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Optimizing the Availability of Water for Planting Area in Wetland Irrigation Area Kumpai Batu-Tanjung Terantang in Kotawaringin Barat Regency

Belly Tahasak, and Mahmud Mahmud*
Department of Civil Engineering, Lambung Mangkurat University, Banjarmasin city, Indonesia
**Corresponding author: Belly Tahasak*

ABSTRACT :*Wetland Irrigation Area (Daerah Irigasi Rawa – DIR) of Kumpai Batu - Tanjung Terantang in Kotawaringin Barat Regency is one of the changes in land use change. Initially it was planned to irrigate 3.650 ha of agricultural land, but the existing conditions at the site in 2017 measured only around 466 ha or 12,8% of the total area. Whereas the rest of the other area has been converted into plantations, settlements and shrubs. This study aims to optimize by analyzing water availability factors based on rainfall at the research site to obtain the maximum agricultural planting area with cropping pattern settings. The calculation of Evapotranspiration using Modified Penmann Method, for dependable flow using the FJ Mock method, and optimizing the availability of water on the planting area is done by using the Microsoft Excel, solver. Based on climatological data, after hydrological analysis and optimization, optimal water availability was obtained on November II period, with the availability of agricultural raw water of 1.728 Ha, from the existing paddy field area of 3.650 Ha, but which could only be 1.397 Ha with cropping patterns paddy-paddy-secondary crops covering 1.468 ha (for paddy plants) and 259 ha (for secondary crops plants).*

KEYWORDS: *FJ. Mock, Penmann Modification, water availability, land area, optimization of cropping patterns.*

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I. INTRODUCTION

In national development, Indonesia as an agrarian country must place the agricultural sector as a top priority. The agricultural sector is one of the strong factors in the country's food security. Food security is an obligation of the government together with the community as stated in Law no.7 of 1996 concerning Food.

One of the Government's efforts in increasing the production of agricultural food crops, especially rice, is to maximize the function and existence of an irrigation network so that it can guarantee the availability of water for agricultural land from preparation for planting, processing, until the time of harvest has arrived. The purpose of the existence of an irrigation area will be achieved as expected if it can maintain the availability of water in an irrigation network to reach the planned land area.

The existence of an irrigation network (weir and channel) becomes very important to be able to guarantee the continuity of the processing process in the irrigated area in accordance with the planned cropping pattern. In some irrigation areas, there are still many agricultural lands that are not used according to the original plan, which is to plant rice and secondary crops. This land has mostly changed its function to become gardens and settlements. One of the factors causing land conversion is one of which is due to insufficient water availability in paddy fields in an irrigation area

The Kumpai Batu Wetland Irrigation Area in Kotawaringin Barat Regency was originally planned to irrigate 3,650 ha of land. The source of water in the form of the Lamandau River tide and the water supply from the Bengaris River through the presence of the Bengaris weir, but the condition of the existing location in 2017 measured the area of rice fields is only about 466 ha or 12.77% of the total area (PT. Prana Kurnia Pratama, 2017). While the rest of the area has been converted to gardens and settlements other than shrubs. Based on these conditions, it is necessary to re-analyze the factor of water availability at the research location to optimize the planting area of rice and secondary crops with appropriate cropping patterns as carried out by the local farming community.

II. RESEARCH METHODS

A. Research Site

This research activity was carried out at Kumpai Batu-Tanjung Terantang Wetland Irrigation Area. This site is located in Arut Selatan District, Kotawaringin Barat Regency, Central Kalimantan Province. The wetland irrigation area covers 3 (three) villages namely Batu Bawah Kumpai, Batu Atas Kump, and Tanjung Terantang.

B. Data Collection

Some data was obtained directly from relevant agencies such as 2009-2018 rainfall data from BWS Kalimantan II, climatology data from BMKG Pangkalan Bun, irrigation network data and land use maps obtained from Anonymous 2017, (PT. Prana Kurnia Pratama), and some other supporting data are as follows:

- Hydrological recording data around the location of the Kumpai Batu irrigation network in Arut Selatan District, Kotawaringin Barat Regency obtained from the BWS Kalimantan II;
- Irrigation network condition data from the results of an inventory study that can be obtained from the Public Works District Office and Spatial Planning District Office of Kotawaringin Barat Regency and BWS Kalimantan II;
- Data on farming activities by the community utilizing irrigation water from the Bengaris weir or from the river tidal system.

C. Reliable Rainfall

The reliable rainfall is expected to be reliable in certain periods for the land. Paddy and secondary crops are set at 80%, the reliable rainfall is calculated using the following formula:

$$R_{80} = \frac{n}{5} + 1 \qquad (1)$$

Where:

R_{80} = Rainfall events with a realibility level of 80% (mm)

n = number of observation years

The average price of rainfall is sorted from the smallest to the largest, based on the name of the month.

D. Effective Rainfall

Effective rainfall is the amount of rain that falls on an area, which is used by plants. Effective rainfall for paddy is set at 70% and 50% for secondary crops.

$$\text{Re Paddy} = \frac{R_{80} \times 0{,}7}{\text{Observation Period}} \qquad (2)$$

$$\text{Re Secondary Crops} = \frac{R_{80} \times 0{,}5}{\text{Observation Periode}} \qquad (3)$$

Where:

Re = Effective Rainfall (mm)

R_{80} = Reliable Rainfall 80%

E. Reliable Discharge Calculation and Analysis

Calculation and analysis of the mainstay discharge using the FJ Mock method approach, where for the needs of paddy plants and secondary crops the reliability of discharge is met by 80%.

F. Determination of Alternative Cropping Patterns

Cropping pattern regulation is an activity to regulate plant types, plant varieties, and the beginning of the planting period. Preparation of cropping patterns aims to get the amount of water requirements in the dry season as small as possible. This study used the paddy-paddy-secondary crops pattern of planting.

G. Water Requirements and Schedules for Alternative Cropping Patterns

Water requirements are calculated based on the amount of rainfall. The initial determination of planting is done by simulations to get the arrangement of cropping patterns. For example, the first alternative if the beginning of rice planting begins in October, then the second alternative in November and so on until the twelfth alternative (number of months in a year). Of the twelve alternatives, the lowest water requirement was chosen as a determination of cropping patterns.

Irrigation water requirements are calculated by the equation (Triatmodjo, 2010):

$$KAI = \frac{(Etc + IR + WLR + P - Re)}{IE} \times A \qquad (4)$$

Where:

KAI: Irrigation water requirements (l/s)

Etc: Consumptive water requirements (mm/day)

P: Percolation (mm/day)

IR: Water requirements for land preparation (mm/day)

WLR: Water requirements for replace the water layer (mm/day)

IE: Irrigation Efficiency irrigation (%)

A: Irrigation land area (ha)
Re : Effective rainfall (mm/day)
H. Optimization of Water and Land Availability

Optimizing the availability of water and land is done by analyzing the water requirements for plants by making a number of alternative planting schedules to find the smallest crop water requirements as an initial period of cropping patterns and the basis for optimizing the area of irrigable land. The optimization analysis is carried out with solver in Microsoft Excel.

III. RESULT AND DISCUSSION

A. Use of Existing Land

Based on the data collected it can be seen that in the DIR Kumpai Batu location, many have experienced land conversion, which was originally planned for 3,650 ha of agricultural land. From the data of land use distribution, there is potential for the development or use of land, which is 774 ha of shrub land that can be developed into agricultural land.

B. Rain Area of DIR Kumpai Batu – Tanjung Terantang

Data on rainfall observations were obtained from the Observation Post of the Kotawaringin Barat Regency and Nangabulik of Lamandau Regency. The average rainfall data from Pangkut and Nangabulik Observation Post is used as average 15 days rainfall. The highest rainfall was in March I, and the lowest was in June II. The average 15 days rainfall data is analyzed to be the reliable rainfall data and used for cropping analysis needs where each month is divided into 2 (two) periods.

C. Reliable Rainfall

From the average 15 days rainfall data sorted from the smallest rainfall to the largest rainfall based on month and number of years of observation (n), then to determine the reliable rainfall (R80) for rice and secondary crops equation (1), so that the value of R80 is in the third row. R80 in January I to May II and October II to December II ranged from 65 - 121 mm, and 4 - 54 mm in June I to October I.

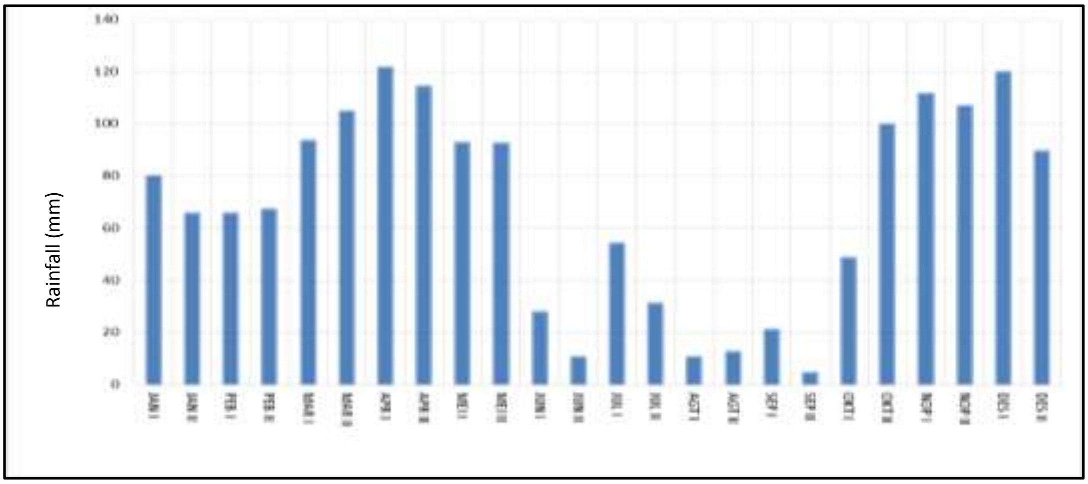

Fig. 1.Reliable rainfall DIR Kumpai Batu – Tanjung Terantang

D. Reliable Discharge with FJ Mock Method Analysis

Discharge analysis that is used to meet the needs of rice and secondary crops is a discharge with reliability met by 80%. As the method of searching for reliable rainfall, each reliable discharge (Q80) is in the 3rd row after the data is sorted from the smallest to the largest discharge based on month and number of years of observation. Graphically, it can be seen that the highest discharge reliability occurs around April and December.

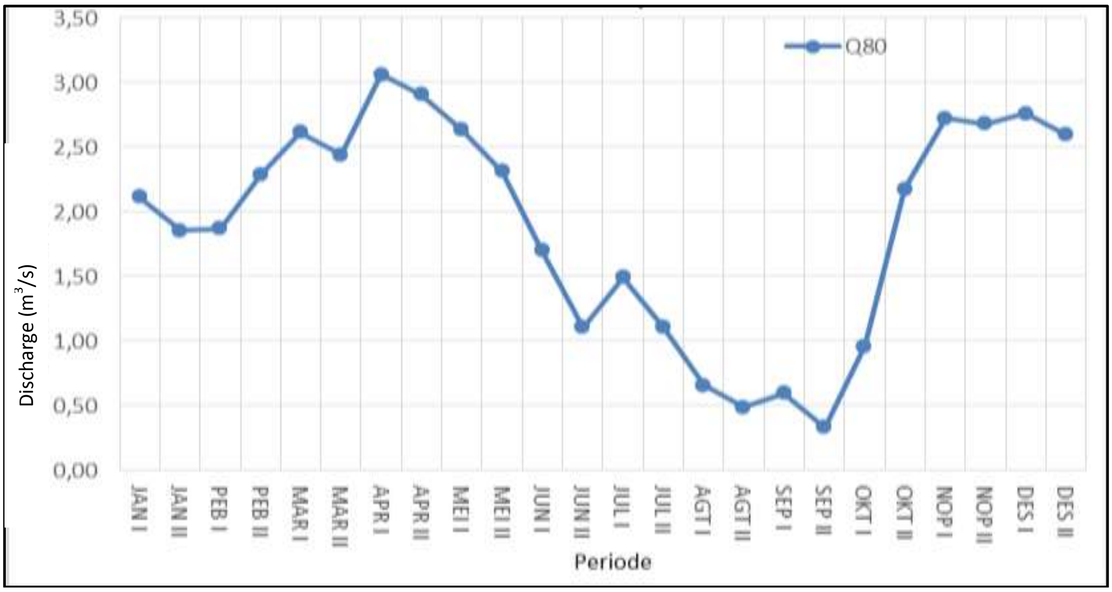

Fig. 2. Reliable discharge DIR Kumapai Batu – Tanjung Terantang FJ Mock Method

In January I to July II and October II to December II the reliable discharge was quite large, ranging from 1,100 - 3,071 l/sec, whereas in August I to October I the reliable discharge ranged from 495 - 950 l/sec.

E. Water Requirements Analysis

The analysis of water requirements is very closely related to the existing cropping patterns as well as the plans implemented at the Kumpai Batu DIR location. In general, the equation used is equation (4). In this research, the cropping pattern is paddy-paddy-secondary crops. The trial for beginning of planting is 15 days periods to get the minimum peak water requirements.

Effective rainfall, cropping patterns, evapotranspiration, replacement of water losses during the land preparation period, percolation, and irrigation efficiency are used to calculate the water requirements. In the same way the results of all calculations of water requirements per initial planting period are then tabulated. From the tabulation results it can be seen that the smallest irrigation water requirements when beginning planting began in the November II and December I periods, that is 1.69 l/sec/ha and 1.60 l/sec/ha with a difference of 0.09 l/sec/ha. This initial planting period will be the basis for optimizing the size of the land that can be irrigated by the availability of available water.

F. Optimization Land Area

With the same cropping pattern, several alternative planting schedules were tried so that the smallest crop water requirements were obtained. The trick is to shift the beginning of planting from January I to December II. The results of the trial were finally obtained at the beginning of planting with the smallest water requirements in December I. However, as a comparison, 2 (two) planting periods before and after will be presented for inclusion in the optimization program. The optimization results used are the widest area for rice plants from the three optimization analyzes

Optimization analysis is carried out with Solver in Microsoft Excel. The optimization model must cover three things:

- Target output; the results to be achieved in this paper are the area of rice planting (X1) and the area of secondary crops planting (X2).
- Variables that affect the target output value are the water requirements of rice plants (A1) and water requirements of secondary crops (A2).
- Variables that show limitations, what conditions to achieve optimization, namely the availability of water for rice and secondary crops (Q)

By inputting the A1, A2, and Q values from the calculation of water requirements data based on the cropping pattern schedule in solver. Solver will adjust the value in the decision variable cell to meet the boundary of the boundary variable cell and provide the desired results. The results of the optimization of the program output obtained optimal area for the beginning of planting November II were 1,468 ha of rice and 259 ha of secondary crops. In the same way, an optimization simulation is carried out with the other planting starts such as Des I and Des II periods.

IV. CONCLUSION

Based on the results of the analysis, it can be concluded:

- Based on rainfall and climatology data, the availability of water for paddy (Q80) ranged from 326 l/sec to 3,072 l/sec with an average of 1,894 l/sec.
- Based on the simulation of water requirements with the pattern of paddy - paddy – secondary crops, it was found that the beginning of planting with the smallest water requirement was in the December I period with the water requirement of 1.60 l/sec/ha.

Based on simulation optimization with solver, for the beginning of planting the period November II, December I, and December II, the largest planting area obtained at the beginning of planting the November II period amounted to 1,728 ha, for paddy was 1,468 ha and 259 ha for secondary crops. The actual condition in the existing field is only 466 ha; garden 157 ha; and 774 ha shrubs. With the availability of water that can irrigate an area of 1,728 ha of rice fields with an existing that can be developed only 1,397 ha, the expansion of agricultural land can be done by utilizing shrubs and reducing the area of oil palm plantations. To irrigate agricultural land from the original plan of 3,650 hectares, water sources from the tidal Lamandau River are needed.

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