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Analysis of Water Balance in Nyaen Irrigation Area Sukoharjo Regency

Muhammad Fitra Zidane[1*], Erni Mulyandari[2], Kukuh Kurniawan[3]
[1,2,3] Universitas Tunas Pembangunan Surakarta, Jawa Tengah, Indonesia
Email: muhammadfitrazidane01@gmail.com, erni.mulyandari@lecture.utp.ac.id and kukuh.kurniawan@lecture.utp.ac.id

Abstract

Nyaen Weir is one of the weirs in Sukoharjo Regency. This weir has an irrigation area called the Nyaen irrigation area. The Nyaen irrigation area experiences water shortages in the third planting period. Therefore, further analysis is needed to overcome the water shortage appropriately. This study aims to determine the water balance in the Nyaen Irrigation Area. The method used is direct observation along with a quantitative descriptive method. The analysis stage begins with a site survey to discover the problems in the irrigation network and then collect secondary data at the research location. The water balance analysis step is to compare the availability of water with irrigation water needs. According to the water balance analysis in the Nyaen Irrigation Area, it is not balanced because the right intake is 25% sufficient, and the left intake is 75% acceptable.

Keywords: Water Balance, Water Availability, Water Demand.

Introduction

Nyaen weir is one of the fixed weirs in Sukoharjo Regency, which is located in Krasak Sub-Village, Kagokan Village, Gatak District, Sukoharjo Regency, Central Java. Nyaen Weir has an irrigation area of 362 Ha. Nyaen Weir takes water from the Gandul River. Over time, the area of rice fields gradually decreases due to the use of rice fields for houses, shops, and industry. It is necessary to calculate the existing irrigation area so that the needs and availability of water can be balanced.

Until now, Nyaen Weir water has still been utilized for irrigation, especially in the Nyaen Irrigation Area, so this research is fundamental to know when water availability will allow or prevent the use of unnecessary amounts of irrigation water. Research on water balance has been conducted in many irrigation areas, including research on Irrigation Water Needs Analysis in Trani Irrigation Area. The aim is to calculate the number of buildings or other physical infrastructure assets on the irrigation network, measuring the area of Trani Irrigation Area, calculating the maximum and minimum amount of water needed for irrigation (Rio Susanto, Erni Mulyandari, 2024).

Analysis of Irrigation Water Balance in Garum and Jatisari Irrigation Areas, Ngajum District, Malang Regency. With the aim of knowing the water balance in Garum and Jatisari Irrigation Areas. Using the Weibull method and comparative method

to determine the need for water. The result is that water discharge tends to be higher during the rainy season and lower during the dry season (Qomariyah, 2023).

Analysis of Water Balance and Efficiency of Anjungan Melancar Irrigation Area in Anjungan District, Mempawah Regency. Aims to determine the water balance in the Anjungan Irrigation Area. Using the Mock method with evapotranspiration potential Penman method. The results of the water balance in Anjungan Melancar Irrigation Area (deficit) - 132.7 lt/det. The BBN2 primary channel loses water Ec = 55.9 lt/det and the efficiency of the water channel Eff = 44% (Saputra, Kartini, & Herawati, 2022).

Water Balance Analysis in Kulon Progo Regency, Special Region of Yogyakarta (Case Study of Progo and Serang Das). With the aim of knowing the comparison of water availability and demand in Kulon Progo Regency in order to meet the raw water needs of the community both now and in the future (Lidwina, Astani Putri, Intan Supraba, 2022). Analysis of water balance in Jetu Irrigation Area Karanganyar Regency. With the aim of knowing the water balance in the Jetu Irrigation Area by calculating the need and availability of weir water. Calculating the need and availability of water using quantitative descriptive methods. The result is that to cover all cropping patterns, a new water source is needed (Handoyo & Mulyandari, 2021).

Imbalance Analysis of the Availability and Needs of Irrigation Water for Rice Fields in Padang Cermin Village, Finish Subdistrict, Langkat Regency. With the aim of knowing the availability of irrigation in Padang Cermin Village, water needs of rice plants in rice fields in Padang Cermin Village, and the balance between the availability and water needs of rice plants in irrigated rice fields in Padang Cermin Village (Rao, 2020).

Analysis of the Size of the Water Imbalance Component on Kelingi Irrigated Land Tugumulyo Musi Rawas Regency South Sumatra Province. With the aim of knowing the water balance on Kelingi irrigated land. Using simulation methods by applying continuous, scheduled, and controlled. The results know the smallest way of giving water, namely scheduled giving (Yendri, Putranto, & Sarino, 2019).

Analysis of water balance of Irrigation Area development in Nangagali Watershed, Sumbawa Regency. With the aim of knowing the water balance in Nangagali Irrigation Areas which is also an important factor for the development of irrigation areas. In this study calculates the discharge with the F.J Movk method to determine the availability of water. The results of the research Nangagali Irrigation Areas can not meet the water needs in seven irrigation development areas (Alfan, 2018).

Analysis of Embung Bayan water balance for raw water and irrigation needs in Bayan Village, Bayan District, North Lombok Regency. This study uses the method used to calculate the availability of dewatered water with the Nreca method. The results of the study indicate that there is the greatest water demand at the beginning of planting in December which cannot be met by the amount of water availability (Pratama, 2018).

The research was titled analysis of water balance in Tukad Sungi watershed in Tabanan Regency. This study aims to determine the water balance in the Tukad Sungi watershed which is used for raw water for residents. The calculation uses the water

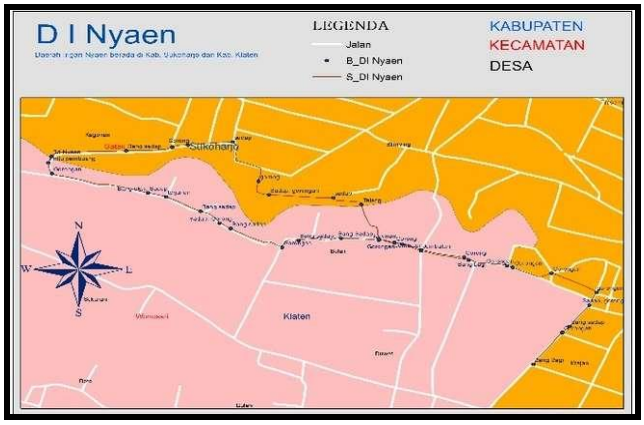
balance method. With the results of knowing when the number of large water needs in the Sungi river (I Made Agus Dwi Hadryana, I Gst. Ngr. Kerta Arsana, 2016).

Analysis of Irrigation Water Needs in Bangbayang Irrigation Area UPTD SDAP Leles Dinas Sumber Daya Air dan Pertambangan Kabupaten Garut. The purpose of this study was to determine the need and availability of water in DI Bangbayang, by analyzing the hydrology of irrigation areas. From the results of the study, it is known the amount of water needed and using a group system or rotation system so that the availability of water can be fulfilled. (Juhana, Permana, & Farida, 2016).

Research Methods

The initial step in this research begins with identifying the problems that exist in the Nyaen irrigation area, which can then be used to formulate problems that will determine the limitations of the issues in this study. The location of Nyaen Weir can be seen in Picture 2. While the map of Nyaen irrigation network can be seen in Picture 3.

Picture 1. Location of Nyaen Weir



Picture 2. Map of Nyaen Irrigation Area
Source : https://bpusdataru-bs.jatengprov.go.id (2024)

The next step is data search and analysis. There are two data types in the data search: primary and secondary. Primary data is obtained by conducting surveys of the research location and interviews, while secondary data in the form of irrigation area

map, cropping patterns, Nyaen weir intake discharge, irrigation area boundaries, climatology data and rain data obtained from relevant agencies, namely the Bengawan Solo Water Resources, and Spatial Planning Public Works Center (BPSDA) and the Bengawan Solo River Basin Center (BBWS) and online sites. There are five stages in the power analysis, namely identifying the condition of irrigation network water flow, analyzing irrigation water availability, existing irrigation area, irrigation water demand, and irrigation water balance analysis. The final step is to draw conclusions based on the results of the data analysis stage. Because drawing conclusions is the last step of a study, it needs to be done systematically.

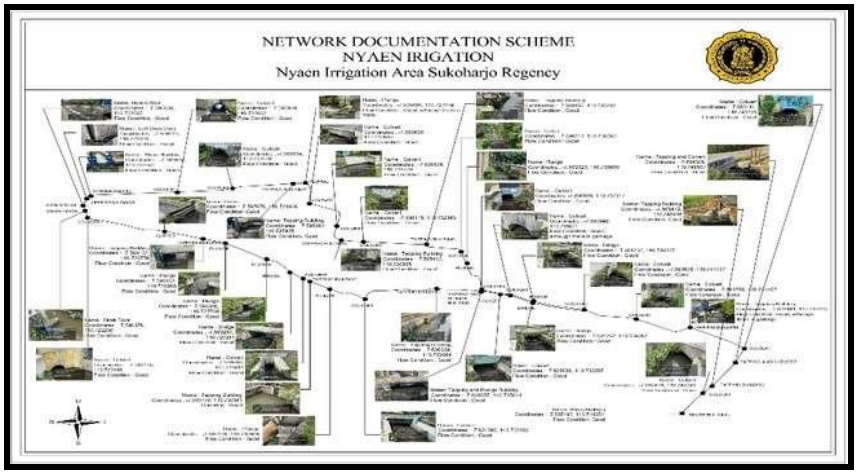
Results and Discussion

1. Analysis of Water Flow Conditions in the Nyaen Irrigation Network

The condition of water flow in the Nyaen irrigation network can be known by surveying the research site (Mulyandari, 2023). The survey was conducted by tracing the network in the irrigation area and conducting interviews with the association of water user farmers in the Nyaen irrigation area. This observation only assesses the condition of water flow, which is said to be good if the water flows and bad if the water can not flow in the irrigation network. An example of the survey form used can be seen in Picture 3, while the documentation scheme for the Nyaen irrigation network can be seen in Picture 4.

No	Building Name	Nomenclature	Coordinate		Documentation	Flow Conditions
			South latitude	North Longitude		
1	Nyaen Weir		-7.596039	110.722565		Good
2	Left Drain (Left Intake)	B_Ny_Ki_1a Hm. 00 + 06	-7.595935	110.722555		Good
3	Culvert (Left Intake)	B_Ny_Ki_1b Hm. 00 + 22	-7.595929	110.722602		Good

Picture 3. Nyaen Irrigation Network Flow Condition Survey Form



Picture 4. Documentation Scheme of Nyaen Irrigation Network

Based on Picture 5 above, it can be seen that the water flow in the Nyaen irrigation network is declared good because it can flow from the weir to the tertiary plot.

2. Analysis of Irrigation Water Availability

The analysis of irrigation water availability is calculated using the mainstay discharge method, which is 80% for rice and 50% for secondary crops. The data is based on the intake discharge in the Nyaen irrigation area. The intake discharge data used in the last 11 years is from 2013 - 2023. Furthermore, calculating the probability with the Weibull method with the following formula (Saud Ismail, 2023).

$$P = \frac{m}{n+1} \times 100\%$$

Where P = Probability (%)

m = Sequence number of the sorted data series

n = Amount of data

This was followed by half-monthly weir discharge data sorted from largest to smallest and interpolated to produce probabilities of 80% and 50%. The recapitulation used is 80% mainstay discharge in planting period one and two months, November - June (rice), and 50% mainstay discharge in planting period three months, July - October (secondary crops), as can be seen in Table 1.

Table 1. Water Availability of Nyaen Weir

Mouth	Period	Intake Discharge (m^3/det)	
		Right	Left
November	I	0.11	0.12
	II	0.12	0.12
December	I	0.12	0.14
	II	0.12	0.14
January	I	0.13	0.16
	II	0.14	0.16
February	I	0.13	0.16

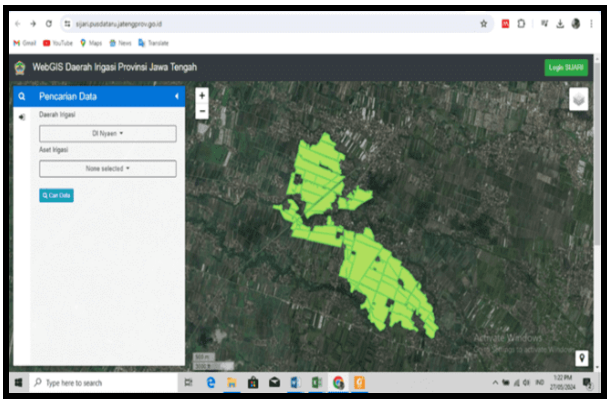
Mouth	Period	Intake Discharge (m^3/det)	
		Right	Left
	II	0.12	0.14
March	I	0.13	0.16
	II	0.14	0.15
April	I	0.14	0.16
	II	0.15	0.16
Mey	I	0.14	0.16
	II	0.15	0.17
June	I	0.13	0.15
	II	0.13	0.15
July	I	0.13	0.16
	II	0.14	0.17
August	I	0.15	0.18
	II	0.16	0.19
September	I	0.13	0.16
	II	0.13	0.16
October	I	0.13	0.14
	II	0.14	0.16

This research calculates the availability of water using the mainstay discharge methods Q80% and Q50%. Secondary data was found in the Nyaen irrigation area, which can be considered more accurate than the Mock method.

3. Analysis of Existing Irrigation Area in Nyaen Irrigation Area

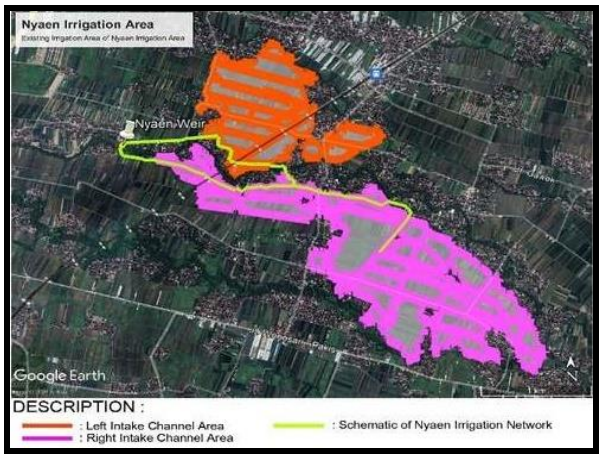
The calculation of the current area is to find out how much rice fields are flowed by the Nyaen Weir. This must be done now, because the area of rice fields will gradually decrease over time due to the use of rice fields for houses, shops, and industry. Determining the extent of existing irrigation is critical for planning water resources, managing agriculture, and further infrastructure development (Lenry Rahman, Fauzi, & Sujatmoko, 2019).

Before determining the existing area, first, find out the boundaries of the Nyaen irrigation area, which can be seen on the website https://sijari.pusdataru.jatengprov.go.id/. The boundaries of the Nyaen irrigation area can be seen in Picture 5. Based on Picture 6, the results of the representation on Google Earth.



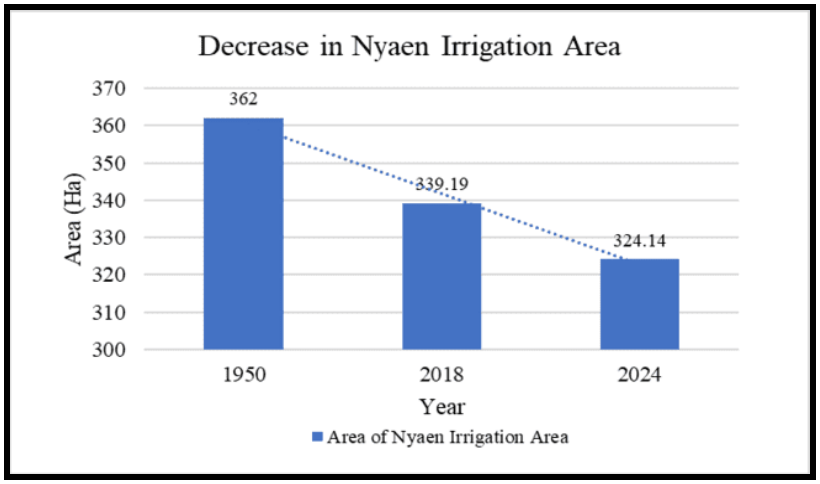
Picture 5. Area Boundary of Nyaen Irrigation Area

Source : *https://sijari.pusdataru.jatengprov.go.id/* (2018)



Picture 6. Representation Results to Google Earth 2024

In Picture 6, it is obtained that the irrigation area is 324.14 Ha with a left intake of 112.75 Ha and a right intake of 211.4 Ha. In the secondary data, Nyaen Weir first had an irrigation area of 362 Ha then according to the website https://sijari.pusdataru.jatengprov.go.id/ had an area of 339.19 Ha, while in 2024 through Google Earth there was an area of 324.14 Ha. A diagram of the decline in the irrigation area of Nyaen irrigation area can be seen in Picture 7.



Picture 7. Decrease in Nyaen Irrigation Area

Based on Picture 8, the decrease in the Nyaen irrigation area from 1950 to 2018 was 0.63% , while from 2018 to 2024, it was 0.44%.

4. Irrigation Water Requirement Analysis

Irrigation water demand analysis is an activity that aims to assess and calculate the volume of water needed to maintain ideal crop development (Direktorat Jendral SDA, 2013). In the Nyaen irrigation area, the beginning of planting was carried out in November, in accordance with the results of planting patterns from related

agencies and the results of interviews with P3A (Association of Water User Farmers) in the Nyaen irrigation area. As for the area of Nyaen irrigation area, using the results of the analysis of the existing irrigation area, which can be seen in Picture 7, the irrigation area is 324.14 Ha with a left intake of 112.75 Ha and a right intake of 211.4 Ha. Based on the rice-rice-secondary cropping pattern (corn), the results of the irrigation water demand analysis can be seen in Table 2.

Table 2. Irrigation Water Requirement of Nyaen Irrigation Area

Planting Period	Month	Period	Irrigation Water Requirement (m^3/det) Intake	
			Right	Left
I	November	I	0.44	0.24
		II	0.49	0.26
I	December	I	0.22	0.12
		II	0.19	0.10
I	January	I	0.09	0.05
		II	0.12	0.06
I	February	I	0.00	0.00
		II	0.00	0.00
II	March	I	0.31	0.17
		II	0.36	0.19
II	April	I	0.19	0.10
		II	0.27	0.15
II	Mey	I	0.32	0.17
		II	0.32	0.17
II	June	I	0.22	0.12
		II	0.09	0.05
III	July	I	0.51	0.27
		II	0.16	0.09
III	August	I	0.18	0.10
		II	0.24	0.13
III	September	I	0.28	0.15
		II	0.25	0.13
III	October	I	0.26	0.14
		II	0.05	0.02

The calculation results in Table 2 show that the maximum water requirement needed in the Nyaen irrigation area for rice planting patterns (MT I and II) at the right intake is 0.49 m^3/dt, and the left intake is 0.26 m^3/dt, while the secondary cropping pattern (MT III) at the right intake is 0.51 m^3/dt, and the left intake is 0.27 m^3/dt.

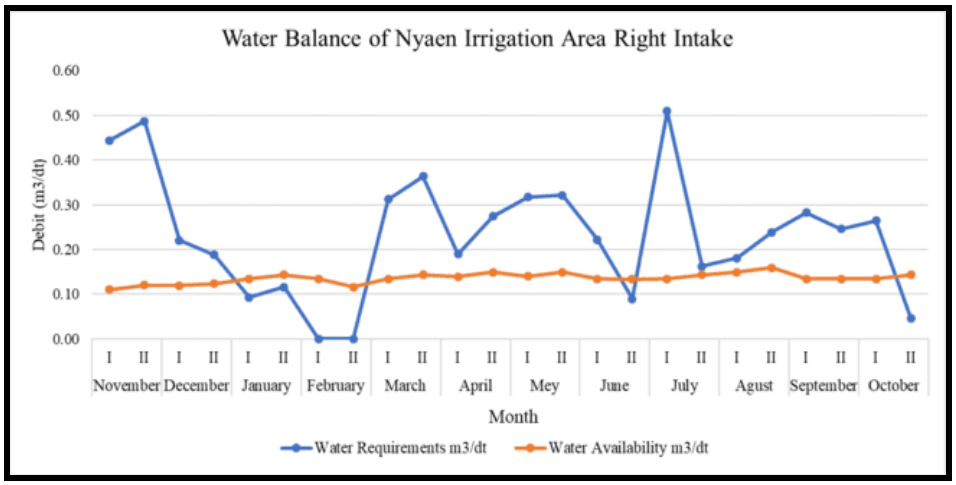
5. Irrigation Water Balance Analysis

Irrigation water balance is a comparison between water demand and water availability in an irrigation area (D Indra F, 2005). If the need for water is greater than the availability of water then it can be concluded that water needs are not met and if the need for water is smaller, it means that irrigation water needs are met. The irrigation water balance analysis table on the right intake can be seen in Table 3, and the left intake in Table 3.

Table 3 Irrigation Water Balance of Nyaen Irrigation Area Right Intake

Month	Period	Irrigation Water Requirement m^3/dt	Water Availability m^3/dt	Description
November	I	0.44	0.11	Not Eligible
	II	0.49	0.12	Not Eligible
December	I	0.22	0.12	Not Eligible
	II	0.19	0.12	Not Eligible
January	I	0.09	0.13	Eligible
	II	0.12	0.14	Eligible
February	I	0.00	0.13	Eligible
	II	0.00	0.12	Eligible
March	I	0.31	0.13	Not Eligible
	II	0.36	0.14	Not Eligible
April	I	0.19	0.14	Not Eligible
	II	0.27	0.15	Not Eligible
Mey	I	0.32	0.14	Not Eligible
	II	0.32	0.15	Not Eligible
June	I	0.22	0.13	Not Eligible
	II	0.09	0.13	Eligible
July	I	0.51	0.13	Not Eligible
	II	0.16	0.14	Not Eligible
August	I	0.18	0.15	Not Eligible
	II	0.24	0.16	Not Eligible
September	I	0.28	0.13	Not Eligible
	II	0.25	0.13	Not Eligible
October	I	0.26	0.13	Not Eligible
	II	0.05	0.14	Eligible

The graph for the water balance at the right intake can be seen in Picture 9 below.



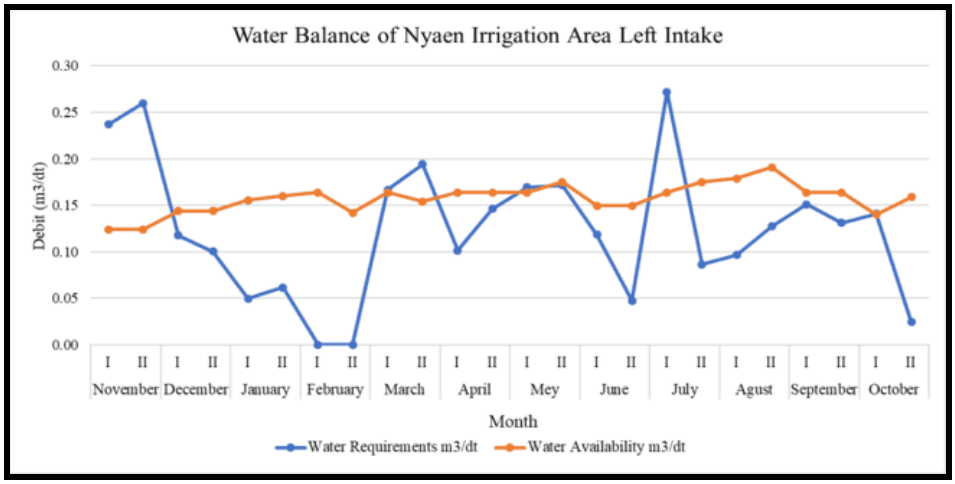
Picture 8. Irrigation Water Balance of Nyaen Irrigation Area Right Intake

Based on Picture 8, it can be seen that only January, February, June II, and October II have their water needs met with a sufficient percentage of 25% and an insufficient percentage of 75%.

Table 4 Irrigation Water Balance of Nyaen Irrigation Area Left Intake

Month	Period	Irrigation Water Requirement m^3/dt	Water Availability m^3/dt	Description
November	I	0.24	0.12	Not Eligible
	II	0.26	0.12	Not Eligible
December	I	0.12	0.14	Eligible
	II	0.10	0.14	Eligible
January	I	0.05	0.16	Eligible
	II	0.06	0.16	Eligible
February	I	0.00	0.16	Eligible
	II	0.00	0.14	Eligible
March	I	0.17	0.16	Not Eligible
	II	0.19	0.15	Not Eligible
April	I	0.10	0.16	Eligible
	II	0.15	0.16	Eligible
Mey	I	0.17	0.16	Not Eligible
	II	0.17	0.17	Eligible
June	I	0.12	0.15	Eligible
	II	0.05	0.15	Eligible
July	I	0.27	0.16	Not Eligible
	II	0.09	0.17	Eligible
August	I	0.10	0.18	Eligible
	II	0.13	0.19	Eligible
September	I	0.15	0.16	Eligible
	II	0.13	0.16	Eligible
October	I	0.14	0.14	Not Eligible
	II	0.02	0.16	Eligible

The graph for the water balance at the left intake can be seen in Picture 10 below.



Picture 9. Irrigation Water Balance of Nyaen Irrigation Area Left Intake

Based on Picture 10, the months of December, January, February, April, May, June, July, August, September, and October were fulfilled wit√h a sufficient percentage of 70.8% and not fulfilled with 29.2%.

Conclusion

The research concludes that the condition of water flow in the Nyaen Irrigation network is declared good because water can flow from the weir to the rice fields. The existing irrigation area of Nyaen irrigation area is obtained 324.14 Ha, namely 112.75 Ha for the left intake channel and 211.4 Ha for the right intake, and the water balance in the Nyaen irrigation area is not balanced, namely on the right intake which is 25% sufficient and on the left intake which is 75% acceptable.

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