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Analysis of Irrigation Water Requirement in The Batang Sanipan 2 Irrigation Area Limapuluh Kota Regency

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ABSTRACT

Limapuluh Kota Regency is one of the rice producing districts in West Sumatra Province, so an irrigation network is needed to meet water requirement for agricultural productivity. The problem that occurs in the Batang Sanipan 2 irrigation area is the inability of water to flow through the service area to the end point of the irrigation area. Based on observations from e-PAKSI data from the Limapuluh Kota Regency Public Works Office, water can only flow up to a distance of 3.175 km from the intake gate and experience water loss along 1.445 km to the end of the canal. Therefore, it is necessary to study the analysis of irrigation water requirement in the irrigation area of Batang Sanipan 2, Limapuluh Kota Regency. This type of research is descriptive with a quantitative approach. Research methods carried out directly in the field. Based on data analysis, the results obtained from the manual calculation of KP – 01 the maximum irrigation water requirement with a value of 0.139 m^3/second which occurred in March, while in the Cropwat software the maximum irrigation water requirement with a value of 0.149 m^3/second which occurred in July. The results of measuring the discharge at the intake of the Batang Sanipan 2 weir obtained a discharge of 0.378 m3/second. Based on this, water is sufficient to flow through the entire agricultural area of the Batang Sanipan 2 irrigation area, but the current conditions are that water is not able to flow through parts of the Batang Sanipan 2 irrigation service area

Keywords: *Irrigation; Water Requirement; Cropwat 8.0*

INTRODUCTION

Limapuluh Kota Regency is one of the rice producing districts in West Sumatra Province, so an irrigation network is needed to meet water needs for agricultural productivity. Irrigation is an effort to obtain water supply through construction and man-made networks, aiming to support agricultural production activities [1]. Irrigation networks are buildings consisting of canals and complementary houses which are a single unit intended for channeling, distributing, managing, using and disposing of water [2]. The aim of irrigation is to use existing irrigation water sources optimally, so that efficiency is maintained and agricultural production results can be increased as expected [3]. Irrigation water is water that flows from rivers, dams or springs to several rice fields [4].

The Batang Sanipan 2 irrigation area is an irrigation channel where water is taken from the Batang Sanipan river weir. In the Batang Sanipan river flow, there are three irrigation canals with each separate weir, namely the Batang Sanipan 1 irrigation area, the Batang Sanipan 2 irrigation area and the Batang Sanipan 3 irrigation area. The irrigation areas experiencing problems are the Batang Sanipan 2 irrigation area. Based on observations from e-PAKSI data from the Limapuluh Kota District Public Works Service, water can only flow up to a distance of 3.175 km from the intake gate and experience loss along 1.445 km to the end of the canal.

The need for irrigation water is the amount of water needed to meet the process of evaporation, water loss, and the needs of plants in the context of irrigation is what is referred to as the need for irrigation water. This includes the volume of water that comes from natural precipitation as well as the contribution of water from groundwater sources [5]. The requirement for irrigation water as a whole needs to be known because it is one of the important stages required in the planning and management of irrigation systems [6]. To estimate the need for irrigation water, the calculation can be based on the KP-01 irrigation network design standard issued by the Directorate General of Water Resources in 1985, or using the Cropwat software developed by FAO's Land and Water Development Division, by applying the Penman-Monteith method. Cropwat was designed as a practical tool to calculate standard evapotranspiration rates, plant water requirements, and regulate crop irrigation [7]. The data needed for the cropwat application is in the form of climatological data, plant data and soil data [8].

The Batang Sanipan 2 irrigation area is an area suitable for planting rice because the surface conditions are relatively flat, making it easier to distribute water for agricultural land. In order to be used optimally as agricultural requirement, research is needed on the irrigation water requirements of Batang Sanipan 2 so that the maximum and minimum water requirements in one year are known. This study is also intended to determine the need for irrigation water in the Batang Sanipan 2 irrigation area and to find out whether the current water availability is still in accordance with the available rice field areas around the Batang Sanipan 2 irrigation.

The novelty in this study was that there was a lack of data for research on analysis of irrigation water requirement, namely climatological data, stem sanipan river flow data and soil data so the authors used several tools and laboratory tests to complete the required data and there were two methods to compare the results of needs analysis irrigation water by using the KP – 01 method and the Cropwat software method.

METHOD

Research Approach

The research method used is descriptive with a quantitative approach. This type of research is carried out to investigate in a predetermined population or sample, where data is collected through research instruments, and the results are analyzed statistically and quantitatively. The purpose of this research is to test the hypotheses that have been formulated before [9].

Research sites

This was carried out in the Batang Sanipan 2 irrigation area in Kenagarian Sarilamak, Harau District, Limapuluh Kota District.

Data collection technique

Data collection is in the form of primary data sourced from data processing directly by the author and secondary data sourced from related agencies. Primary data includes observations, interviews, rainfall data, climatological data and percolation data. While secondary data includes rainfall data, climatology data and area size.

KP method data analysis stage – 01

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1. Processing of rainfall data for the last 13 years into half-monthly average rainfall in one year
2. Calculating the reliable rainfall (R80) is determined based on the Weibul equation as follows:

m/(n+1) x100%
Where:
P = Probability
m = Data sequence number
n = amount of data

3. Calculate the effective rainfall based on reliable rainfall (R80) in a 15-day period with the following equation [10]:

Rainfall for paddy:
Re = (R8 x 0.7/observation period) mm/day
Where
Re = Effective rainfall (mm/day)
R8 = Daily rainfall with a probability of occurring 80% during a year

4. Calculating evapotranspiration using the modified Penman method with the following formula [10]:

ET0 = C x W x Rn + (1-W) x f(u) x (ea – ed)
Where:
ET0 = Reference Evapotranspiration (mm/day)
C = correction factor
W = weight factor related to temperature and elevation
Rn = solar radiation (mm/day)
f(u) = wind function
ea = saturated vapor pressure (mbar)
ed = real vapor pressure (mbar)

5. Calculating the consumptive water requirement of plants can use the following empirical equation [10]:

Etc = kc x Eto
Where:
Kc = crop coefficient
Eto = potential evapotranspiration (mm/day)
Etc = plant evapotranspiration (mm/day)

6. The requirement for irrigation water during land preparation uses the method developed by Van De Goor and Zijlstra (1986), namely as follows [11]:

IR = M.ek / (ek – 1)
Where:
IR = irrigation water requirement for soil management (mm/day)
M = water requirement to replace water loss due to evaporation and percolation in saturated rice fields where M=Eo+P
Eo = evaporation of open water (mm/day) = Etox 1.10
P = water loss due to percolation (mm/day) (depending on texture land)
K = MT/S
T = land preparation period (days)
S = water requirement (for saturation plus a layer of water 50 mm, that is, 200 + 50 = 250 mm

7. The calculation of water requirements for plants depends on a standard water balance in paddy fields, where climatic elements are calculated through the application of commonly used empirical formulas. The quantity of water requirement in paddy fields (NFR) is calculated using the following formula [12]:

NFR = Etc + WLR + P – Re

Where:

NFR = water requirement for land preparation (mm/day)
Etc = evapotranspiration for plants (mm/day)
WLR = water requirement for subsoil replacement
P = percolation
Re = effective rainfall (mm/day)

8. Determining irrigation efficiency is referred to as 90% for the primary level and 80% for the tertiary level. Total irrigation efficiency is calculated by multiplying the efficiency of each level, namely 0.9 x 0.9 x 0.8 = 0.648 or around 65% [13].
9. Water balance is determined by reducing the amount of available irrigation water with the requirement for irrigation water [14].

Data analysis using cropwat 8.0

The analysis phase uses Cropwat 8.0 which is as follows [15]:

1. Run the CropWat 8.0 application
2. Click the climate/Eto icon
3. Enter climatological data:
   a. Data country / country of the recording station
   b. Climatology station name
   c. Coordinate data and elevation data of the recording station
   d. Enter average temperature data (Co)
   e. Enter relative humidity data (%)
   f. Enter wind speed data (Km/day)
   g. Enter the sun exposure data (%)
   h. Eto results will appear automatically
4. Click the Rain icon
5. Enter the rainfall data
   a. Click the menu option, fill in the fixed percentage (70%) for rice plants
   b. Enter the total average rainfall for the year
   c. Automatic effective rainfall immediately appears
6. Click the Crop icon
7. Enter crop data from the FAO – Rice default data base, then correct the planting start date
8. Click the Soil icon
9. Enter soil data by taking the default FAO – Medium data base
10. Click the CWR icon, the results of the irrigation water demand analysis will appear automatically.

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RESULTS AND DISCUSSION

Analysis of irrigation water requirement KP – 01 method

1. Calculation of evapotranspiration (Eto)

Table 1. ETo Calculation of Modified Penman Method

month	Jan	Feb	Mar	Apr	May	Jun	Jul	Agust	Sep	Okt	Nov	Dec
Eto mm/days	3,26	3,11	3,36	3,47	3,02	2,72	3,02	3,35	3,21	3,15	3,22	3,29

2. Calculation of effective rainfall (Re)

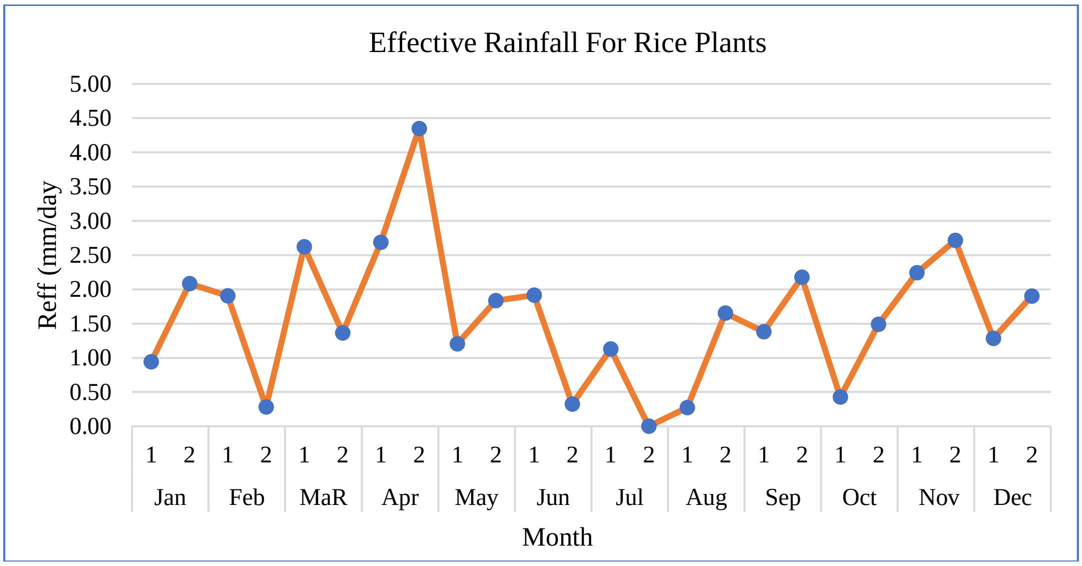

Figure 1. Analysis of Effective Rainfall for Rice Plants

3. Calculation of irrigation water requirement

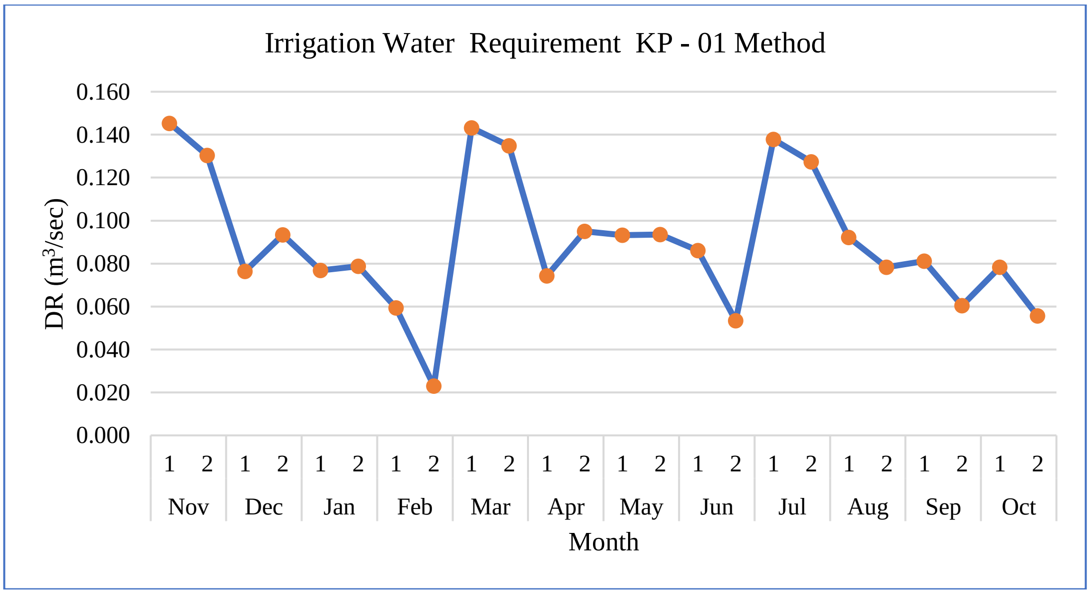

Figure 2. Recapitulation of Calculation Results of Irrigation Water requirement KP – 01 Method

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Analysis of Irrigation Water requirement Using Cropwat 8.0

1. Calculation of evapotranspiration (Eto)

Table 2. Evapotranspiration (ETo) Summary of Cropwat 8.0 Software

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Agust	Sep	Oct	Nov	Dec
Eto	2,96	2,86	3,11	3,18	2,87	2,61	2,81	3,09	3,02	2,93	2,95	3,00

2. Calculation of Effective Rainfall (Reff)

Table 3. Effective Rainfall Summary of Cropwat 8.0

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Agust	Sep	Oct	Nov	Dec
Reff (mm/bln)	125,4	111,2	142,4	188,1	111,4	89	75,2	92,7	125,7	125	212	173,1

3. Calculation of Plant Water requirement (CWR)

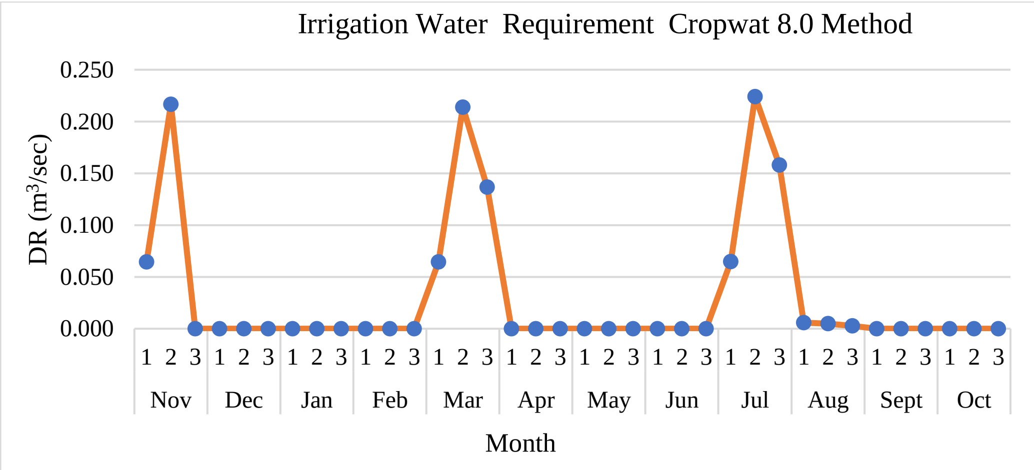

Figure 3. Irrigation Water Requirement Cropwat 8.0 Method

Based on calculations from two methods, namely using the manual method and the Cropwat application, the results of the Evapotranspiration calculations from the Modified Penman and Penman Monteith methods are obtained and the results of calculating water requirements using the KP – 01 method and the use of the Cropwat 8.0 application. The following comparison of the evapotranspiration value from the use of the manual method and the Cropwat software can diagram:

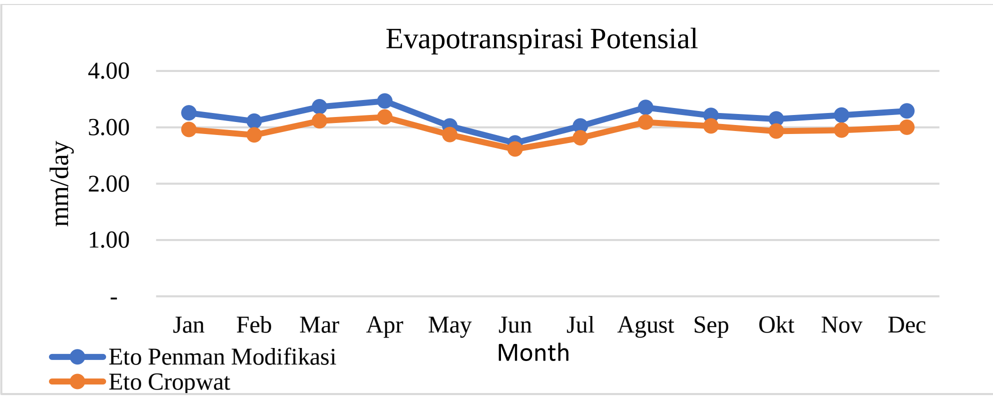

Figure 4. Potential Evapotranspiration Calculation Result Diagram Penman Modification and Software Cropwat 8.0

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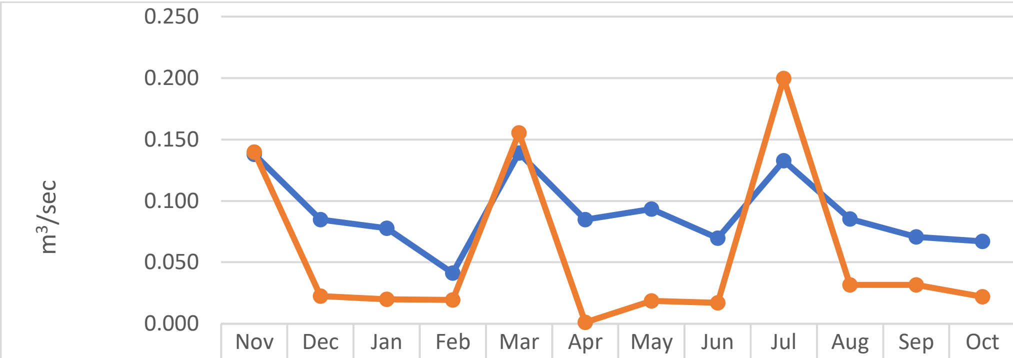
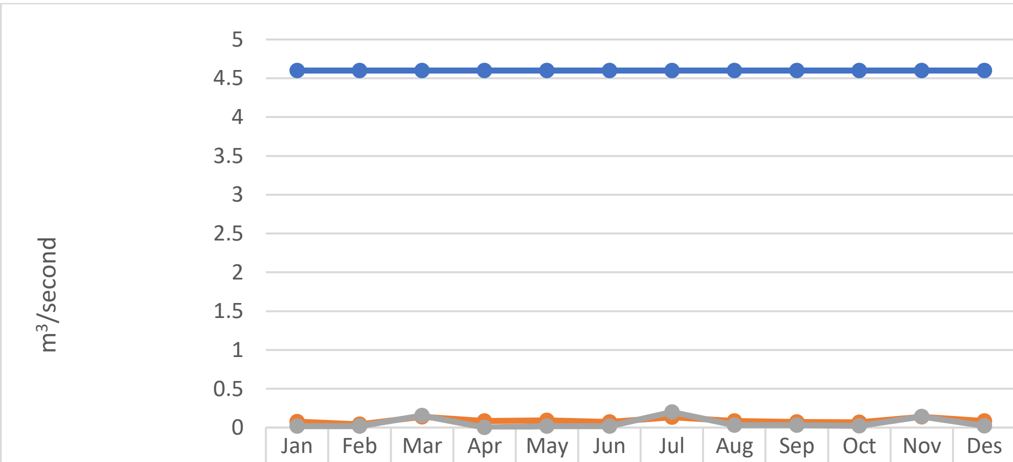
In calculating the irrigation water requirement of the Batang Sanipan 2 area using the KP-01 method and the Cropwat software, after calculating the water requirement of the plants, the irrigation water requirement are obtained based on irrigation efficiency of 65% and an agricultural area of 73.64 ha. Comparison of the results of calculating the average monthly irrigation water requirement using the KP-01 method and the Cropwat 8.0 software in the Batang Sanipan 2 Irrigation area can be diagram:



	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
DR KP - 01	0.138	0.085	0.078	0.041	0.139	0.085	0.093	0.070	0.133	0.085	0.071	0.067
DR Cropwat	0.140	0.022	0.020	0.019	0.155	0.001	0.019	0.017	0.200	0.032	0.032	0.022

Figure 5. Diagram of Calculation Results for Irrigation Water Requirement –Average Monthly *KP-01 Method and Cropwat 8.0 Software*

Based on data analysis, the results obtained from the manual calculation of KP – 01 the maximum irrigation water requirement with a value of 0.139 m^3/second which occurred in March, while in the Cropwat software the maximum irrigation water requirement with a value of 0.200 m^3/second which occurred in July.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des
Ketersediaan Air	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
DR KP - 01	0.078	0.041	0.139	0.085	0.093	0.070	0.133	0.085	0.071	0.067	0.138	0.085
DR Cropwat	0.020	0.019	0.155	0.001	0.019	0.017	0.200	0.032	0.032	0.022	0.140	0.022

Figure 6. Batang Sanipan Watershed Water Balance Diagram

Based on the picture above, it is known that water demand in one year shows that there is a surplus or excess availability of water in the Batang Sanipan watershed when viewed only from the irrigation water needs of Batang Sanipan 2. When compared to the maximum water demand that occurred in July, which was 0.200 m^3/second, the irrigation water requirement of Batang

Sanipan 2 only requires 4.35% of the known Batang Sanipan watershed discharge of 4.6. m^3/second.

CONCLUSION

The results of measuring the discharge at the intake gate of the Batang Sanipan 2 weir obtained a discharge of 0.378 m^3/second while the maximum water demand in one year occurred in July of 0.200 m^3/second from the calculation results of the Cropwat 8.0 software. Based on this, water is sufficient to flow through the entire agricultural area of the Batang Sanipan 2 irrigation area, but the current conditions are that water is not able to flow through parts of the Batang Sanipan 2 irrigation service area. During field observations, it was found that there were many leaks in the canals and the use of irrigation water that was not in accordance with the main function of the irrigation network so that the water is unable to flow to some of the Batang Sanipan 2 irrigation service areas.

REFERENCE

[1] Mawardi, Erman. (2010). *Desain Hidraulik Bangunan Irigasi* (2 ed.). Alfabeta. Jakarta.

[2] Ismaya, T., Sulakasana, J., & Hadiana, D. (2016). Pengembangan dan pengelolaan jaringan irigasi untuk meningkatkan hasil produksi dan pendapatan usahatani padi sawah. *Agrivet: Jurnal Ilmu-Ilmu Pertanian dan Peternakan (Journal of Agricultural Sciences and Veteriner)*, *4*(2).

[3] Juhana, E. A., Permana, S., & Farida, I. (2015). Analisis Kebutuhan Air Irigasi Pada Daerah Irigasi Bangbayang Uptd Sdap Leles Dinas Sumber Daya Air Dan Pertambangan Kabupaten Garut. http://jurnal.sttgarut.ac.id

[4] Krispedana, I. W., Setiyo, Y., & Madrini, I. A. G. B. (2022). Analisis Persentase Kekurangan Air Irigasi pada Subak di Das Ho Saat Musim Kemarau. JURNAL BETA (BIOSISTEM DAN TEKNIK PERTANIAN). 10(1), 1–11.

[5] Sosrodarsono, S., & Takeda, K. (2003). *Hidrologi untuk pengairan*, PT. Pradnya Paramita, Jakarta.

[6] Sari, K., & Sulaeman, B. (2020). Analisis Kebutuhan Air Irigasi Pada Jaringan Sekunder Di Kota Palopo. PENA TEKNIK: Jurnal Ilmiah Ilmu-Ilmu Teknik, 5(2), 82-90.

[7] Marica, A. (2000). Short Description of CROPWAT Model. 17 February 2022.

[8] Shalsabillah, H., Amri, K., & Gunawan, G. (2018). Analisis Kebutuhan Air Irigasi Menggunakan Metode Cropwat Version 8.0 (Studi Kasus Pada Daerah Irigasi Air Nipis Kabupaten Bengkulu Selatan). Jurnal Inersia Oktober, 10(2)..

[9] Direktorat Jenderal Sumber Daya Air. (2013). Standar Perencanaan Irigasi Kriteria Perencanaan Bagian Jaringan Irigasi Kp-01.

[10] Sugiyono. 2014, *Metode Penelitian Kuantitatif, Kualitatif, dan Kombinasi (Mixed Methods)*. Bandung: Alfabeta.

[11] Direktorat Jenderal Sumber Daya Air. (2013). *Standar Perencanaan Irigasi Kriteria*

Perencanaan Bagian Jaringan Irigasi Kp-01.

[11] Priyonugroho, A. (2014). Analisis kebutuhan air irigasi (studi kasus pada daerah irigasi sungai air keban daerah kabupaten empat lawang) (Doctoral dissertation, Sriwijaya University).

[12] Dasril, D., Istijono, B., & Nurhamidah, N. (2021). Evaluasi kebutuhan air irigasi dengan aplikasi cropwat 8.0 daerah irigasi Amping Parak. Rang Teknik Journal, 4(2), 374-382.

[13] Rizqi, M., Yasar, M. Y., & Jayanti, D. S. (2019). Analisis Kebutuhan Air Irigasi Menggunakan CROPWAT 8.0 pada Daerah Irigasi Krueng Jreu Kabupaten Aceh Besar. Jurnal Ilmiah Mahasiswa Pertanian, 4(4), 412-421.

[14] Fatahillah, A., Meliyana, M., Syahputra, I., Amin, A., & Rahmawati, C. (2023). Analisis Ketersediaan Air Irigasi dan Kebutuhan Air Irigasi Menggunakan Software Cropwat Version 8.0. Jurnal Teknik Sipil Unaya, 9(1), 30-37.

[15] Prastowo, D. R. (2016). Penggunaan model cropwat untuk menduga evapotranspirasi standar dan penyusunan neraca air tanaman kedelai (Glycine max (L) Merrill) di dua lokasi berbeda. *Jurnal Teknik Pertanian Lampung (Journal of Agricultural Engineering)*, *5*(1).