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The Analysis of the Irrigation System in Ciwaringin Weir, Majalengka Regency

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ABSTRACT
The Ciwaringin Weir is located in Lame Village, Leuwimunding District, Majalengka Regency, West Java Province. It irrigates an area of approximately ±4364 hectares, comprising 3261 hectares in Majalengka Regency and 1103 hectares in Cirebon Regency. The core components of this irrigation system consist of primary and secondary canals. This study aims to evaluate the structural performance based on damage conditions, assess the current operational state, and determine the component weights of the canals and Ciwaringin Weir structures. Primary data were collected through field observations, while secondary data were obtained from relevant agencies, including the Cimanuk-Cisanggarung River Basin Organization (BBWS), UPTD PSDA Sumberjaya, and SUP Cimanuk Hilir-Kaliwedi. The research employed a qualitative method with a descriptive-inductive approach. The findings indicate that the performance of the primary and secondary canals of the Ciwaringin Weir, based on condition and function, is 36% in good condition, 37% moderate, and 27% damaged—indicating that the average condition is classified as moderately damaged. Meanwhile, the structural condition of the weir shows 34% good, 57% moderate, and 9% damaged, suggesting that the weir's overall condition is still acceptable. Analysis comparing rainfall and discharge availability in the Ciwaringin Irrigation Area reveals that water availability exceeds demand, thus ensuring that the irrigation water needs in the area are fully met.

INTRODUCTION

The Ciwaringin Weir is one of the weirs located in Majalengka Regency, West Java. Astronomically, it is situated at coordinates 6ˀ45'51.5" S and 108ˀ20'04.7" E, within Lame Village, Leuwimunding District, Majalengka Regency, West Java Province. The weir serves five districts: Leuwimunding (1054 ha), Sumberjaya (1095 ha), and Ligung (1112 ha) in Majalengka; Susukan (795 ha) and Ciwaringin (308 ha) in Cirebon, with a total irrigated area of 4364 hectares.

The weir's performance frequently faces issues, such as structural deterioration and suboptimal water distribution through the irrigation network. Other concerns include limited budget allocations for operations and maintenance, as well as insufficient management personnel, which affect the weir's capacity to support irrigation needs effectively (Dirawan & Jannah, 2023; Juwono & Subagiyo, 2018; Rengganis, 2018; Yuliana, 2019). To address these challenges, it is essential to conduct a performance evaluation of the Ciwaringin Weir, which can provide insight into its current management and operational status (Lansia et al., 2021; NURFADILA, 2023; Putri et al., 2020; Widyaningsih et al., 2021). Such evaluations are guided by national regulations on water and irrigation resource management, including the Minister of Public Works Regulations No. 32/PRT/M/2007 on Operation and Maintenance of Irrigation Networks and No. 33/PRT/M/2007 on Empowerment Guidelines for P3A, GP3A, and IP3A (PARMAN et al., 2024).

Previous research has highlighted the importance of evaluating weir performance but has often been limited in scope. Juwono and Subagiyo (2018) examined several irrigation weirs in Central Java, finding that structural deterioration and insufficient maintenance funding significantly reduced irrigation efficiency. However, their study focused primarily on physical infrastructure, with limited attention to institutional management and community participation. Similarly, Nurfadila (2023) conducted an assessment of irrigation network performance in South Sulawesi, emphasizing the mismatch between water availability and crop water demand. While valuable, the research did not incorporate institutional aspects such as the effectiveness of farmer water user associations (P3A) or compliance with national regulations. These studies indicate that existing evaluations tend to emphasize either technical or hydrological dimensions, leaving a gap in integrative approaches that combine infrastructure, hydrology, operations and maintenance (O&M), and governance.

This study aims to assess the physical condition of infrastructure, analyze irrigation water requirements and available discharge, evaluate operational and maintenance implementation (AKNOP), and examine the effectiveness of institutional irrigation management. The findings are expected to provide a reference for policy decisions regarding the improvement and strengthening of the irrigation system, ensuring long-term agricultural productivity within the Ciwaringin irrigation area.

METHOD

The object of this research is the Ciwaringin Weir located in Lame Village, Leuwimunding District, Majalengka Regency. The following is a map of the research location:

Figure 1. Research Location Map

Source : Google Earth Pro

Figure 2. Bendung Ciwaringin
Source : Personal Documents

Data collection techniques used in this study include (Sidiq et al., 2019):

1. Observation, namely a method of collecting data through direct observation of conditions in the field.
2. Interviews, namely a technique for obtaining information through direct or face-to-face communication with sources who have related knowledge.
3. Literature Study, namely an information collection technique that is sourced from theories or references related to the research problem.

This study uses a qualitative method with a descriptive-inductive approach. The descriptive approach aims to provide an overview and explanation of the data and information collected during the research process. Meanwhile, the inductive approach is carried out through a reasoning process based on field findings or empirical facts (Sulistiyo, 2023). With this descriptive-inductive qualitative method, the research attempts to describe the conditions of the subjects and objects of research in accordance with the facts obtained, especially in evaluating the performance of the irrigation system and revealing the relationship between the aspects studied in depth (Hotimah et al., 2024).

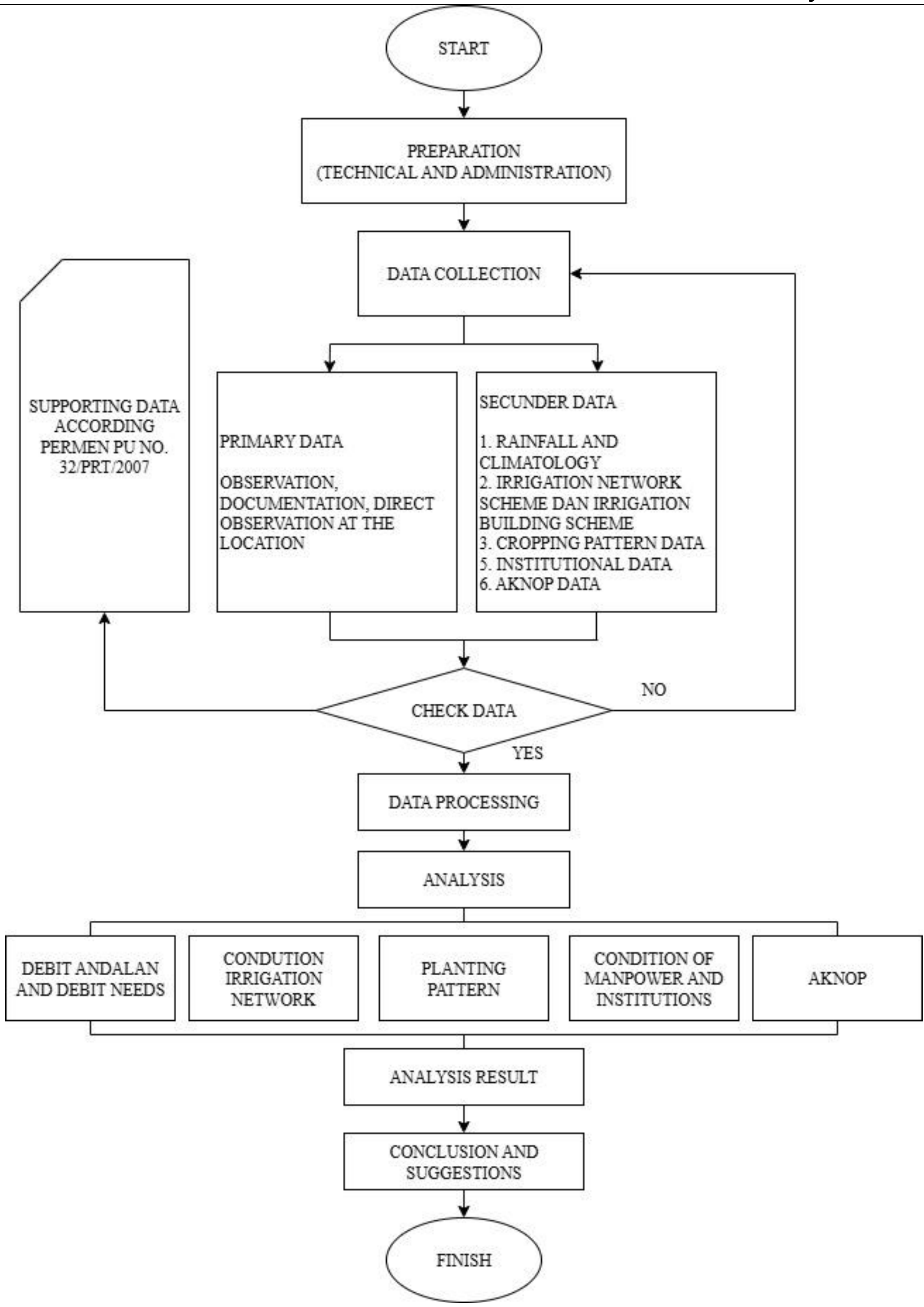

Figure 3. Research Path Diagram

Source: Data Processed, 2025

There are everal formulas are used in the analysis to calculate results, including:

Thiessen Polygon

This method requires a minimum of three rainfall stations, even if they are not evenly distributed. The Thiessen method produces more accurate results than simple algebraic averaging (Alchoiri, 2020).

Thiessen Polygon Formula:

$$R = \frac{A1R1 + A2R2 + A3R3 + \ldots + AnRn}{A1 + A2 + A3 \ldots + An}$$

Where :

R : Average rainfall (mm)

$R_1, R_2 . R_{3,\ldots,} R_n$: Rainfall at stations 1,2,3, n adalah jumlah titik – titik pengamatan

$A_1, A_2, A_{3,\ldots,} A_n$: Area of each polygon corresponding to each station

Reliable Discharge

$$R_{80} = n/5 + 1$$

Where :

R_{80} : Eliable monthly rainfall

n : Number of years observed

Potential Evaporation (Eto)

$$Etc = Kc \times Eto$$

Where :

Etc : Crop evapotranspiration (mm/day)

Eto : Eference evapotranspiration (mm/day), calculated using a modified planting method

Kc : Crop coefficient

Field Water Requirements

KAS = ”a ” x Area

Where :

KAS : Field water requiements

”a ” : Irrigation water requirements

Area : Planted Area

RESULTS

Thiessen Polygon

To construct a Thiessen polygon, a watershed map (DAS) is required. The Ciwaringin Weir diverts flow from a river with a length of 24.4 km.

Figure 4. Thiessen Polygon

Based on manual measurements of the watershed map using AutoCAD, rainfall data were sourced from three stations: Lame, Sindangpano, and Payung.

The following are the results of the Thiessen Polygon method applied to the largest catchment area:

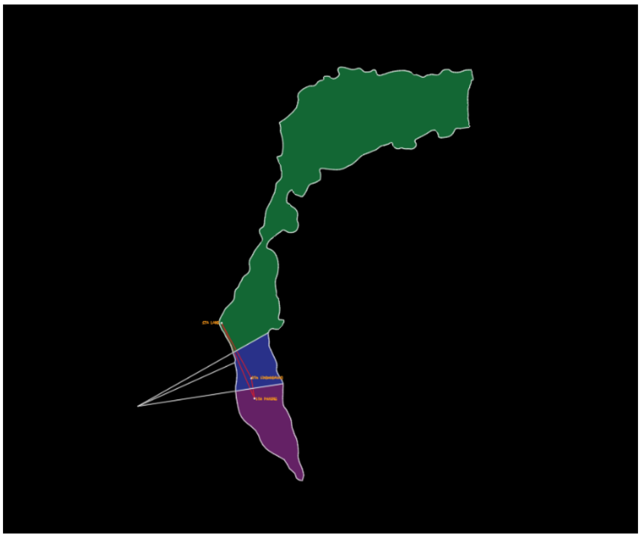

Table 1. Polygon's Impact

Station	Polygon 's Factor	
	Area (KM²)	**Percentage**
Lame	174,2	80,13%
Sindangpano	16,1	7,41%
Payung	27,1	12,47%
Total	217,4	100%

Source: Calculations Results, 2025

From the Thiessen Polygon analysis, the respective areas covered by each rainfall station are determined, with a total area of 217.4 km².

Hidrological Analysis

Table 2. Avarege Annual Rainfall for 3 (three) STA

YEAR	Rainfall Station (mm)		
	Lame	Sindangpano	Payung
2015	4336,46	6576,28	3506,05
2016	6132,92	5572,77	5981,15
2017	5251,44	4357,82	4148,52
2018	4585,78	5384,86	3308,50
2019	4330,57	5326,08	3488,70
2020	6709,96	4555,05	6866,11
2021	4822,77	5093,86	6127,53
2022	5599,16	6071,61	6007,38
2023	4434,58	6573,42	5201,88
2024	4644,06	5266,92	6868,69

Source: Calculations Results, 2025

Reliable Discharge Analysis

Before calculating the 80% dependable discharge (R80), the discharge values are sorted from highest to lowest (Susilowati & Yuhanda, 2024). The sorted data are used to determine the R80 value.

Table 3. 80% Semi-Monthly Debit

Month		Mainstay Debit Sequence (m3/second)									
		1	2	3	4	5	6	7	8	9	10
January	I	288,57	276,16	244,62	228,82	192,29	190,07	181,14	**180,31**	178,26	174,68
	II	397,89	325,14	244,64	225,04	207,31	171,69	162,74	**162,60**	158,22	118,23
February	I	316,24	280,23	263,19	244,96	244,95	228,08	211,17	**190,57**	108,96	106,82
	II	329,17	283,74	215,29	210,65	201,51	189,68	188,80	**186,58**	155,36	114,02
March	I	314,28	276,03	238,12	227,04	224,93	222,38	211,99	**185,35**	161,02	139,99
	II	216,77	192,55	169,26	167,32	164,40	163,75	143,39	**119,57**	115,45	95,99
April	I	246,14	206,71	195,00	182,33	167,67	164,65	132,63	**108,08**	106,72	77,18
	II	178,67	173,27	171,05	132,17	131,75	125,14	89,15	**83,93**	83,90	49,51
May	I	151,93	116,66	90,84	81,04	75,61	68,22	61,70	**35,40**	32,60	21,44
	II	146,62	140,02	123,10	63,64	53,66	52,23	51,61	**50,10**	30,91	20,85
June	I	91,86	78,09	76,16	62,63	45,97	45,77	32,21	**31,86**	28,55	16,05
	II	113,11	104,97	63,89	52,69	43,85	36,52	34,75	**33,32**	32,76	14,80
July	I	109,46	97,35	66,41	53,32	48,88	48,22	20,40	**20,27**	18,80	16,95
	II	70,64	61,05	55,77	54,36	37,88	24,86	23,85	**23,23**	18,59	16,80
August	I	56,10	45,83	37,72	36,57	30,70	27,70	24,33	**18,74**	17,03	14,73
	II	71,12	69,69	68,59	53,27	40,64	25,85	24,25	**23,24**	18,38	12,26
September	I	92,47	79,32	77,78	54,59	54,02	47,43	29,52	**23,01**	20,42	13,83
	II	187,58	109,62	91,11	82,83	68,73	61,86	54,26	**26,30**	22,70	14,28
October	I	167,25	156,77	132,10	131,64	121,93	96,41	94,36	**67,89**	53,49	43,87
	II	234,52	182,03	150,12	131,84	131,74	127,36	99,88	**93,75**	58,97	54,51
November	I	373,66	212,97	171,08	160,58	159,35	143,33	127,56	**95,47**	72,61	62,44
	II	346,86	235,33	209,88	165,10	151,23	137,88	111,25	**99,07**	92,70	80,25
December	I	239,85	226,35	198,65	176,57	171,91	168,06	158,44	**152,47**	151,61	144,70
	II	276,94	206,31	193,52	162,67	145,36	144,62	144,54	**130,60**	111,27	106,98

Source: Calculations Results, 2025

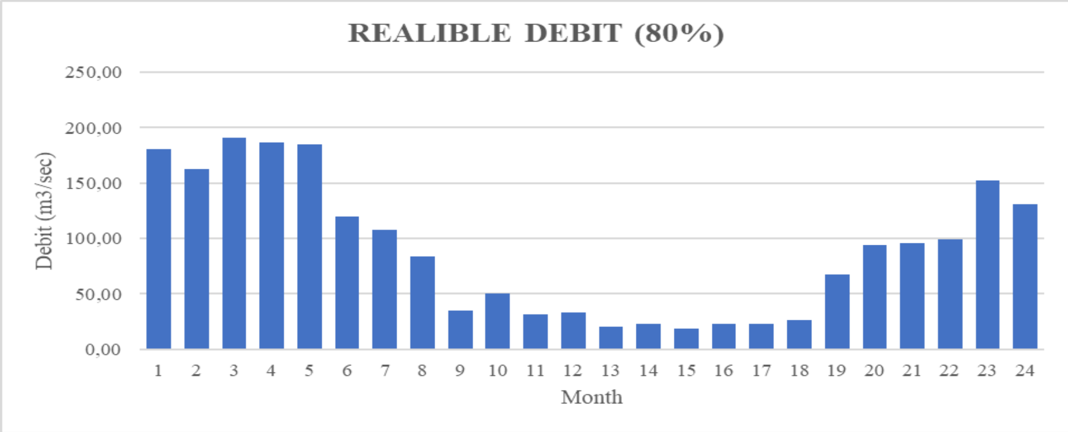

Figure 5. 80 % Half Debit Graph Monthly

Source: Data Processed, 2025

Potential Evaporasi (Eto)

Evaporation rates, transpiration rates, and evapotranspiration rates (mm/day) are used in the calculations (Febrian, 2023; Mindiastiwi et al., 2023; Taufik et al., 2023). The data required to calculate the value of evapotranspiration in a planned irrigation area (Andita & Lipu, 2020). Required climatological data include rainfall, humidity, solar radiation, wind speed, and air temperature (Panggabean et al., 2021).

Eto (mm/day) = c x Eto
= 1.10 x 4.03
= 4.43 mm/day
Furthermore, the calculations are shown in Table 4.

Tabel 4. Potential Evaporasi

Month	Eto (mm/day)
January	4,43
February	4,17
March	4,46
April	3,53
May	3,60
June	3,61
July	4,28
August	5,70
September	6,72
October	6,83
November	5,37
December	4,66

Source: Calculations Results, 2025

Water Requirements Analysis

Field preparation for paddy planting starts in December.
Selected location = 2 mm/day
Field preparation period (T) = 15 days

Saturation level = 250 mm

The net field water requirements (NFR) for rice is calculated as:

NFR = ETc + P + WLR + Re

= 5,59 + 2 + 0 + 15,66

= 22,31 mm/day

For secondary crops:

NFR = Etc – Re

= 4,28 – 3,60

= 0,69 mm/day

After obtaining the NFR for each crop type per year, irrigation water demand is determined using a total irrigation efficiency of 0.65. The formula is (Miftahul, 2022):

Irrigation water requirements = NFR / (Efficiency x 8,64)

= 29,42 / (0,85 x 8,64)

= 4,01 l/dtk/ha

Table 5. Irrigation Water Requirement

T YPES	PADDY	0,85
I	29,42	4,01
II	29,42	4,01
III	29,42	4,01
	SECONDARY CROPS	0,85
I	7,16	0,98
II	12,46	1,70
III	7,16	0,98

Source: Calculations Results, 2025

Field Water Requirement Calculation for 3 Crop Groups:

a. Land Preparation

KAS = “ a” (land preparation) x Area (ha)

= 0,86 x 170

= 146,04 l/dt

b. Planting, Growing, and Ripening Phase:

KAS = “ a” x Area (ha)

= 4,01 x 170

= 681,01 l/dt

Table 6. Water Requirement for 3 Planting Seasons

Planting Season	Month		Flow Requirement (m3/second)	Availability Flow (m3/second)
MT I	December	I	146,04	152470,35
		II	6014,11	130603,43
	January	I	18585,72	180319,01
		II	18585,72	162603,84
	February	I	18585,72	190573,63
		II	18585,72	186580,06

Planting Season	Month		Flow Requirement (m3/second)	Availability Flow (m3/second)
	March	I	18585,72	185349,93
		II	18585,72	119572,90
MT II	April	I	18148,83	108087,79
		II	6228.31	83937,17
	May	I	8739.51	35403,40
		II	8739.51	50108,06
	June	I	8739.51	31860,16
		II	8739.51	33321,05
	July	I	8739.51	20273,19
		II	8739.51	23232,30
MT III	August	I	4641.00	18741,47
		II	11414.98	23242,58
	September	I	12923.86	23016,31
		II	12923.86	26303,93
	October	I	12923.86	67890,54
		II	12923.86	93756,98
	November	I	12923.86	95470,67
		II	12923.86	99078,36
	December	I	12187.14	152470,35

Source: Calculations Results, 2025

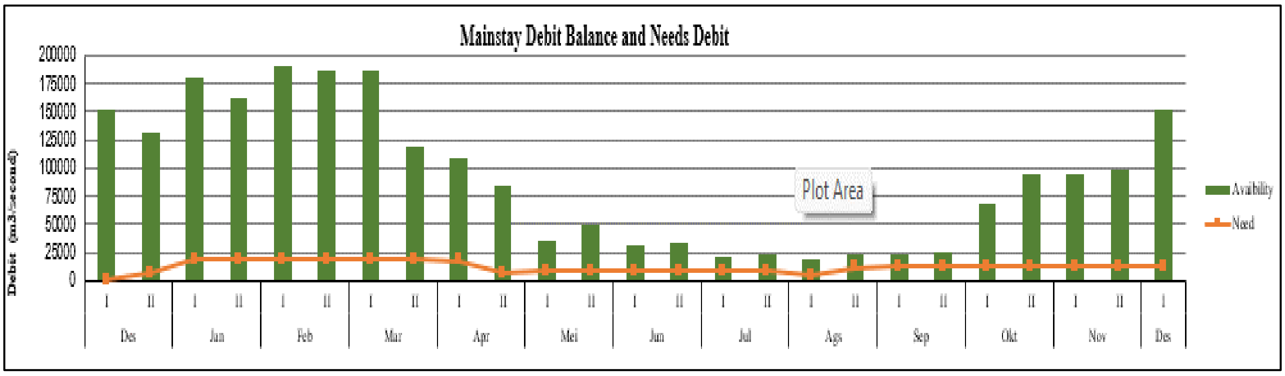

Figure 6. Water Balance Graph Based on Demand and Availability

Planting Pattern

The first planting season begins in early December, followed by a triple Paddy cropping pattern (Paddy – Paddy – Paddy) applied in the Ciwaringin Weir Irrigation Area. Farmers in this region cultivate paddy during all three planting seasons. This cropping pattern is used to optimize the abundant irrigation water supply and support food self-sufficiency throughout the rice-growing seasons.

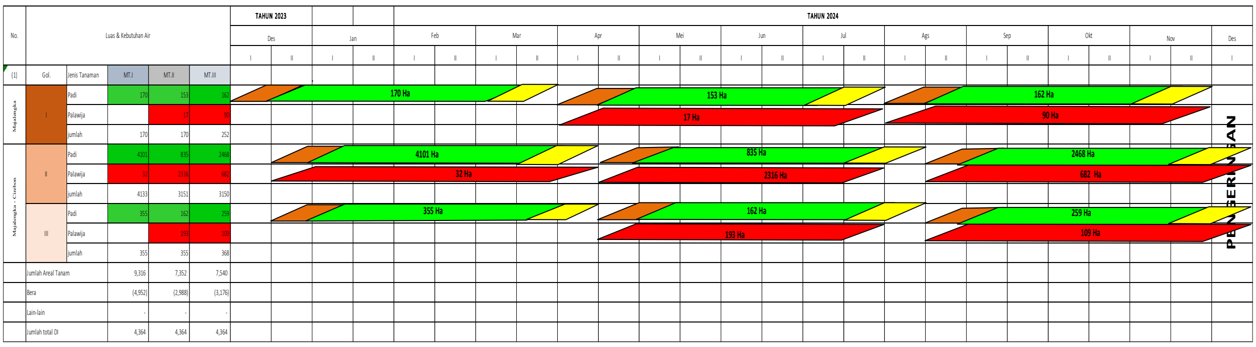

Figure 7. Planting Pattern in the Ciwaringin Weir Irrigation Area

Condition of the Irrigation Network

Table 7. Condition of Irrigation Channels

Channel	Volume (km)	Condition (%)				Function			Note
		Good	Slightly Damage	Moderately Damage	Severely Damage	Good	Moderate	Damage	
Primary									
Ciwaringin	8,03	5,48	1,53	0,28	0,73	68%	23%	9%	Good
Jasem	3,62	1,03	0,93	0,6	1,05	28%	42%	29%	Moderately Damage
Cidenok	3,4	1	0,75	0,9	0,75	29%	49%	22%	Moderately Damage
Secondary									
Nangka Pendek	2	0,5	0,3	0,2	1	25%	25%	50%	Severely Damage
Mirat	5,37	2,15	0,72	1,44	1,05	40%	40%	20%	Moderately Damaged
Muncang	2,06	1,04	0,11	0,15	0,75	50%	13%	36%	Moderately Damaged
Walini	5,54	1,4	2,1	0,54	1,5	25%	48%	27%	Moderately Damaged
Sawit	1,48	0,47	0,5	-	0,51	32%	34%	34%	Moderately Damaged
Leuweung Hapit	2,063	0,7	0,5	0,26	0,6	34%	37%	29%	Moderately Damaged
Kedung Kencana	4,19	1	1,49	0,95	0,75	24%	58%	18%	Moderately Damaged
Total	37,753	14,8	8,93	5,32	8,69	39%	38%	23%	Moderately Damaged
Average		2,69	1,624	1,064	1,58	36%	37%	27%	Moderately Damaged

Source: Calculations Results, 2025

Table 8. Condition of Ciwaringin Weir Structures

Structure Type	Volume (bh)	Condition (%)				Function (%)			Note
		Good	Slightly Damage	Moderately Damage	Severely Damage	Good	Moderate	Damage	
Main Structures									
Weir	1	1	-	-	-	100%	0%	0%	Good
Sluice Gate	5	3	-	-	2	60%	0%	40%	Moderately Damage
Distribution Regulator									
Divider Intake	2	-	2	-	-	0%	100%	0%	Good
Intake	17	2	9	-	6	12%	53%	35%	Moderately Damaged
Direct Intake	41	-	6	11	24	0%	41%	59%	Severely Damaged
Supplementary Structures									

Structure Type	Volume (bh)	Condition (%)				Function (%)			Note
		Good	Slightly Damage	Moderately Damage	Severely Damage	Good	Moderate	Damage	
Sluice Gate	8	-	-	8	-	0%	100%	0%	Good
Measurement Structure	10	2	-	7	1	20%	70%	10%	Moderately Damage
Drop Structure	4	1	2	1	-	25%	75%	0%	Good
Aqueduct	4	4	-	-	-	100%	0%	0%	Good
Culvert	19	-	2	17	-	0%	100%	0%	Good
Outlet	9	6	1	2	-	67%	33%	0%	Good
Drain	3	3	-	-	-	100%	0%	0%	Good
Supplement	19	-	8	11	-	0%	100%	0%	Good
Pedestrian Bridge	10	1	3	6	-	10%	90%	0%	Good
Village Bridge	11	-	8	3	-	0%	100%	0%	Good
Washing Spot	4	2	2	-	-	50%	50%	0%	Good
Total	167	25	43	66	33				
Average		2,5	4,3	7,3	8,25	34%	57%	9%	Good

Source: Calculations Results, 2025

Institutional and Human Resources

Table 9. On-Site Irrigation Management Personnel in Ciwaringin

Channel Name	Long	PERSONNEL																
		Waterman			POB			PPA			PPS			Amount			There is	Not Enough
	(Km)	Need	There is	Not Enough	Need	There is	Not Enough	Need	There is	Not Enough	Need	There is	Not Enough	Need	There is	Not Enough	%	%
Main	15,1	4	4	0	1	1	0	8	10	0	8	0	8	21	15	8	71%	38%
Secondary	22,7	0	0	0	0	0	0	11	12	0	9	0	9	20	12	9	60%	45%
Amount	37,775	4	4	0	1	1	0	19	22	0	17	0	17	41	27	17	66%	41%

Source: Calculations Results, 2025

From the analysis above, it is identified that the Ciwaringin Irrigation Area currently has 27 field personnel. However, the required number is 41. This indicates a 41% personnel shortage, which affects the overall service quality and condition of irrigation channels.

Actual Operation and Maintenance Requirement (AKNOP)

Table 10. Operation and Maintenance Cost at Ciwaringin Weir

Year	Management	Opration	Maintenance	Amount
2022	Rp 1.776.934.500,00	Rp 561.990.000,00	Rp 956.704.238,00	Rp 3.295.630.760,00
2023	Rp 2.135.057.000,00	Rp 117.266.100,00	Rp 1.163.127.782,00	Rp 3.415.452.905,00
2024	Rp 2.132.901.000,00	Rp 118.232.100,00	Rp 24.442.191.402,00	Rp 26.693.326.526,00

Source: Cimanuk – Cisanggarung River Region Grand Hall

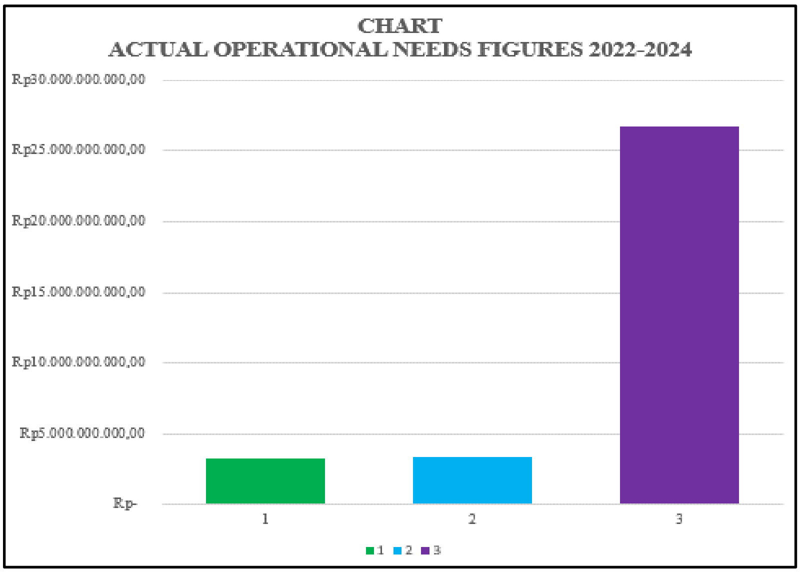

Figure 8. Graph of Needs Figures Real Operation and Maintenance

Based on the data, the 2024 operation and maintenance budget for the Ciwaringin Irrigation Area has increased significantly, suggesting that financial management in this area still needs improvement.

CONCLUSION

The analysis of the Ciwaringin Weir Irrigation Area shows that river discharge surpasses total water demand, supporting the triple paddy cropping pattern and contributing to national food self-sufficiency. However, 65% of the irrigation channels and structures are moderately to severely damaged, highlighting the need for regular maintenance. A 41% shortage in field personnel further hampers effective irrigation management, and the substantial increase in the 2024 operation and maintenance budget indicates suboptimal financial governance requiring improved allocation and oversight. Future research should focus on developing effective maintenance strategies, optimizing staffing levels, and enhancing budget management to ensure sustainable irrigation system performance.

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