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ANALYSIS OF WATER AVAILABILITY AND WATER DEMAND IN PEMATANG PANJANG AGRICULTURAL AREA

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ABSTRACT

Sungai Tabuk district is one of the areas in South Kalimantan where most of the population has a livelihood as a farmer. Sungai Tabuk district has several sub-districts including Pematang Panjang sub-district. This area has a problem, which is the source of irrigation water is only rain-fed so local farmers' profits are not maximized.

In this study, secondary data were used in the form of rain data, climatological data, and river discharge data. These data were analyzed using several methods including the Weibull method to obtain effective rainfall, the Penman-Monteith method to obtain evapotranspiration values, and the F.J. Mock method to obtain dependable flow or water availability.

From this study, the average value of irrigation water demand was 0,2384 m^3/sec. In addition, it is also known that the dependable flow or maximum water availability occurs in the first half of February, which is 1,961 m^3/s, while the lowest dependable flow occurs in the first half of August, which is 0,103 m^3/s.

Keywords: Penman-Monteith, F.J. Mock, Evapotranspiration, Dependable Flow, Pematang Panjang.

1. INTRODUCTION

The growth of rice plants is influenced by natural supporting factors, namely climate, and soil, while global climate change affects rainfall patterns in various regions. Rainfall in Indonesia is quite high, namely 2,000 - 4,000 mm/year, so rainwater is an alternative source of water for irrigation.

According to the statistical agency, the Sungai Tabuk sub-district has a paddy field area of 8,756 ha in 2019, which produced 30,726 tonnes of rice production. The problem faced in the Pematang Panjang agricultural area is the source of irrigation water is only rain-fed.

To maximize the potential of the agricultural area, this research was carried out by comparing the needs and availability of existing water but limited to the availability of water only taking into account rainfall.

2. THEORETICAL STUDY

2.1 Rainfall and Climatology

Rain is different from rainfall. The general understanding of rain is the phenomenon of falling water from the sky, while rainfall is a unit volume of rainwater. Effective rainfall is part of the rain that represents the whole rain. So it is necessary to do a rainfall analysis to determine the effective rainfall. (Department of Public Works, 2013)

The calculation of effective rainfall can be seen in equation 1

$$Re = 0{,}7 \times \frac{1}{15}R \qquad (1)$$

Where :

Re = Effective rainfall (mm/day)

R (half a month) = Mid-month rainfall

Climatology is the study of climate and weather, and how climate and weather affect life on earth. There are some climate data needed to take into account the amount of evaporation including solar radiation, air temperature, relative humidity, and maximum wind speed.

2.2 Dependable Flow

Dependable Flow is used for irrigation. In this study, the mainstay discharge is a discharge that has a probability of 80%. A discharge with an 80% probability is a discharge that has a probability of occurring at a weir of 80% out of 100% of events. The number of events in question is the amount of data used to analyze the probability. The minimum amount of data required for analysis is five years and in general to obtain a good value the data used should be 10 years of data.

The minimum river discharge is analyzed based on river rainfall discharge. Due to the minimal data, the reliable discharge calculation method uses the water balance simulation method from Dr. FJMock. With input data from rainfall in the watershed, evapotranspiration, vegetation, and geological characteristics of the watershed.

This method assumes that part of the rainwater that falls on the catchment area (DAS) will become direct runoff and some will enter the soil as infiltration water, then if the soil's moisture holding capacity is exceeded, the water will flow downward due to gravity.

2.3 Irrigation Water Demand

250 mm of water is in demand for paddy fields, and at the beginning of the transplant, add another 50 mm layer of water. The water requirement above is if the soil is in heavily textured conditions, suitable for flooding and the land has not been watery for more than 2.5 months. (Dinas-PU, 2013)

The equation used to estimate water requirements for land preparation using the Van de Goor and Zijlstra (1968) method can be seen in equations 2, 3, and 4.

$$IR = M.e^k/(e^k - 1) \quad (2)$$

$$M = E_0 + P \quad (3)$$

$$k = M.T/S \quad (4)$$

Where:

IR = Water requirement for land preparation irrigation

M = Demand to meet water loss due to evaporation and percolation

e = Napier Number = 2.7183

E0 = Evaporation of open water 1.1 ET0 during land preparation (mm/day)

P = Percolation

k = Constant

T = Term land preparation time (days)

S = Water requirement is added with a layer of 50 mm water

The need for clean water in paddy fields (NFR) is influenced by NFR factors such as land preparation, consumptive use, flooding, irrigation efficiency, percolation, and infiltration, taking into account the effective rainfall (Re). The difference in the need for uptake of irrigation water (DR) is also determined by taking into account the overall irrigation efficiency factor (e). Calculation of irrigation water needs can be seen in equations 5 and 6.

$$\text{NFR} = \text{Etc} + \text{P} + \text{WLR} - \text{Re} \quad (5)$$

$$\text{DR} = \frac{(\text{NFR x A})}{e} \quad (6)$$

where:

NFR = Need for irrigation water in paddy fields (lt/s/Ha)

DR = Need for water at the intake point (lt/s/Ha)

Etc = Consumptive use (mm/day)

P = Percolation (mm/day)

WLR = Replacement of the water layer (mm/day)

Re = Effective rainfall

A = Planned irrigation area (Ha)

e = Irrigation efficiency

The price of the crop coefficient for calculating water needs for consumptive plants can be seen in Tables 1 and 2.

Table 1. Coefficient Price of Rice

Month	Common Varieties	Superior Varieties
0,5	1,10	1,10
1	1,10	1,10
1,5	1,10	1,05
2	1,10	1,05
2,5	1,10	0,95
3	1,05	0,00
3,5	0,95	
4	0,00	

Sources: Irrigation Planning Standards KP-01 Yr. 2013

Table 2. Coefficient Price of Palawija Plants

Month	Plants				
	Soybeans	Corn	Peanuts	Onion	Beans
0,5	0,50	0,50	0,50	0,50	0,50
1	0,75	0,59	0,51	0,51	0,64
1,5	1,00	0,96	0,66	0,69	0,89
2	1,00	1,05	0,85	0,90	0,95
2,5	0,82	1,02	0,95	0,95	0,88
3	0,45	0,95	0,95		
3,5			0,95		
4			0,55		

Sources: Irrigation Planning Standards KP-01 Yr. 2013

3. METHODS

3.1 Research Sites

The research was conducted in the agricultural area of Pematang Panjang in Sungai Tabuk district, Banjar Regency, South Kalimantan. The agricultural area of Pematang Panjang is geographically located at 3.324761"South Latitude to 3.325331" South Latitude and 114.693549"East Longitude to 114.694913"East Longitude.

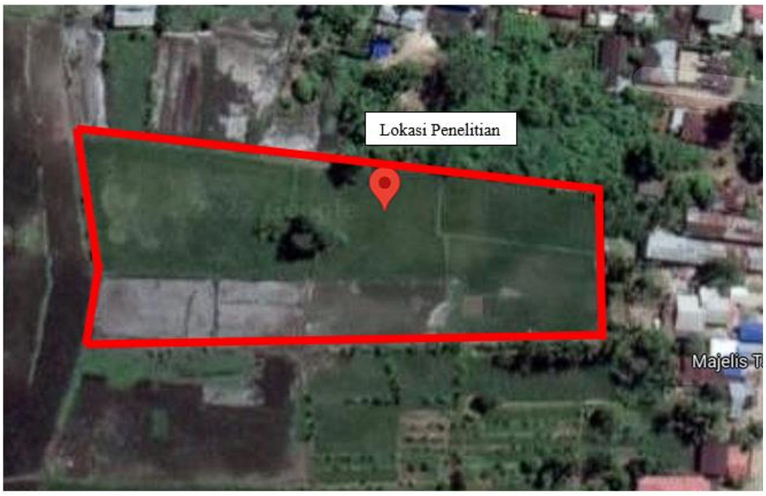

Figure 1. Research Location

3.2 Research Data

In this study, secondary data was used in the form of 19 years of rainfall data and climatological data consisting of average daily temperature, relative humidity, solar radiation, and maximum wind speed.

3.3 Research Procedure

The stages that will be carried out in this study are as follows:

1. Data collection, namely the stage intended in analyzing the availability and demand of irrigation water.
2. Dependable Flow analysis using the FJ Mock methods.
3. Analysis of irrigation water demand.

4. RESULT AND DISCUSSION

4.1 Rainfall

The daily rainfall data used in this study are located at the Syamsudin Noor Meteorological Station, Banjarmasin. The data obtained consists of daily rainfall data every year from 2001 to 2021 which can be seen in Figure 2.

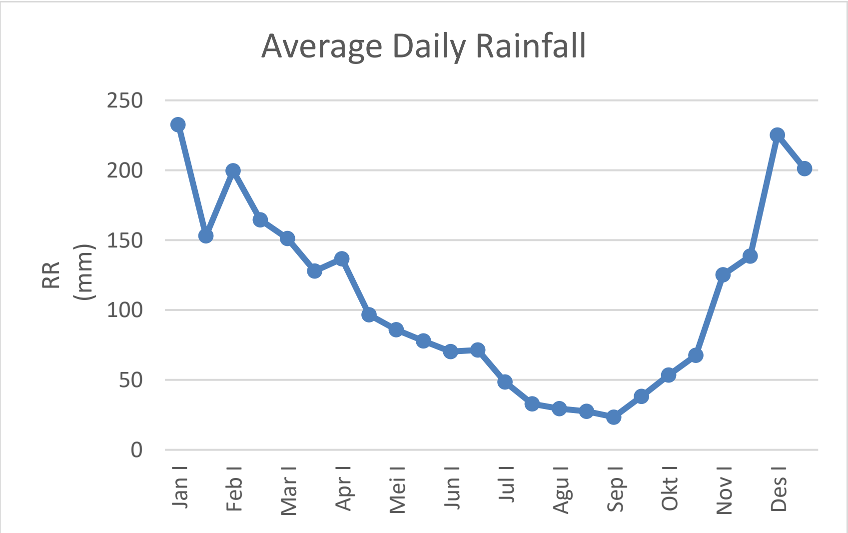

Figure 2. Average Monthly Rainfall for 2001-2021

Effective rainfall is used to calculate irrigation demand, rainfall data is half monthly with a period of 19 years and then calculated with the equation 1 probability value with a probability of 80% for rice and 50% for secondary crops. The results of calculating effective rainfall for rice and secondary crops can be seen in Tables 3 and 4.

Table 3. Effective Rainfall January – June (mm/day)

Effective Rainfall for Rice & Palawija Plants												
Re	January		February		March		April		May		June	
	I	II	I	II	I	II	I	II	I	II	I	II
80%	150,10	89,50	104,00	82,10	97,50	67,50	91,70	37,80	38,50	36,80	25,50	32,20
50%	206,90	131,90	170,50	160,30	127,60	137,50	131,70	74,20	95,80	66,90	75,00	54,90
Rice	7,00	4,18	4,85	3,83	4,55	3,15	4,28	1,76	1,80	1,72	1,19	1,50
Palawija	9,66	6,16	7,96	7,48	5,95	6,42	6,15	3,46	4,47	3,12	3,50	2,56

Table 4. Effective Rainfall July – December (mm/day)

Effective Rainfall for Rice & Palawija Plants												
Re	July		August		September		October		November		December	
	I	II	I	II	I	II	I	II	I	II	I	II
80%	14,70	0,50	3,60	0,00	0,00	2,70	13,40	18,50	50,80	63,80	136,40	139,20
50%	47,10	14,80	19,40	19,00	14,50	22,50	52,70	60,00	116,40	136,40	211,80	204,10
Rice	0,69	0,02	0,17	0,00	0,00	0,13	0,63	0,86	2,37	2,98	6,37	6,50
Palawija	2,20	0,69	0,91	0,89	0,68	1,05	2,46	2,80	5,43	6,37	9,88	9,52

4.2 Climatology

The climatological data consists of air temperature, humidity, maximum wind speed, and solar radiation period. Climatological data can be seen in Figures 3, 4, 5, and 6.

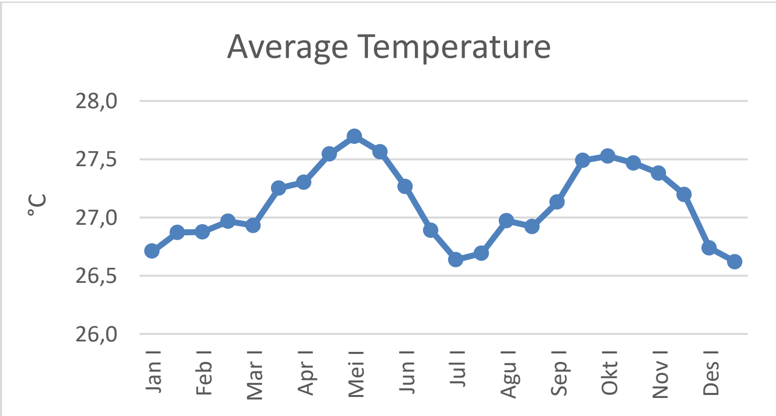

Figure 3. Average Temperature for 2001-2021

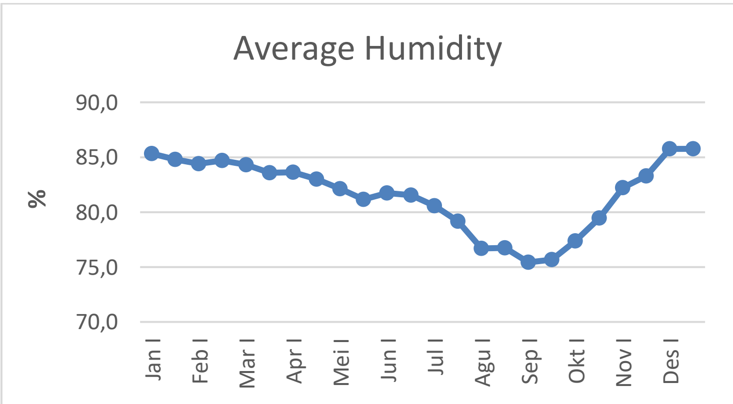

Figure 4. Average Humidity for 2001-2021

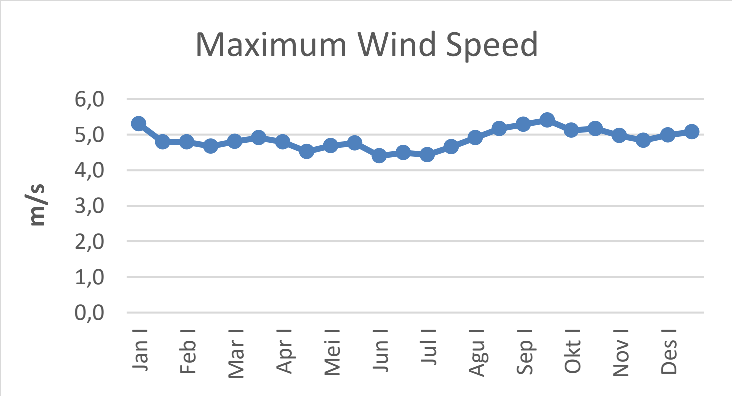

Figure 5. Maximum Wind Speed for 2001-2021

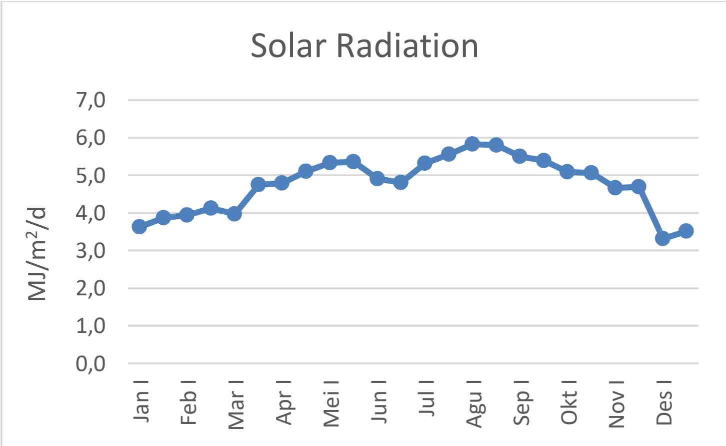

Figure 6. Solar Radiation Period for 2001-2021

Using climatological data and the Penman-Monteith method, evapotranspiration calculations can be carried out.

4.3 Irrigation Water Availability

Calculation of the availability of irrigation water using the water balance method of the F.J. Mock model. The dependable flow calculations include the calculation of rainfall data, evapotranspiration using the Penman-Monteith method, the balance of water on the ground surface, runoff, and groundwater storage of river flows. After calculating the availability of water, the available debit is calculated by taking the value of 80% of the debit calculated between 2001 and 2021. The results of calculating water availability can be seen in Figure 7.

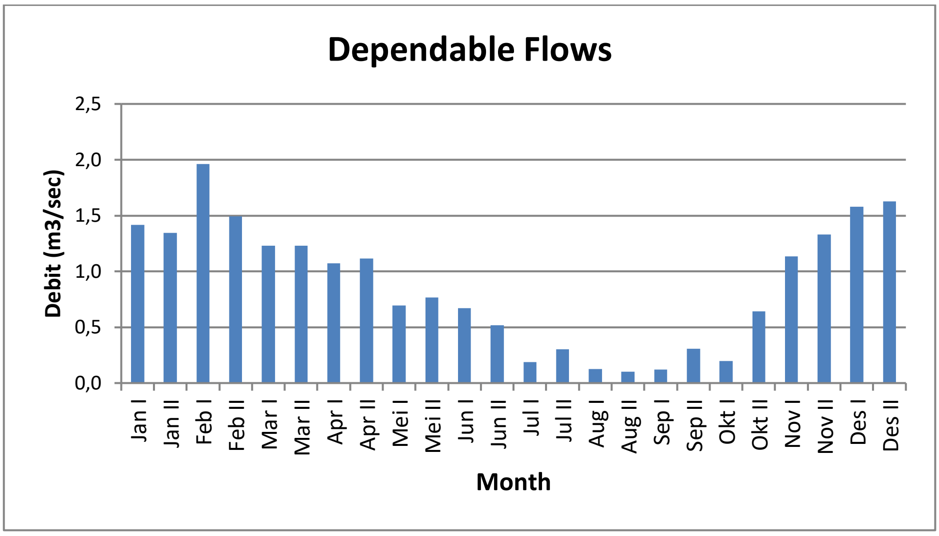

Figure 7. Debit Availability 80% Chart

4.4 Irrigation Water Demand

Calculating the demand for irrigation water is obtained using Equation 2 to Equation 6. The results of the calculation and the comparison of water demand with water availability can be seen in Figure 8.

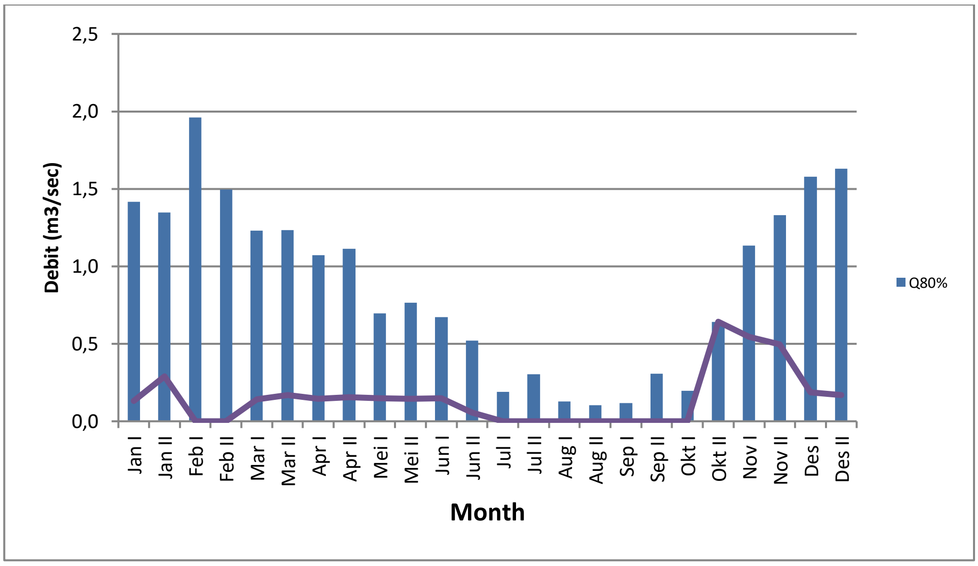

Figure 8. Comparison of Water Availability with Water Demand Chart

5. CONCLUSION

From this study it can be concluded that the results of the analysis of water availability and water demand in the agricultural area of Pematang Panjang are as follows:

1. From the dependable flow analysis based on rainfall and using the F.J. Mock method, it can be seen that the maximum water availability occurs in the first half of February, which is 1,961 m^3/s, while the lowest dependable flow occurs in the first half of August, which is 0,103 m^3/s.
2. The average demand for irrigation water in the agricultural area of Pematang Panjang is 0,2384 m^3/sec.

DAFTAR PUSTAKA

1. BPS Sungai Tabuk District. (2020). **Sungai Tabuk District in Figures 2020**. BPS Banjar Regency. Banjar Regency.
2. Public Works Department. (2013). **Irrigation Planning Standards KP-01**. Ministry of Public Works.
3. Hadisusanto, N. (2010). **Hydrology Application**. Jogja Mediautama. Yogyakarta.
4. Widyaningsih, D.H . (2021). **Comparison of the F.J. Mock and NRECA Methods for the Transformation of Rain into Discharge in the Metro Watershed in Malang**. East Java
5. Panjaitan, D. (2012). **Standard Potential Evapotranspiration Study in Muara Jalai Irrigation Area, Kampar Regency**. Pekanbaru.
6. Richard G. Allen, L. S.. (1998). **FAO Irrigation and Drainage Paper No.56**.
7. Soemarto, C. D. (1987). **Technical Hydrology**. Usaha Nasional. Surabaya.
8. Sosrodarsono, S. (1987). **Hydrology for Irrigation**. Pradnya Paramitha. Jakarta.
9. Sugiyono. (2003). **Research Methods**. Alfabeta. Bandung.
10. Suripin. (2004). **Sustainable Urban Drainage Systems**. ANDI Offset. Yogyakarta.
11. Sutrisno, F. S. (2017). **Study on Application of F.J. Mock Method and Statistics for Calculating Dependable Flow of PLTA Bakaru Pinrang Regency**. Makassar.
12. Triatmodjo, B. (2008). **Applied Hydrology**. Beta Offset. Yogyakarta.
13. Wiguna, P. P. (2019). **Equation Methods for Irrigation Water Demand**. Udayana University. Denpasar.