[1]Civil Engineering, Faculty of Engineering, Lambung Mangkurat University, Banjarbaru, South Kalimantan, Indonesia

*novitasari@ulm.ac.id

Abstract. Agricultural land in South Borneo has high rice productivity. The supporting factors for rice productivity are irrigation areas, one of which is the Maluka Baulin Swamp Irrigation Area (DIR). It is located in Kurau, Tanah Laut Regency. It has an area of 421 ha (Decree of the Minister PUPR of the Republic Indonesia) now to 286 ha (land function and administrative other villages) with use as agricultural land. It so far has a low average rice production and cropping index of one crop in one year. The purpose of this study was to analyze the availability and demand of water well as the provision of irrigation water based on the water balance for the development of cropping patterns and schedules. This study collects primary and secondary data. Preliminary data are location survey, instantaneous discharge, and questionnaire. Secondary data are climatological data, maps of land types, and data on the discharge Tabanio-Bajuin River. The water requirement is obtained from the calculation of land preparation and consumptive use of water for plants. Water availability is obtained by analyzing rainfall, calculating evapotranspiration, calibrating F.J. Mock Model discharge, and calculating mainstay discharge. The temporary result obtained the water balance is land area is obtained with cropping pattern and schedule that increases to paddy-paddy-palawija, which was previously only paddy-paddy. Then, agricultural production, especially rice and secondary crops, will directly grow.

1. Introduction

Paddy fields in lebak (non-tidal) swamps and tidal swamps that have the potential to be optimized and developed are in the province of South Kalimantan. According to [1], rice productivity in South Kalimantan is the highest compared to 4 other provinces on the island of Kalimantan, which is 4,19 tons/ha. Rice productivity in South Kalimantan is still much lower at 79.42% of the average national rice productivity of 5,34 tons/ha. Agricultural Survey Data Land in 2015 showed that the paddy fields planted with rice were 450,024 ha, consisting of 47,877 ha of irrigated paddy fields, 141,033 ha of rainfed land, 166,317 ha of tidal swamps, and 94,797 ha of lebak swamps. The total paddy field planted with rice once a year is 408,870 ha (90.86%), planted with rice twice a year is 41,014 ha (9.11%), and planted with rice three times a year is 140 ha (0.03%).

The total paddy field, which is a supporting factor for rice productivity in the land, is the irrigation area. According to [2], South Kalimantan Province has 535 Swamp Irrigation Areas (DIR) under the authority of district governments. One of them is the DIR in Tanah Laut Regency, and the name is DIR Maluka Baulin which has an area of 421 ha (Permen-PUPR No. 14/2015). DIR Maluka Baulin is located in Kurau District, Tanah Laut Regency.

The problem that is often faced by the farmers of DIR Maluka Baulin is the lack of water, especially during the dry season, causing several problems, such as reduced yields, vulnerability to pest attacks, and uneven distribution of water which causes competition for water to irrigate paddy fields. According to secondary data obtained from the Agricultural Extension Center (BPP) of Kurau District in 2021, the average rice production in Kurau District is around 3.4 tons/ha, while the average cropping index (IP 100) or one crop per hectare one year. Based on research conducted by [3], rice production in Kurau District can be said to be low, classified below the median or average. One of the causes of low rice production is the uneven water balance in the Maluku Baulin DIR area. Water balance is a balance between water availability and water demand.

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Water balance is closely related to water balance. The water balance is a quantitative relationship model between the amount of water available above and in the soil and the amount of rainfall that falls on an area within a certain time [4]. Therefore, it is necessary to use irrigation water optimally by streamlining the distribution and use of irrigation water so that existing agricultural land can be irrigated optimally. In order to make efficient use of irrigation water, it is necessary to conduct research on adjusting the amount of water demand for plants and setting cropping patterns according to the availability of water in the DIR Maluka Baulin.

2. Materials and Methods

2.1 Collection Data

Primary Data

Data collection was obtained directly in the field, namely DIR Maluka Baulin. The primary data in this study are as follows: (i) Research site survey; (ii) Filling out questionnaires (land type, cropping index, pattern, and planting schedule); (iii) Measuring the discharge of DIR Maluka Baulin.

Secondary Data

Data collection was obtained from the relevant agencies. Requests for secondary data for this study include the Department of Agriculture, Horticulture and Plantation, Tanah Laut Regency, Agricultural Extension Center (BPP) in Kurau District, and Class 1 Banjarbaru Climatology Station. The secondary data required are as follows: (i) The geospatial data of Kurau District consists of: Map of land and irrigation network, a map of land area; (ii) Rainfall data consists of Banjarbaru Climatology Data for 20 years (2002-2021); (iii) Climatological data from BMKG Banjarbaru Station.

2.2 Water Availability Analysis

Calculating Planned

Rainfall Planned rainfall is calculated on a monthly basis; a cumulative value of 15 days will be taken. The planned rainfall will get the mainstay of rainfall. The mainstay rainfall obtained is the mainstay rainfall (R_{80}) and (R_{50}). R_{80} means that out of 10 planned rainfall events, eight times will be exceeded. At the same time, R_{50} means that out of 10 planned rainfall events, five times will be exceeded.

Calculating Evapotranspiration

Evapotranspiration is calculated based on the FJ Mock Method. Before calculating the evapotranspiration value, climatological data is needed first. The climatological data will be used to calculate the value of potential evapotranspiration that occurs at the study site; daily evapotranspiration is calculated based on the Penman-Monteith, Thornthwaite, and Hargreaves formulas.

Calculating the Discharge Calibration of the FJ Mock Model

Method *Mock* was developed by Dr. FJ Mock. Method *Mock* is used to estimating the amount of discharge in a watershed based on the concept of water balance. Rainwater (precipitation) that falls will experience evapotranspiration according to the vegetation that covers the catchment area. Evapotranspiration in the *Mock* is evapotranspiration which is influenced by the type of vegetation, soil surface, and the number of rainy days [5].

Discharge data of the Tabanio-Bajuin River is used for the calibration process to obtain the parameters used in the simulation or experiment stage. The parameters obtained include the infiltration coefficient, initial soil moisture, soil moisture capacity, and initial groundwater storage so that the simulation process can be calculated with the reference year 2001-2020; this simulation discharge data will be tested with measured discharge data from field observations at DIR Maluka Baulin.

Calculating Mainstay Discharge

The analysis is continued by calculating the mainstay discharge using the Weibull method to meet water demand at the research site. The mainstay discharge analysis is calculated based on the results of water availability by taking the probabilities of 80% and 50% for the function of irrigation water demand.

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2.3 Water Demand Analysis

Calculating Land Preparation

The method developed by [6] to calculate irrigation needs during land preparation was used. The method is based on a constant water rate in lt/s/ha during the land preparation period. According to [7] from several studies, it was found that the Penman-Monteith Model provides accurate estimates, so FAO recommends its use for estimating standard evapotranspiration in estimating water demand for plants.

Calculating Plant Water

Use Consumptive use is the amount of water used by plants for the photosynthesis process of these plants. The calculation of plant water demand is assisted by the CROPWAT 8.0 Application. The main functions of *CROPWAT*, according to [8], are: (i) To calculate evapotranspiration references; (ii) To calculate crop water requirements; (iii) To calculate the need for irrigation water; (iv) to prepare irrigation schedules; (v) to make a pattern of water availability; (vi) to evaluate rainfall; and (vii) to evaluate the efficiency of irrigation practices.

2.4 Maluka Baulin DIR Water Balance Optimizing the Maluka Baulin

DIR is done after getting the water balance between water availability and water demand at the research site. There are two conditions resulting from the water balance; namely, the availability of water is greater than water demand ($Q_{available} > Q_{requirement}$), or water availability is smaller than water demand ($Q_{available} < Q_{requirement}$). Optimization is carried out in 3 ways, namely optimizing land area, optimizing cropping patterns, and optimizing planting schedules.

3. Results and Discussions

3.1 Water Demand Analysis

Explained by [9] that the cropping pattern is the order of the types of plants cultivated on a plot of agricultural land in one year, including the tillage period and the rest period. The cropping pattern in this study uses paddy-paddy-palawija. Calculation of water needs is contained in the calculating irrigation water needs. The calculation of irrigation water needs is based [10]. The results of these calculations are shown in **Table 1**.

Table 1. Water Demand

Month		Water Demand lt/sec/ha	Type Plant	Month		Water Demand lt/sec/ha	Type Plant
Jan	I	0,06	Palawija	Jul	I	5,56	Paddy
	II	0,15			II	0,95	
Feb	I	0,44		Agt	I	1,04	
	II	5,39			II	1,04	
Mar	I	5,26	Paddy	Sep	I	1,09	
	II	5,53			II	0,83	
Apr	I	0,57		Oct	I	7,93	
	II	0,61			II	7,84	
May	I	0,72		Nop	I	6,84	Palawija
	II	0,87			II	0,03	
Jun	I	0,59		Dec	I	0,10	
	II	4,78			II	0,11	

The start planting in **Table 1.** was carried out on the second of March. The maximum water demand in the first October was 7.93 lt/sec/ha, and the minimum water demand in the second November was 0.03 lt/sec/ha.

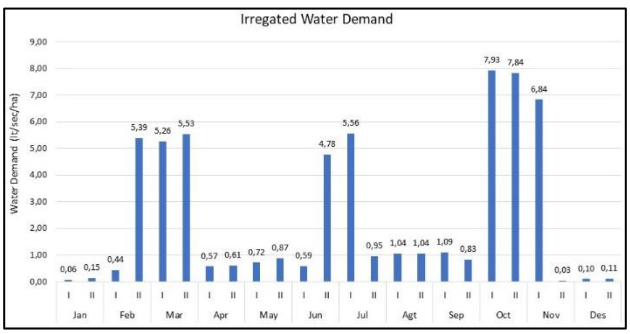

Figure 1. Barchart of Irrigated Water Demand

3.2 Water Availability Analysis
Calibration F.J. Mock Method
The availability of water at DIR Maluka Baulin can be calculated using the FJ Mock Method. The data needed to calculate using the F.J. Mock Method include the following:
1. Potential evapotranspiration
2. Rainfall
3. Measurable discharge data

The obstacle faced in general when calculating water availability is that the available data is very minimal. The discharge data used in this study is the discharge date of the Tabanio-Bajuin River due to the unavailability of discharge data in the rivers closest to the study site. The steps for calculating water availability using the FJ Mock Method are described in detail as follows:

Table 2. Tabanio-Bajuin Semi-Monthly Measured Discharge Data

Month		Average	Month		Average
Jan	I	16,19	Jul	I	4,35
	II	23,27		II	6,63
Feb	I	22,05	Agt	I	3,98
	II	8,87		II	6,60
Mar	I	7,36	Sep	I	5,89
	II	16,23		II	4,43
Apr	I	16,43	Oct	I	4,57
	II	5,74		II	6,57
May	I	5,48	Nop	I	8,95
	II	4,65		II	13,49
Jun	I	14,55	Dec	I	27,28
	II	6,68		II	25,04

The calibration results obtained a *volume error* of 0.048 and a correlation of 0.714, which means that it has a slight error rate and a strong relationship so that the calculation can proceed to the simulation stage. The graph of the calibration results is shown in **Figure 2**.

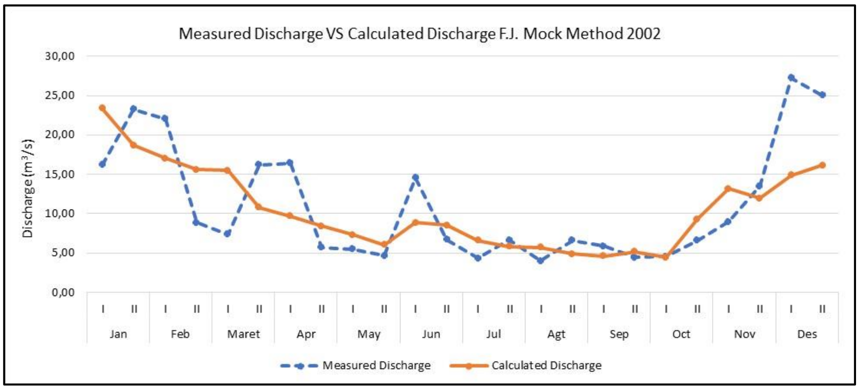

Figure 2. Calibration F.J. Mock Method of Measured Discharge VS Calculated Discharge

It can be concluded that the value of the calibration parameters that will be used in the next stage, namely the simulation stage, is as follows, which is attached in the form of **Table 3**.

Table 3. Parameter of Calibration Result and Specification

Parameter	Calibration Result	Specification
DIC	0,80	$0{,}0001 \leq DIC \leq 0{,}9999$
WIC	0,65	$0{,}0001 \leq WIC \leq 0{,}9999$
ISM	200	$ISM \geq 0{,}0001$
SMC	188	$50 \leq SMC \leq 250$
IGWS	1000	$IGWS \geq 0{,}0001$
k	0,84	$0{,}0001 \leq k \leq 0{,}9999$

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The calibration result in the next step of simulation F.J. Mock Method shows in **Figure 3**.

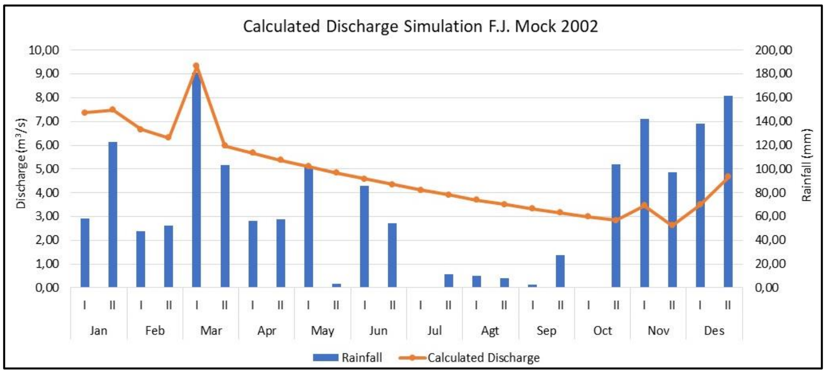

Figure 3. F.J. Mock Calculated Discharge Simulation Resulted in 2002

The amount of the debit value is based on calculations in 2002; the maximum debit value occurred in the first March with a debit value of 9.33 $m^{3/}s$, and the minimum debit occurred in the second November with a debit value of 2.62 $m^{3/}s$.

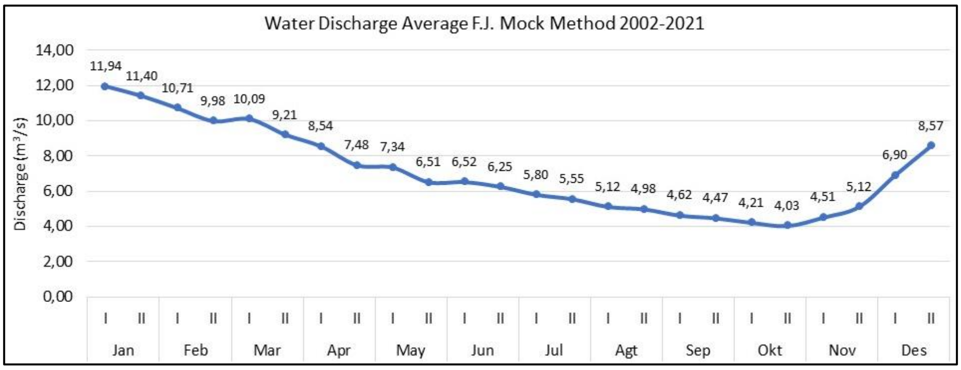

Figure 4. Water Discharge Average F.J. Mock Method 2002-2021

The average monthly discharge value is obtained by averaging the debit data each year in the same month so that the maximum debit value occurs in the first January with a debit value of 11.94 $m^{3/}s$ and the minimum debit value occurs in the second October with a value discharge of 4.03 $m^{3/}s$.

Analyze Water Availability

Water Availability with the Weibull method is shown chart shown in **Figure 5**.

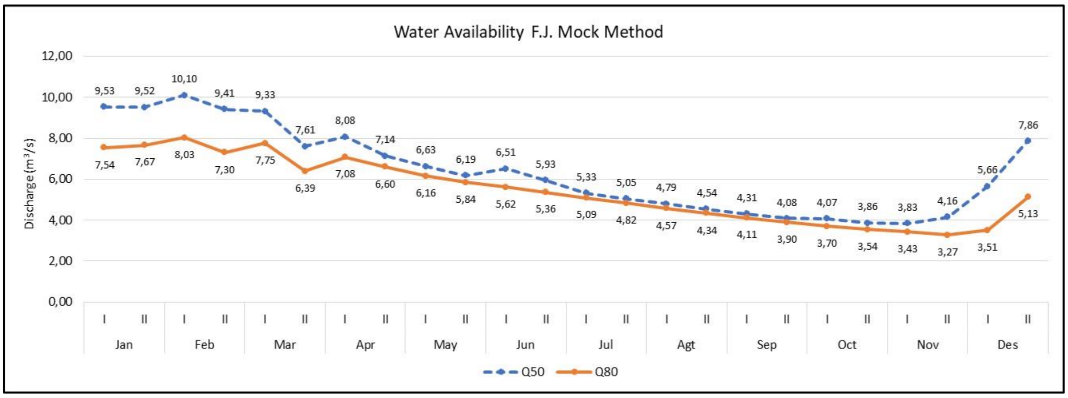

Figure 5. Chart of Water Availability F.J. Mock Method

Discharge of irrigation water needs using the F.J. Mock method; the maximum for secondary crops (Q_{50}) occurred in the first February with a discharge value of 10.10 $m^{3/}s$, and the minimum occurred in the first November with a discharge value of 3.83 $m^{3/}s$. The maximum irrigation water demand discharge for rice (Q_{80}) occurred on the first of February with a discharge value of 8.03 $m^{3/}s$, and the minimum occurred on the second of November with a discharge value of 3.27 $m^{3/}s$. The availability of water in the Maluka Baulin DIR will be used for the service area of the irrigation area, especially for groundwater storage, crop water needs, and water needs in Kurau District, Tanah Laut Regency. The availability of water at DIR Maluka Baulin is expected to be used at the end of each rainy season to be used during the dry season.

3.3 Water Balance

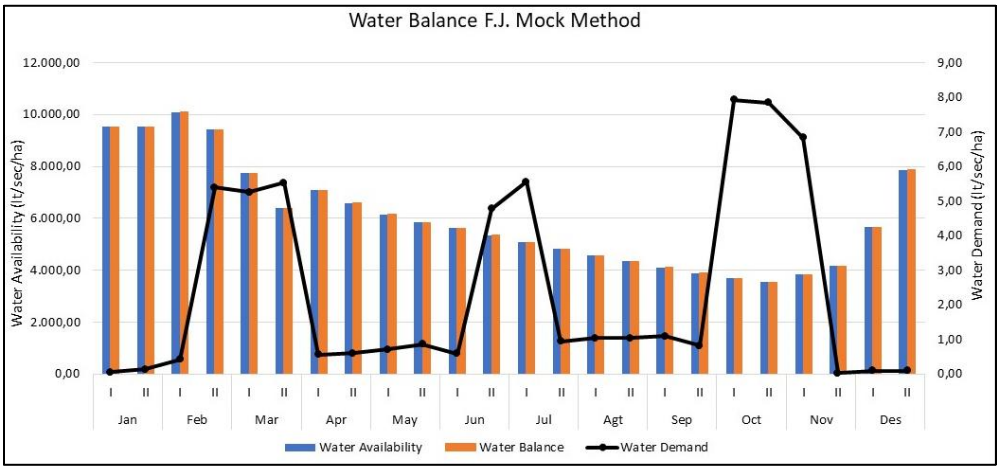

Figure 6. Water Balance F.J. Mock Method

Availability of water in **Figure 6**, the maximum in the first February was 10,100 lt/sec/ha, and the minimum in the second October was 3,540 lt/sec/ha. The maximum water demand on the first October was 7.93 lt/sec/ha, and the minimum water demand in the second November was 0.03 lt/sec/ha. The maximum water balance in the first February was 10,099.56 lt/sec/ha, and the minimum in the second October was 3,532.16 lt/sec/ha during the land preparation period.

4. Conclusions

The maximum water demand in the first October was 7.93 lt/sec/ha, and the minimum water demand in the second November was 0.03 lt/sec/ha. The calibration results obtained a *volume error* of 0.048 and a correlation of 0.714, which means that it has a slight error rate and a strong relationship so that the calculation can proceed to the simulation stage. And then, the water availability maximum in the first February was 10,100 lt/sec/ha, and the minimum in the second October was 3,540 lt/sec/ha. The maximum water requirement on the first October was 7.93 lt/sec/ha, and the minimum water requirement in the second November was 0.03 lt/sec/ha. The maximum water balance in the first February was 10,099.56 lt/sec/ha, and the minimum in the second October was 3,532.16 lt/sec/ha during the land preparation period.

This research needs to be strengthened by rainfall that is close to the location under study, for example, satellite data on rainfall or rain-captive equipment at the research location, so that the results of water availability and water demand are more accurate.

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