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Analysis of Irrigation Water Needs in The Kelingi Tugumulyo Water Irrigation Service Area

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Abstract

In order to meet water needs, especially for water needs in rice fields, it is necessary to establish an irrigation system and build a weir. The need for water in rice fields is then called the need for irrigation water. This research aims to determine and analyze irrigation water needs in the Air Kelingi Tugu Mulyo irrigation service area. The results of the research produced irrigation water requirements in the Kelingi irrigation service area of 0.2847 – 11.5184 m^3/sec. The need for irrigation water during each planting period I. The maximum water requirement occurs in the third week of November at 11,038 m^3/s. This occurs because that month is the month for preparing the land for the planting period I, so the need for irrigation water increases. During the second planting period, the maximum water requirement occurs in the third week of March at 11.5184 m^3/sec. This also occurs because that month is the month for land preparation for the second planting period, so the need for irrigation water increases. The balance of irrigation water in the Kelingi irrigation service area is based on a comparison of needs, plans and realization of irrigation water discharge. The planned discharge is 7,223 m^3/sec.

***Keywords**: Irrigation used, Air kelingi irrigation, Water balance*

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I. INTRODUCTION

Water is a natural resource that is crucial for the survival of all living things. It is also essential for industrial activities, fisheries, agriculture, and other businesses. Therefore, water availability must always be maintained and managed properly.

To meet water needs, particularly for rice fields, irrigation systems and dams are necessary. This water requirement in rice fields is referred to as irrigation water demand. Irrigation water demand is the volume of water required to meet evaporation, water loss, and crop water needs, taking into account the amount of water provided by nature through rainfall and the contribution of groundwater (Sosrodarsono and Takeda, 2003).

Irrigation water in Indonesia generally comes from rivers, reservoirs, groundwater, and tidal systems. One effort to increase food production, especially rice, is to ensure the availability of irrigation water to rice fields according to demand. The Kelingi Tugumulyo River is the primary water source for irrigating agricultural land, which consists of two irrigation service areas: Lubuk Linggau City and Musi Rawas Regency. The Kelingi River is a tributary of the Musi River, originating in the Bukit Barisan Rejang Lebong area of Bengkulu and flowing into the Beliti River, which then flows into the Musi River. At the headwaters of the Kelingi River is the Kelingi Tugumulyo Dam, located in Watervang Village, East Lubuk Linggau District, Lubuk Linggau City. This dam was built in 1941 and is approximately 350 km from Palembang City.

The water needs of irrigation areas vary. Knowing the irrigation water needs allows us to predict when water availability will or will not meet irrigation needs. Understanding the overall irrigation water needs is crucial for planning and managing irrigation systems, preventing imbalances between water availability and demand. Due to water shortages/losses in several tertiary areas, an Irrigation Water Needs Analysis is necessary for the Kelingi Tugumulyo Irrigation Service Area.

II. LITERATURE REVIEW

2.1 Definition, Purpose, and Benefits of Irrigation

Irrigation is the provision, withdrawal, distribution, distribution, and flow of water using specific systems, channels, and structures to support agricultural, rice, and fishery production. The term "irrigation" comes from the Dutch word "irrigate" and the English word "irrigation," which means watering or flooding.

Irrigation is the provision, regulation, and disposal of irrigation water to support agriculture. Types include surface irrigation, swamp irrigation, groundwater irrigation, pump irrigation, and pond irrigation (PP No. 20 of 2006 concerning Irrigation).

According to the Irrigation Planning Standard KP-01, irrigation is a system for supplying water to agricultural land to meet the needs of crops for proper growth.

Irrigation is essential for agriculture, plantations, and other areas. The benefits of irrigation are as follows:

1. Adding water to the soil to provide the necessary fluids for plant growth.
2. Providing harvest security during short dry seasons.
3. To cool the soil and atmosphere, thus creating a favorable environment for plant growth.
4. To wash and reduce soil salts.
5. To reduce the risk of soil erosion.
6. To soften soil and loosen clods.

Irrigation Canals

Irrigation canals can be divided into several canal networks, including:

a. Main Irrigation Canal Network

Primary canals carry water from the main network to secondary canals and to irrigated tertiary plots. The end of the primary canal is at the last drainage structure.

Secondary canals carry water from the primary canal to the tertiary plots served by the secondary canal. The end of the secondary canal is at the last drainage structure.

Conveyor canals carry irrigation water from other water sources (not the source that supplies the main structure) to the primary irrigation network.

Tertiary drainage canals carry water from the tertiary drainage structure to a tertiary plot located opposite another tertiary plot.

b. Tertiary Irrigation Canal Network

Tertiary irrigation canals carry water from tertiary drainage structures in the main network into tertiary plots and then into quarter canals. The end of these canals is the box for the last quarter.

Quarter canals carry water from the quarter drainage structures through tertiary drainage structures or rice field ditches to the rice fields.

c. Main Drainage Canal Network

Primary drainage canals carry water in excess of the secondary drainage canals out of the irrigation area. Primary drainage canals are often natural drainage canals that drain excess water into rivers, creeks, or the sea.

Secondary drainage canals collect water from the tertiary drainage network and discharge it into primary drainage canals or directly into natural drainage canals and out of the irrigation area.

d. Tertiary Drainage Canal Network

Tertiary drainage canals are located in and between tertiary plots within the same secondary irrigation unit and collect water from both quarter drainage and rice fields. This water is discharged into the secondary drainage network.

The secondary drainage channel receives water discharge from the quarter drainage channel which collects water directly from the rice fields.

III. RESEARCH METHODS

3.1 Research Location and Schedule

3.1.1 Research Location

This research was conducted in the Kelingi River watershed within the Kelingi Tugumulyo Irrigation Service Area, East Lubuk Linggau I District, Lubuk Linggau City. The location can be seen in Figure 3.1.

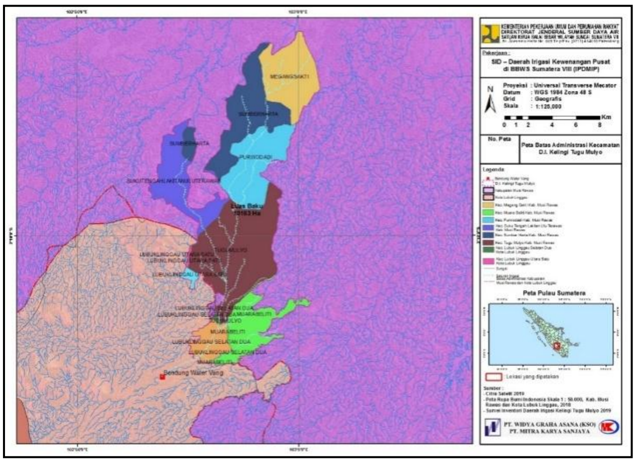

Figure 1: Research location

3.2 Data Collection

This stage relates to the collection of data used in the research. The data processed to calculate water requirements in this study is secondary data. This secondary data was obtained from relevant agencies. The secondary data in this study were obtained from the BBWS Sumatra VIII, OP SDA I Palembang, and BMKG Class I Palembang.

3.3 Discussion Stage

Analysis is conducted based on the data obtained. Data processing can then be carried out. The data is processed according to the analysis performed, namely the water requirements analysis.

3.3.1. Water Requirements Analysis

The calculated water requirements are irrigation water requirements. The calculation of irrigation water requirements is limited to the Kelingi Tugumulyo irrigation service area.

3.3.2. Irrigation Water Requirements

There are several stages in calculating irrigation water requirements, namely:

a. Potential Evapotranspiration

Calculate the potential evapotranspiration value using climatological data in the form of air temperature, humidity, solar radiation, and average wind speed over the past ten years. The potential evapotranspiration value is calculated using the modified Penman method.

b. Effective Rainfall

Calculate the effective rainfall, R80, using the planning base year method. The value is obtained using the Harza equation. Effective rainfall for rice is 70% of the mid-month rainfall, with a 20% probability of failure (R80), while for secondary crops it is determined at 50%.

c. Land Preparation

Irrigation water requirements are influenced by the water requirements during land preparation, which depend on the length of time required and the amount of water required for land preparation.

The calculation of land preparation water requirements includes the open evaporation value (Eo) during land preparation, 1.1 ETo during land preparation, the determination of the percolation rate according to the soil conditions in the irrigated area (percolation rates can reach 1-3 mm/day), and the water requirement to replace water losses due to evaporation.

d. Irrigation Water Requirements

Basic water requirements for rice fields are first calculated based on crop water requirements, land preparation water requirements, percolation rate, water layer replacement, and effective rainfall. Finally, irrigation water requirements can be calculated by dividing the basic water requirements for rice fields by irrigation efficiency.

4.1 Regional Overview

The regional overview explains the location of the area covered by this Final Project. The research area is located in the Kelingi River watershed within the Kelingi Tugumulyo Irrigation Service Area, Lubuk Linggau I District, Lubuk Linggau City.

Data on the area of the Kelingi Tugumulyo irrigation service area can be seen in Appendix 1, while a map and network diagram of the Kelingi Tugumulyo irrigation service area can be seen in Figures 4.1 and 4.2.

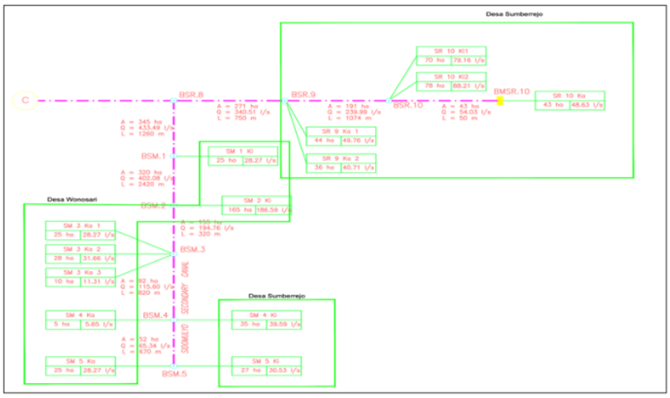

Figure 2: Network Scheme of the Kelingi Tugumulyo Irrigation Service Area
(Sources: Water resources Operation I Palembang Area, 2023)

1. Calculation of Irrigation Water Requirements

Water provision for irrigation in the Kelingi irrigation service area to meet irrigation water needs is based on a classification system. There are three classifications of irrigation water distribution areas. The Kelingi irrigation service area falls into classification I. The cropping system used is rice and paddy, with two planting seasons per year. Water supply is scheduled to begin in October II (16-31). The calculation of irrigation water requirements for rice crops in October II (16-31) is as follows:

ETc =Kc * ETo = 0 *5,6012 mm/day = 0mm/day (land preparation period)
IR = 10,6011 mm/day
WLR = 0 mm/day (water replacement is required after one and two months of transplantation. Since October II is the land preparation period, no water replacement is performed)
P = 2 mm/day
Re_{rice} = 1.0063 mm/day

NFR = ETc + IR + P + WLR – Re
= (0 + 10.6011 + 2 + 0 – 1.0063) mm/day
= 11.5949 mm/day

Water withdrawal requirements at the source:

$$DR = \frac{NFR}{8{,}64 \times Ei} \quad (1)$$

= 2.0646 l/sec/Ha

The rice field area for October II (16-31) of the first planting season (rice) is 5,346.27 hectares. Therefore, the irrigation water requirement for this rice field area is:

KAI = DR*A
KAI = 2.0646 l/sec/Ha * 6.051 Ha
= 11,037.9972 l/sec

Water withdrawal requirements at the source:

$$DR = \frac{NFR}{8{,}64 \times Ei}$$

= 0.5071 l/sec/Ha

III. RESULTSAND DISCUSSION

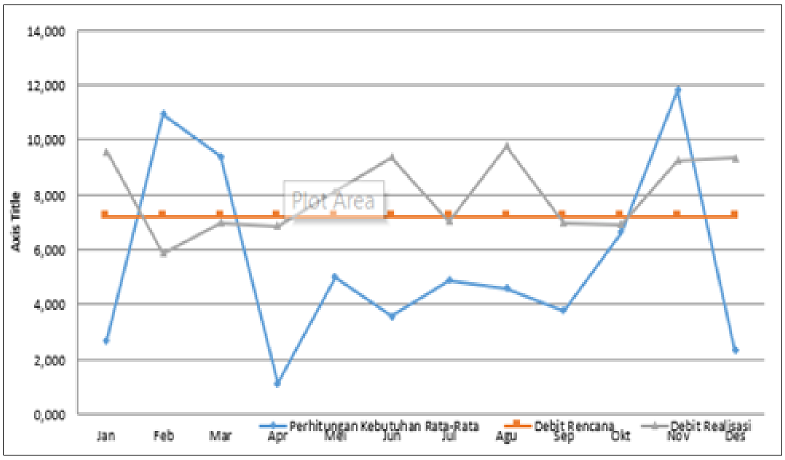

Figure 3: Comparison of irrigation needs, plans, and actual discharge

Irrigation water requirements in the Kelingi irrigation service area are based on Table 4.13, using a rice-rice cropping system. Water supply is scheduled to begin in October II (16-31) for rice in the first planting season (MT I) with a rice paddy area of 6,051 hectares, and in February II (16-29) for rice in the second planting season (MT II) with a rice paddy area of 6,051 hectares.

Land preparation (IR) for rice plants takes 1.5 months to complete in all tertiary plots, while transplanting rice seedlings into the rice fields begins four weeks later in some tertiary plots where land preparation has been completed. Additionally, for rice plants, water replacement (WLR) is carried out twice, at a rate of 3.3 mm/day, for half a month, one month and two months after transplanting rice seedlings into the rice fields. The rice crop used is a superior variety, therefore, the rice crop coefficient established by the FAO is used.

In calculating irrigation water requirements during Planting Season I (MT I), the maximum irrigation water requirement occurs in November II (16-30), amounting to 12,263.0211 liters/second, while the minimum irrigation water requirement occurs in January I (1-15).

In calculating irrigation water requirements during Planting Season II (MT II), the maximum irrigation water requirement occurs in March II (16-30), amounting to 11,518.4258 liters/second, while the minimum irrigation water requirement occurs in April I (1-15). The total irrigation water requirement can be seen in Table 4.14.

IV. CONCLUSION

Based on the results and discussions, the following can be concluded:

1. Irrigation water demand in the Kelingi irrigation service area is 0.2847 – 11.5184 m3/sec.
2. Irrigation water demand for each planting season is as follows:

a. During the first planting season, the maximum water demand occurs in the third week of November at 11.038 m3/sec. This occurs because that month is the month for land preparation for the first planting season, resulting in increased irrigation water demand.

b. During the second planting season, the maximum water demand occurs in the third week of March at 11.5184 m3/sec. This also occurs because that month is the month for land preparation for the second planting season, resulting in increased irrigation water demand.

3. The irrigation water balance in the Kelingi irrigation service area, based on a comparison of demand, planned, and actual irrigation water discharge, is as follows:

a. Planned discharge of 7.223 m3/sec.

b. In certain months, the calculated irrigation water demand does not meet either the planned or actual openings of the sluice gates.

b. The sluice gate discharge has been set through an irrigation commission meeting, but water is lost in several channels, prompting farmers to request an increase in the actual discharge to allow water to reach their rice fields. Factors that can cause discharge losses include:

- Leaks in the channels
- Channels that are still earthen channels

- Illegal water extraction
- Human error in measuring at the sluice gates

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