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ANALYSIS OF THE SALAMDARMA IRRIGATION AREA PERFORMANCE

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ABSTRACT

Salamdarma weir is located right in the border area of Indramayu and Subang, belongs to administrative area of Anjatan District, Indramayu Regency. Managed by PT Jasa Tirta II Section of Patrol. This irrigation netwoork has a total service area of 35871 Ha, the service area includes Subang District and Indramayu District. The existence of Salamdarma irrigation network has an important role for the farmers especially during dry season to support the crops' growth.

In this research to analyze the performance used parameter from Permen No 11/PRT/M/2015 and calculated using Hydrology regulation from KP 01 Irrigation 2013.

The analysis result of this research show that 80,9% of structures and 95,1% of canals are in damaged condition with different various level of damage. Based on the calculation and comparison between potential discharge and water requirement, the potential discharge has fulfilled the irrigation water requirement and the comparison. The water requirement is 29890 lt/s and the potential discharge is 64074 lt/s. The human resources in Salamdarma irrigation there is only deficient in the head of branch position of 12%. For POB, PPA, PPS Personel amount has fulfilled the required amount of personel. The Operation and Maintenance budget in Salamdarma Irrigation is increased at 30,112% between 2016 to 2017.

Keyword : Irrigation, Salamdarma, Performance, Irrigation water requirement.

I. INTRODUCTION

1.1 BACKGROUND

Water is one of the important elements in human survival. In addition to support the daily needs of human's life, many fields of work done by human are related to water, one of the fields of work that require water as the main component is the sector of agriculture. Therefore to support the agricultural sector, water must be available in sufficient quantities and adequate quality. For the implementation it is required supporting facilities and infrastructure as well as good management to support the performance of the irrigation system optimally.

Salamdarma weir is located right in the border area of Indramayu and Subang, belongs to administrative area of Anjatan District, Indramayu Regency. it was built in 1927 during the Dutch colonial period and it is managed by PT Jasa Tirta II Section of Patrol. This irrigation netwoork has a total service area of 36168 Ha, but has experienced depreciation due to land conversion to 35871 Ha in 2018, the service area includes Subang District and Indramayu District. The existence of Salamdarma irrigation network has an important role for the farmers especially during dry season to support the crops' growth.

Several factors affect the performance of the salamdarma irrigation system such as sedimentation, damage to facilities and infrastructures resulting in irregular and inefficient irrigation water management, in other words, excessive use and use of water may occur in a tertiary block, whereas in other blocks there is water shortage. The decreased performance of the irrigation system can lead to less balanced between the available discharge and the required discharge. Thus the productivity of the agricultural sector becomes less maximal.

1.2 FORMULATION OF THE PROBLEM

Based on the description on the background, obtained formulation of the problem as follows :

1. Does the available discharge meet the required discharge?
2. How is the performance of Salamdarma irrigation area system?
3. How is the cropping pattern in Salamdarma irrigation area?

1.3 PURPOSE & OBJECTIVE OF THE RESEARCH

1. Purpose

The purpose of this analysis is to provide an overview and solutions in the problems that occur at the level of irrigation networks in Salamdarma irrigation area, to restore and optimize on its function.

2. Objective

The objective of Salamdarama irrigation area performance analysis are :

1. Knowing whether the available discharge meets the required discharge.
2. Knowing the performance of salamdarma weir irrigation area system.
3. Knowing the cropping pattern of salamdarma weir irrigation area system.

1.4 SCOPE OF THE RESEARCH

In order to focus to discussion in this research, here are the limitations of the problem in the thesis of analysis of salamdarma irrigation area performance :

1. The research is focus to the salamdarma irrigation field area.
2. The research doesn't calculate the dimension/ cross section of the canals.

1.5 FUNCTION OF THE RESEARCH

1. Theoretical Function

This research is expected could be an input of academic study that is useful in studying cases related to this research topic.

2. Practical Function

This research is expected to be an input for the relevant departement of irrigation management and utilization in an effort to optimize salamdarma irrigation area system performance and become an input to improve the procedure of management and utilization of the irrigation system

1.6 THINKING FRAMEWORK

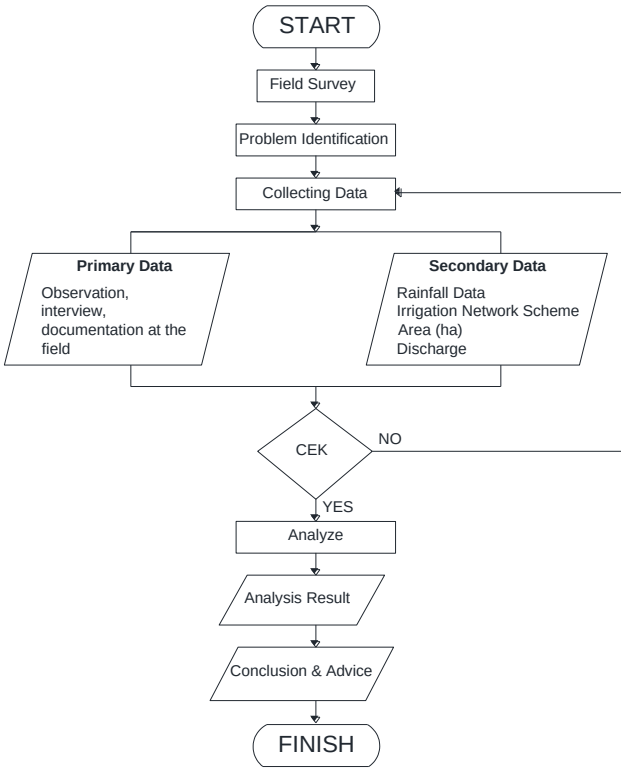


Figure 1. Thinking Framework

II. LITERATURE REVIEW AND THEORETICAL BASIS

2.1.PREVIOUS RELEVANT RESEARCH

1. Evaluation of Operation and Maintenance of Cangkuang Weir Babakan District Cirebon Regency (*Ade Joni Alfian, 2013. Swadaya Gunung Jati University)*
2. Department of Civil Engineering Faculty of Engineering Sriwijaya University (*Anton Priyonugroho Department of Civil Engineering Faculty of Engineering Sriwijaya University)*
3. Analysis of Water Allocation between Irrigation Area Ciwaringin And Walahar Irrigation Area In Majalengka Regency *(Riffan Jaya Hidayat, 2015 Swadaya Gunung Jati University)*

2.2.THEORETICAL BASIS

1. Irrigation

Irrigation is the artificial application of water to soil for the purpose of crop production. Irrigation water is supplied to supplement the available water from rainfall and the contribution to soil moisture from groundwater. In many areas of the world the amount and timing of rainfall are not adequate to meet the moisture requirement of crops and irrigation is essential to raise crops requirement to meet the needs of food and fibre. (A.M Michael).

Irrigation is generally defined as the artificial application of water to soil for the purpose of supplying the moisture essential for plant growth. (Israelson & Hensen 1940). However a broader and more inclusive definition of the term irrigation is the application of water to soil for any number of the following six purposes :

1. To add water to soil to supply the moisture essential for plant growth.
2. To provide crop insurance against short duation drought.
3. To cool the soil and atmosphere, thereby making more favourable environment for crop growth.
4. To wash out or dilute salts in the soil.
5. To reduce the hazard of soil piping.
6. To soften tillage pans. (big clods are soften for sowing)

In short, irrigation is the science of harnessing and controlling various natural sources of water for the benefit of agriculture. (US Walia and friends 2011).

2. Irrigation Water Requirement

The irrigation water requirement is the amount of water volume needed to meet evaporation requirement, water loss, water requirements for the plant by taking into account the amount of water provided by nature through rainfall and the contribution of groundwater (Sosrodarsono and Takeda, 2003).

Crops field water requirement for paddy is determined by the following factors:

1. Land preparation

Water requirements for land preparation generally determine the need for irrigation water on an irrigation project. Important factors that determine the amount of water requirement for land preparation are:

a. the length of time required to complete the land preparation work.
b. the amount of water needed for land preparation

The Important factors determining the length of the land preparation period are:

a. the availability of labor and the cultivators or tractors to work on the land
b. it is necessary to shorten the time period in order to provide sufficient time to plant the paddy rice or second field rice

These factors are interrelated, social conditions, cultures that exist in the rice growing area will affect the length of time required for land preparation. For new irrigation areas, the period of land preparation will be determined by the prevailing customs of the nearby areas. As a guideline is taken 1.5 months to complete the preparation of land throughout tertiary blocks.

If for the preparation of land is expected to be widely used equipment machine, then the period of preparation of land will be taken 1 month.

2. Consumptive use

Consumptive use is the amount of water used by plants for photosynthesis process. Consumptive water use is what plants need for evapotranspiration or evapotranspiration of reference crops (KP 01 Irrigation Design Standard 2013).

3. Percolation and seepage

The rate of percolation is highly dependent on soil properties. In heavy clay soil with good processing characteristics, percolation rate can reach 1-3 mm / day. On lighter soils, then percolation could be higher. From the results of agricultural land investigations and permeability investigations, the magnitude of percolation rates and the level of soil suitability for soil tillage can be established and recommended for use. In order to determine the rate of percolation, the water table height must also be calculated. The seepage occurs due to the absorption of water through the dike fields.

4. Substitution of water layer

Replacement of water layer is done after fertilization. Replacement of water coating is done according to need. If there is no such scheduling, do the replacement 2 times, each 50 mm (or 3.3 mm / day for 1/2 month) for a month and two months after the transplant.

5. Effective rainfall

Calculates effective rainfall for rice by 70% of R80 from time in a period while for effective rainfall of secondary crops is 50% and is associated with Table. Average monthly ET crops and average monthly rainfall (USDA (SCS), 1696)

3. Operation & Maintenance of Irrigation

According to Minister of Public Works Regulation no. 32 / PRT / M / 2007, it is explained that operation of irrigation networks is an effort to regulate irrigation water and its drainage, including the opening and closing of the irrigation structure gates, arranging the planting plan, preparing grouping system, preparing water distribution plan, carrying out gate/structure calibration, collecting data, monitoring and evaluating. while maintenance of irrigation network is an effort to maintain and preserve irrigation networks in order to always have proper function for facilitating the implementation of operations and maintain its sustainability.

Classification of the physical condition of irrigation networks will be shown in the following table :

Table 1. Classification of the physical condition of irrigation network

No	Condition	Damage Level (%)	Maintenance Recommendation
1	Good	<10	routine maintenance
2	Light damage	10-20	Periodic maintenance such as treatment
3	Moderate damage	21-40	Maintenance such as repair
4	Heavy damage	>40	heavy repairement or replacement

Source : Permen No. 12/PRT/M/2015

III. RESEARCH METHODOLOGY

3.1. RESEARCH LOCATION

Salamdarma weir is one of the weir in Indramayu Regency, located on the border area between Subang Regency and Indramayu Regency. Precisely located in the administrative area of Bugis Tua Village, Anjatan District, Indramayu Regency, West Java.

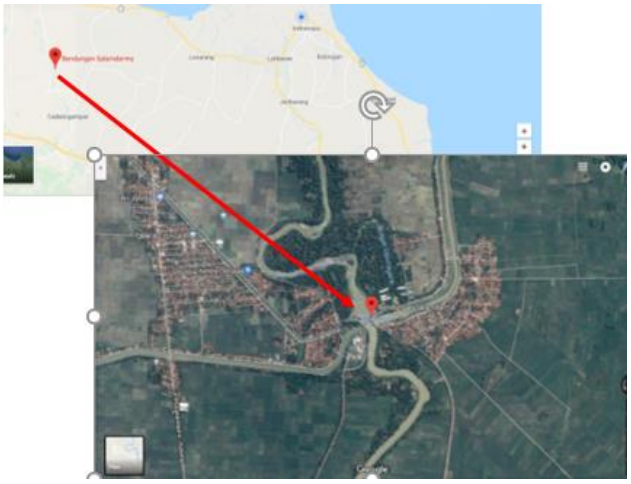


Figure 2. Research Location.

3.2. TYPE AND SOURCE OF DATA

1. Type of Data

   a. Primary Data

   Primary Data, is data in the form of verbal or spoken words orally, gestures or behaviors performed by a reliable subject, ie the subject of research or informants regarding the studied variables or obtained data from respondents directly (Arikunto, 2010: 22)

   b. Secondary Data

   Secondary data, is obtained data from data collection techniques that support primary data. In this research obtained from the observations made by the author as well as from literature studies. Can be said this secondary data can come from graphic documents such as tables, notes, SMS, photos and others (Arikunto, 2010: 22).

2. Source of Data

   a. Location of study.
   b. BMKG Jatiwangi, Citeko.
   c. PJT II.
   d. elements / agencies / institutions concerned

3.3. DATA ANALYSIS TECHNIQUE

1. Analysis of Physical Condition

An inventory of irrigation networks is carried out to obtain data on the number, dimensions, types, conditions and functions of all irrigation assets and water availability data, the value of irrigation network assets and service areas in each irrigation area. The inventory of irrigation networks is carried out annually in accordance with applicable provisions / guidelines. For maintenance activities of the inventory which is indispensable is the data condition of the irrigation network which includes damage data and its influence on the service area. (Permen Pu 32/PRT/M/2007.

Classification of physical condition of irrigation network as follows:

- Good condition if the damage level is at <10% from initial condition of structure / canal and required routine maintenance.
- Light damage condition if the damage level is at 10 - 20% from initial condition of structure / canal and required periodic maintenance that tend to treatment.
- Moderate damage if the damage level is at 21 - 40% from initial

condition of structure / canal and required meintenance that tend to repair.

- The condition is severely damaged if the damage level is at >40% from the initial condition of the structure / canal and required heavy repair or replacement.

(Permen 12/PRT/M/2015)

2. Analysis of Hydrology

- Rainfall

In this research, the method used in the calculation of the average rainfall area of the watershed (DAS) is Thiessen polygon method.

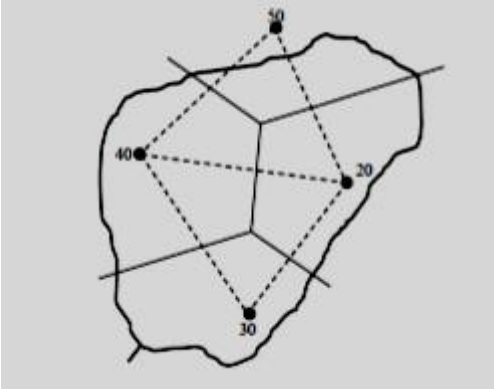


Figure 2. Polygon *Thiessen* Method (Triatmodjo, 2008)

The thiessen method takes into account the weight of each station that represents the area around it. In an area within the watershed it is assumed that the rain is the same as that at the nearest station, so that the recorded rain on a station represents that area. This method is used when the deployment of rain stations in the area under review is uneven. Thiessen polygon calculation as in the equation as below:

$$P = \frac{P_1A_1 + P_2A_2 \ldots + P_nA_n}{\sum A}$$

Information :

P = Regional Rainfall Average

P1,P2,Pn = Rainfall at station 1,2,n

A1,A2,An = Area of the station 1,2,n

To complete the rainfall data, in 1958 Linsley, Kohler and Paulus suggested a method called "Normal Ratio Method" as follows:

$$Px = \frac{1}{n}\left(\frac{P1}{N1}Nx + \frac{P2}{N2}Nx + \frac{P2}{N2}Nx \ldots + \frac{Pn}{Nn}Nx\right)$$

Information:

Px= Estimated rainfall at station X

Nx = Number of Stations Around Station x

P1 P2 P3 Pn = Rainfall Data at the station during the same period

Nx = Amount of annual Rain at station X in the previous year

N1 N2 N3 Nn = Annual Rain at around station x in the previous year

- Effective Rainfall (Re)

Effective rainfall is determined the amount of R80 which is the rainfall whose magnitude can be exceeded by 80% or in other words exceeded 8 times the incidence of 10 events. so that the smaller rainfall value of R80 has a probability of only 20% (R80 rainfall). By using Basic Year with the formula:

R80 = n / 5 + 1

n = years number of observation

- Dependable Flow

According to KP 01 Irrigation Planning 2013, the dependable flow is the minimum river flow for a prescribed predetermined probability that can be used for irrigation. The probability of being fulfilled is set at 80% (the probability that the river flow is lower than the dependable flow is 20%).

80% dependable flow is determined in the following way:

m = 0,2 x n (Basic Year Method)

Information :

m = sequence of the year used as dependable flow

n = number of years of observation

- Irrigation Water Requirement

Water Requirement in Rice Fields Based on planting plan, crop water requirement, and water loss in channel. Water Requirement in Rice Field formulated:

KAS = Plant Area x Coefficient

The water requirement coefficient on the canals is as follows:

Tertiary water requirement coefficient : 1.25
Secondary water requirement coefficient : 1.10
Tertiary water requirement coefficient : 1.05

Table 2. Coefficient Paddy

No	Desc	Time (Month)	Water Requirement (L/s/Ha)
1	Land Preparation	0,5	1,20
2	Plant	0,5	1,00
3	Growth	2	0,80
4	Harvest	1	0,20
Amount		**4**	**3,20**

Source : Dirjen pengairan, Bina program PSA 010, 1985

- Analysis of Cropping pattern and Grouping System

In order to meet water requirement for crops, the determination of cropping patterns is a matter to consider. The table below is an example of a usable cropping pattern.

Table 3. Cropping Pattern

Water Availability for Irrigation	Croppig Pattern in One Year
plenty of water available	paddy-paddy-secondary crop
available enough water	paddy-paddy-bera paddy-secondarycrop-secondarycrop
tend to lack of water	paddy-secondarycrop-bera secondarycrop-paddy-bera

Source : S.K. Sidharta, Irigasi dan Bangunan Air, 1997.

- Analysis of institutional and Human Resources

In institutional analysis and human resources it is indicated to know the available human resources in the irrigation network management institution complying with the regulations stated in Permen 12 / PRT / M / 2015, Requirements of Operations & Maintenance Personnel:

a. Head of branch / observer / UPTD / branch office / korwil: 1 person + 5 staff per 5.000 – 7.500 Ha.
b. Irrigation worker (Mantri/Juru): 1 person per 750 – 1.500 Ha.
c. Weir Operation Personnel (POB): 1 person per weir, can be added some personnels for large weir.
d. Water Supply Officers (PPA): 1 person per 3 - 5 off-take structure and division structure for the canal spaced between 2-3 km or 150 to 500 ha service area.
e. Canal Personnel (PS): 1 person per 2-3 km canal length.

- Analysis of Operation of Maintenance Budget

Based on Minister of Public Works PU Regulation. No.32 / PRT / M / 2007 concerning Operation and Maintenance Guidance of Irrigation Network stated that each activity proposal should be based on the calculation of Real Operation and Maintenance (AKNOP) needs, where the implementation of AKNOP is a real cost proposal that is needed in an irrigation area because in the implementation must conduct a survey to the field directly by collecting assets one by one in detail both irrigation facilities and infrastructure. (Minister of Public Work PU No.32 / PRT / M / 2007).

IV. RESEARCH RESULT AND DISCUSSION

4.1. ANALYSIS RESULT

1. Analysis of Physical Condition

Table 4. Irrigation Structures Condition

No	Irrigation Structures	Amount (Pc)	Average Conditio	Damage Level			
				<10%	10-20%	21-40%	>40%
				Good	Light damage	Intermediate	heavy damage
Headworks							
1	Weir	1	65.00			1	
2	Scouring Sluice	3	83.33		2	1	
3	Intake Gate	6	90.00	6			
Structures							
4	Main Division Structure	1	95.00	1			
5	Division Off-take Structure	112	72.23	22	28	56	6
6	Off-take Structure	16	73.75	3	3	9	1
7	End Structure	36	68.06	4	8	19	5
10	Bridge	12	73.33		6	5	1
11	Syphon	8	70.63	2		5	1
12	Aqueduct	4	71.25	-	2	2	
	TOTAL AMOUNT	199		**38**	**49**	**98**	**14**
	TOTAL AVERAGE		76.26				

Source : PJT II

Table 5. Irrigation Canals Condition

No	Irrigation Canals	Amount (Pc)	Average Condition (%)	Damage Level			
				<10%	10-20%	21-40%	>40%
				Good	Light damage	Intermediate	heavy damage
1	Primary Canal	1	90.00	1			
Secondary Canal							
1	SS. Pamanukan	1	75.83			1	
2	SS. Wates	1	80.00		1		
3	SS. Sukanagara	1	65.00			1	
4	SS. Ratug	1	65.00			1	
5	SS. Pakandangan	1	85.00				
6	SS. Gempol	1	80.00		1		
7	SS Karang Anyar	1	70.00			1	
8	SS. Patimban	1	65.00			1	
9	SS. Curug Jati	1	75.00			1	
10	SS. Cigugur	1	80.00		1		
11	SS. Rangdu	1	85.00		1		
12	SS. Pangarengan	1	75.91			1	
13	SS. Sukra	1	85.83		1		
14	SS. Bogor	1	80.00		1		
15	SS. Liang Buaya	1	80.00		1		
16	SS. Ujung Gebang	1	80.00		1		
17	SS. Anjatan	1	75.83			1	
18	SS. Sukatani	1	72.50			1	
19	SS. Plawad	1	85.00		1		
20	SS. Konca	1	80.00		1		
21	SS. Bugel	1	83.75		1		
22	SS. Mangsetan	1	70.00			1	
23	SS. Patrol	1	72.00			1	
24	SS. Ujung Ori	1	85.00		1		
25	SS. Tengah	1	85.00		1		
26	SS. Eretan	1	77.92			1	
27	SS. Penanggul	1	90.00	1			
28	SS. Maung	1	80.00		1		
29	SS. Jamban Ketos	1	90.00	1			
30	SS. Babakan Plawad	1	70.00			1	
31	SS. Kandanghaur	1	85.00		1		
32	SS. Wanguk	1	85.00		1		
33	SS. Bongas	1	72.00			1	
34	SS. Tundagan	1	70.56			1	
35	SS. Margamulya	1	85.00		1		
36	SS. Gabus	1	70.00			1	
37	SS. Curug	1	74.44			1	
38	SS. Kali Asin	1	75.00			1	
39	SS. Pranti	1	90.00	1			
	Amount (Sec. Canals)	**39**		**3**	**18**	**18**	**0**
	Average (Sec. Canals)		**78.31**				
Drainage Canal							
1	SUB SI. Bugis	2	32.50	-	-	-	2
2	SUB SI. Pusakanagara	17	72.94	1	9	7	-
3	SUB SI. Sukra	7	65.00	-	-	7	-
4	SUB SI Anjatan & Eretan	32	58.13		4	-	28
5	SUB SI Gabuswetan	4	66.25	-	2	-	2
	Amount (Drainage Canals)	**62**		**1**	**15**	**14**	**32**
	Average (Drainage Canals)		**65.58**				
	TOTAL AMOUNT	**102**		**5**	**33**	**32**	**32**

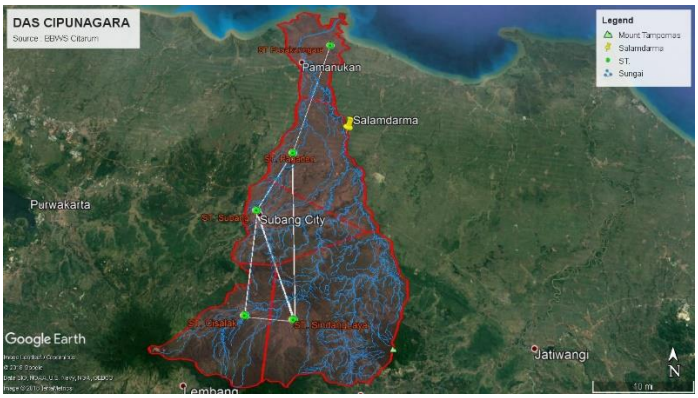
Source : PJT II

From the condition of structures and canals above, there are only 19,10% of structures that in good condition with total average condition is 76,26%, there are 4,90% of canals that in good condition with total average condition of secondary canals is 78,31% and total average condition of drainage canals is 65,58%. The damage that occurred in most structures is due to age factor and the damage that occurred in most canals is due to sedimentation and garbage factor. Therefore, the damage that occurred in the structures and canals could have a major impact on the decrease of salamdarma irrigation network function, it could inhibit the distribution of irrigation water from main structure (weir) to the tertiary blocks because the structures and canals function has decreased due to the damage, for example the discharge that should be distributed to a particular tertiary block could not be distributed optimally to the tertiary block because the division/offtake structure is damaged.

2. Analysis of Hydrology

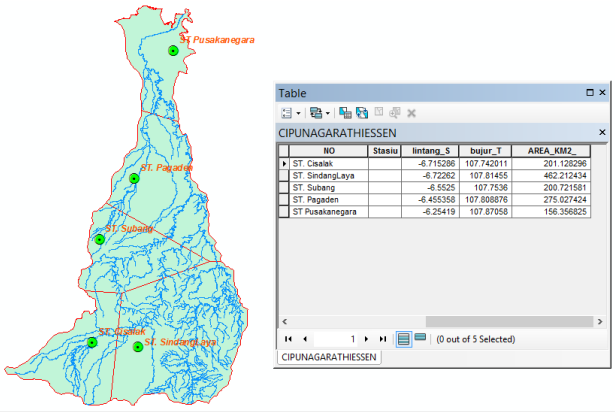
- Rainfall

Polygon thiessen result in Cipunagara watershed.



Source :BBWS Citarum;Google Earth.

Figure 3. Watershed (DAS) Cipunagara



Source: ArcGIS 10.3 Calculation

Figure 4. Polygon thiessen

Table 6. Polygon Area

NO	Rainfall Station	Area (km²)
1	Cisalak	201.1283
2	SindangLaya	462.2124
3	Subang	200.7216
4	Pagaden	275.0274
5	Pusakanegara	156.3568
	Total	1295.4466

Table 7. Average Rainfall Area

NO	YEAR	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	
1	1998	82	95	100	66	93	93	105	52	72	42	30	33	41	22	6	22	5	0	20	78	125	106	98	
2	1999	86	164	176	69	74	68	76	41	67	8	45	0	40	1	0	0	0	4	17	56	124	190	63	1
3	2000	110	311	105	79	91	110	77	82	55	46	53	47	6	11	10	6	23	17	39	138	93	197	65	
4	2001	76	82	128	75	72	79	72	75	31	43	87	12	17	1	0	24	8	0	74	35	66	200	66	
5	2002	128	317	267	180	84	94	138	63	116	4	7	0	62	46	2	0	2	2	15	24	64	141	66	1
6	2003	91	136	182	86	93	78	85	32	111	38	25	6	12	4	2	0	20	28	61	41	73	117	105	1
7	2004	240	159	328	263	135	113	14	34	48	46	77	33	12	14	2	0	23	6	20	39	81	111	79	1
8	2005	112	190	141	106	106	125	107	33	33	38	12	27	22	20	13	1	0	0	26	84	92	90	153	1
9	2006	224	300	97	100	167	129	145	67	106	81	63	65	13	32	9	17	35	47	58	71	101	107	82	1
10	2007	133	178	375	159	171	100	79	90	46	42	16	70	0	4	0	3	0	22	42	84	108	103	118	1
11	2008	170	149	202	120	217	209	172	153	152	36	37	0	0	0	2	38	17	0	60	17	153	168	300	1
12	2009	112	186	196	202	228	138	67	72	36	136	106	36	1	3	0	7	0	7	92	40	107	226	116	1
13	2010	159	228	165	149	225	122	26	109	81	83	47	23	12	13	18	50	101	69	97	54	268	152	118	1
14	2011	72	75	89	62	67	118	166	163	127	83	40	27	22	0	0	0	0	0	31	90	203	141	178	2
15	2012	150	111	238	114	98	138	261	67	120	23	82	14	0	0	0	2	16	16	46	56	225	130	2	
16	2013	168	244	244	82	153	292	257	192	85	234	124	67	155	69	18	2	38	4	60	65	115	128	228	1
17	2014	186	418	147	155	265	127	169	143	31	56	61	73	21	77	12	0	1	14	50	77	105	121	100	2
18	2015	75	313	194	133	159	221	183	98	92	15	7	2	6	0	0	0	4	0	22	2	99	83	197	1
19	2016	152	226	341	202	260	244	209	180	73	162	164	181	61	145	116	112	124	249	196	231	207	181	154	
20	2017	93	161	157	173	216	217	196	129	86	13	61	55	6	29	2	3	0	65	98	194	233	180	122	1

Source : Calculation

: Data with example calculation

Jan I 2017 :

P1= 92 A1= 201,128 St Cisalak

P2= 101 A2= 462,212 St SindangLaya

P3= 168 A3= 200,722 St Subang

P4= 52 A4= 275,027 St Pagaden

P5= 50 A5= 156,357 St Pusakanegara

∑A = 1295,447

Thiessen Formula :		
P =	P1.A1.+P2.A2+P3.A3+P4.A4+P5.A5	=
	∑A	

((92 x 201,128)+(101 x 462,212)+(168 x 200,722)+(52 x 275,027)+(50 x 156,357))

1295,447

= 93 mm/15day

From the result of polygon thiessen formula, the averaga rainfall area of DAS Cipunagara for **Jan I 2017** is **93 mm/15days** (Example Calculation).

- Effective Rainfall

Table 8. Sorted Rainfall Data

NO	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	
1	93	161	157	173	216	217	196	129	86	13	61	55	6	29	2	3	0	65	98	194	233	180	122	1
2	98	164	176	69	74	68	76	41	67	8	45	0	40	1	0	0	0	4	17	56	124	190	63	1
3	105	52	72	42	30	33	41	22	6	22	5	0	20	78	125	106	98							
4	72	76	41	67	8	45	0	40	1	0	0	0	4	17	56	124	190	63	1					
5	77	82	55	46	53	47	6	11	10	6	23	17	39	138	93	197	65							
6	72	75	31	43	87	12	17	1	0	24	8	0	74	35	66	200	66							
7	138	63	116	4	7	0	62	46	2	0	2	2	15	24	64	141	66	1						
8	85	32	111	38	25	6	12	4	2	0	20	28	61	41	73	117	105	1						
9	14	34	48	46	77	33	12	14	2	0	23	6	20	39	81	111	79	1						
10	107	33	33	38	12	27	22	20	13	1	0	0	26	84	92	90	153	1						
11	167	129	145	67	106	81	63	65	13	32	9	17	35	47	58	71	101	107	82	1				
12	79	90	46	42	16	70	0	4	0	3	0	22	42	84	108	103	118	1						
13	172	153	152	36	37	0	0	0	2	38	17	0	60	17	153	168	300	1						
14	67	72	36	136	106	36	1	3	0	7	0	7	92	40	107	226	116	1						
15	109	81	83	47	23	12	13	18	50	101	69	97	54	268	152	118	1							
16	261	67	120	23	82	14	0	0	0	2	16	16	46	56	225	130	2							
17	257	192	85	234	124	67	155	69	18	2	38	4	60	65	115	128	228	1						
18	169	143	31	56	61	73	21	77	12	0	1	14	50	77	105	121	100	2						
19	183	98	92	15	7	2	6	0	0	0	4	0	22	2	99	83	197	1						
20	209	180	73	162	164	181	61	145	116	112	124	249	196	231	207	181	154							

Source : Calculation

R80 = n/5 +1 = 20/5 +1 = 5 (Data Number 5) (Basic Year Method)

From May II-Oct I = Max Rainfall x 0,2
= 234 x 0,2
= 47 (May II)

- Discharge Analysis

Potential Discharge

Table 9. Potential Discharge

RAINFALL VOLUME 2 WEEKLY DAS CIPUNAGARA				
DAS Area	1295.4466 km2		1295446600 m2	
MONTH	**Rainfall R80% (m)**	**Volume (m^3)**	**Q (m^3/s)**	**Q (l/s)**
January I	0.00576	7458884	86.330	86330
January II	0.00909	11773404	136.266	136266
February I	0.00851	11019802	127.544	127544
February II	0.00526	6819240	78.926	78926
March I	0.00608	7870282	91.091	91091
March II	0.00626	8111110	93.879	93879
April I	0.00510	6605162	76.449	76449
April II	0.00347	4489854	51.966	51966
May I	0.00305	3957215	45.801	45801
May II	0.00312	4046098	46.830	46830
June I	0.00219	2838007	32.847	32847
June II	0.00241	3118314	36.092	36092
July I	0.00207	2682367	31.046	31046
July II	0.00193	2499021	28.924	28924
August I	0.00154	2001396	23.164	23164
August II	0.00150	1939072	22.443	22443
September I	0.00165	2140608	24.776	24776
Septembber II	0.00332	4296935	49.733	49733
October I	0.00261	3387446	39.207	39207
October II	0.00261	3381934	39.143	39143
November I	0.00541	7010829	81.144	81144
November II	0.00713	9233108	106.865	106865
December I	0.00527	6827146	79.018	79018
December II	0.00722	9357495	108.304	108304
Average		**5,536,030**	**64.074**	**64,074.427**

Source : Calculatio

Rainfall (m) : R80% / 1000 /15
Volume : Rainfall (m) x DAS Area(m^2)
Q (m^3/s) : Volume (m^3) / 86400 s
Q (l/s) : Q (m^3/s) x 1000

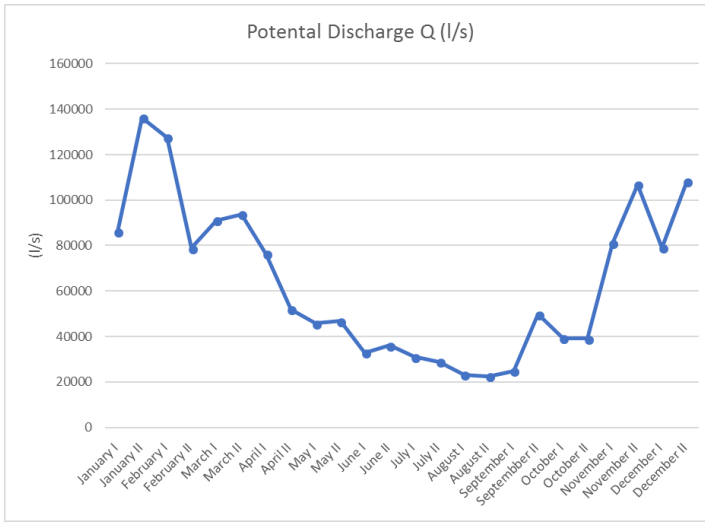


Figure 5. Potential Discharge Graphic

- Irrigation Water Requirement

Example Calculation Nov 1
KAS = SKA x Area = 1,2 l/s.ha x 19405 ha = 23286 l/s
KAS tertiary = 1,25 x 23286 =29107 l/s
KAS Secondary = 1,10 x 29107 = 32018 l/s
KAS Primary = 1,05 x 32018 = 33619 l/s
Crop water requirement = 33619 l/s

Total amount =
crop water requirement + Water Req Industry + Water Req Etc
33619 + 100 + 50 = 33769 l/s

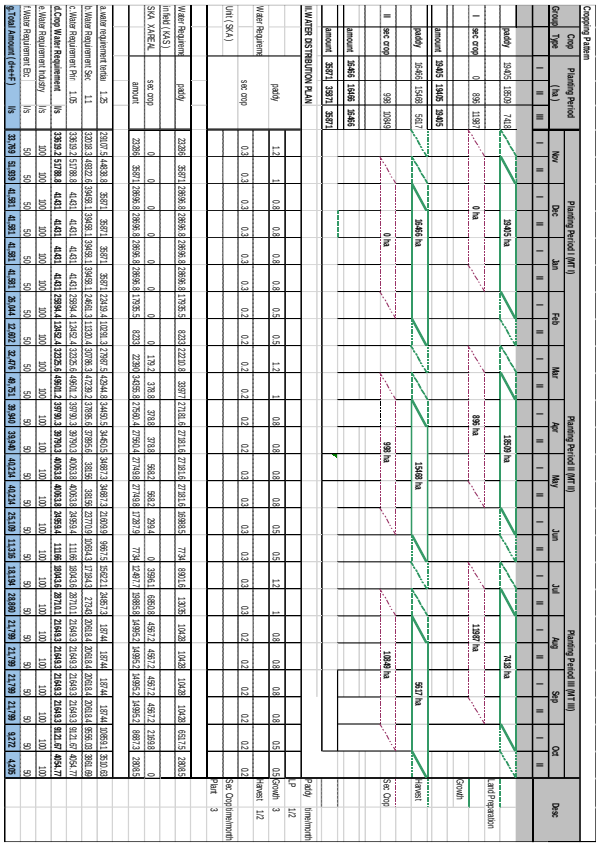


Table 11. Resume Water Requirement half-monthly

Planting Periode	MONTH	Periode	Water Requirement (lt/s)
MT I	NOV	I	33769
		II	51939
	DEC	I	41581
		II	41581
	JAN	I	41581
		II	41581
	FEB	I	26044
		II	12602
MT II	MAR	I	32476
		II	49751
	APR	I	39940
		II	39940
	MAY	I	40214
		II	40214
	JUN	I	25109
		II	11316
MT III	JUL	I	18194
		II	28860
	AGT	I	21799
		II	21799
	SEP	I	21799
		II	21799
	OCT	I	9272
		II	4205
AVERAGE			29890

Source : Calculation

Table 10. Water Requirement Calculation

Table 12. Resume Water Requirement & Potential Discharge

MONTH	Water Requirement (l/s)	Potential Discharge (l/s)
January I	41581	86330
January II	41581	136266
February I	26044	127544
February II	12602	78926
March I	32476	91091
March II	49751	93879
April I	39940	76449
April II	39940	51966
May I	40214	45801
May II	40214	46830
June I	25109	32847
June II	11316	36092
July I	18194	31046
July II	28860	28924
August I	21799	23164
August II	21799	22443
September I	21799	24776
Septembber II	21799	49733
October I	9272	39207
October II	4205	39143
November I	33769	81144
November II	51939	106865
December I	41581	79018
December II	41581	108304
Average	29890	64074

Source : Calculation

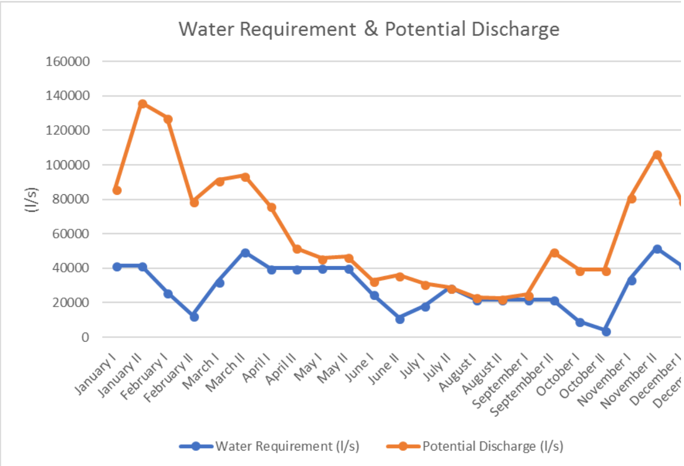


Figure 6. Water Requirement and Potential Discharge

From the result of water requirement compared to potential discharge that is available in Salamdarma Irrigation, the average of water requirement is 29890 l/s and the average of potential discharge is 64074 l/s , it can be concluded that the potential discharge has fulfilled the requirement water in salamdarma irrigation area

- Analysis of Cropping Pattern and Grouping System

The cropping pattern is arranged based on the availability of the water in irrigation network, from the comparison between potential discharge and water requirement in Salamdarma irrigation area, the potential dicharge has met the requirement water, so it can be concluded that Paddy-Paddy-Palawija (Secondary Crop) that supposed for the irrigation network that has plenty of water available is suitable to be used in Salamdarma irrigation network, because salamdarama irrigation has plenty of water available to support the water requirement based on comparison between potential discharge and water requirement

Salamdarma irrigation has service area of 35871 Ha of field, based on KP 01 Irrigation Design Standard 2013 (Page 179), the irrigation networks that has service area more than 25000 Ha needed to be divided into some groups (grouping system), grouping system has function to reduce peak-taking demand of irrigation water. In Salamdarma irrigation the grouping system divided into 2 groups of planting period, the first grouping system starts at Nov I and the second grouping system start at Nov II

- Analysis of Institutional and Human Resources

Table 13. Institutional and Human Resources

No	Chanel Name	Length	Areal	PERSONEL																				Ket
				Head of Branch + Staff			Mantri/Juru			POB			PPA			PS			Amount			Available	Deficient	
		(Km)	(Ha)	Required	Available	Deficient	Required	Available	Deficient	Required	Available	Deficient	Required	Available	Deficient	Required	Available	Deficient	Required	Available	Deficient	%	%	
1	SI Bugis	6.86	457	1+5 Staff	1+3 Staff	2 staff	1	1	0	2	2	0	3	3	0	4	4	0	16	14	2	87.50	12.50	
2	SI Pusakanagara	67.32	11640				8	8	0	-	-	-	24	24	0	23	23	0	55	55	0	100.00	0.00	
3	SI Sukra	36.15	4443				5	5	0	-	-	-	10	10	0	14	14	0	29	29	0	100.00	0.00	
4	SI Anjatan-Eretan	60.55	10068				7	7	0	-	-	-	21	21	0	22	22	0	50	50	0	100.00	0.00	
5	SI Gabuswetan	57.06	9263				9	9	0	-	-	-	20	20	0	29	29	0	58	58	0	100.00	0.00	
	Jumlah	227.94	35871				4	3	1	2	2	0	27	27	0	27	27	0	208	206	2			
	Rata-rata																							

Source : PJT II Patrol

12/PRT/M/2015 :

a. Head of branch / observer / UPTD / branch office / korwil: 1 person + 5 staff per 5.000 – 7.500 Ha.

b. Irrigation worker (Mantri/Juru): 1 person per 750 – 1.500 Ha.

c. Weir Operation Personnel (POB): 1 person per weir, can be added some personnels for large weir.

d. Water Supply Officers (PPA): 1 person per 3 - 5 off-take structure and division structure for the channel spaced between 2-3 km or 150 to 500 ha service area.

e. Channel Personnel (PS): 1 person per 2-3 km channel length.

From the analysis table above, there's 12,50% defficient in Head of Branch Human Resources, the other personel has fulfilled the requirement amount of personels, so it can be concluded that the condition of institutional and

human resources in Salamdarma irrigation area is in good condition based on the amount of personel it has met the required personel amount referred to parameter from 12/PRT/M/2015.

- Analysis of Operation and Maintenance Budget

Table 14. O & M Budget

NO	YEAR	RKT	OPERATION BUDGET	MAINTENANCE			TOTAL
				SPAREPARTS BUDGET	MAINTENANCE BUDGET	ROUTINE MAINTENANCE	
1	2016	I	Rp15,000,000.00	Rp10,000,000.00	Rp400,000,000.00		Rp425,000,000.00
2		II	Rp10,000,000.00	Rp7,000,000.00	Rp360,000,000.00		Rp377,000,000.00
3		III	Rp16,000,000.00	Rp3,000,000.00	Rp400,000,000.00	Rp15,000,000.00	Rp434,000,000.00
4		IV	Rp16,000,000.00		Rp690,000,000.00	Rp15,000,000.00	Rp721,000,000.00
						ANNUAL O&P	Rp1,957,000,000.00
5	2017	I	Rp16,000,000.00	Rp7,000,000.00	Rp250,000,000.00	Rp150,000,000.00	Rp423,000,000.00
6		II	Rp16,000,000.00	Rp7,000,000.00	Rp1,145,000,000.00	Rp150,000,000.00	Rp1,318,000,000.00
7		III	Rp16,000,000.00	Rp7,000,000.00	Rp705,000,000.00		Rp728,000,000.00
8		IV	Rp15,000,000.00	Rp7,000,000.00	Rp309,200,000.00		Rp331,200,000.00
						ANNUAL O&P	Rp2,800,200,000.00

From the result analysis of O&M Budget, in 2016 the O&M has total value budget of Rp1,957,000,000.00. while in 2017 the total O&M budget value of Rp2,800,200,000.00. The O&M budget between 2016-2017 is increased by 30.112%. as the increased of O&M it can be indicator the maintenance of the structure and canals must be optimized due to the damage of the structures and canals, so it can be optimize the function of Salamdarma irrigation network. between 2016-2017 6 structures have been fixed.

V. CONCLUSION AND RECOMMENDATION

5.1. CONCLUSION

1. The condition of structures and canals in Salamdarma Irrigation network. There are 19,10% of structures are in good condition with total average condition is 76,26%. 4,90% of canals are in good condition with total average condition of secondary canals is 78,31% and total average condition of drainage canals is 65,58%. The damage that occurred in most structures is due to age factor and the damage that occurred in most canals is due to sedimentation and garbage factor. The damage that occurred in the structures and canals could have an impact on the decrease of salamdarma irrigation network function, it could inhibit the distribution of irrigation water to the tertiary blocks because the structures and canals function has decreased due to the damage, for example the discharge that should be distributed to a particular tertiary block could not be distributed optimally to the tertiary block because the division/offtake structure is damaged. The right handling should be implemented immediately to optimize and restore its performance.
2. The Water Requirement, and Potential Discharge in Salamdarma : The average of water requirement is 29890 lt/s, The average of potential disharge is 64074 lt/s.
3. Based on the comparison between potential discharge and water requirement, the potential discharge has fulfilled the irrigation water requirement for agricultural sector using paddy-paddy-secondary crop pattern, the cropping pattern suitable based on the available of irrigation water in Salamdarma.
4. The human resources in Salamdarma irrigation there is only deficient in the head of branch position of 12%. For POB, PPA, PPS Personel amount has fulfilled the required amount of personel. This is calculated based on parameter on Permen 12/PRT/M.2015.
5. The Operation and Maintenance budget in Salamdarma Irrigation is increased at 30,112% between 2016 to 2017. The fund is budgeted every 3 months, in 2016 the total budget for a year is Rp1,957,000,000.00 and in 2017 the total budget for O&P is Rp2,800,200,000.00. Between 2016-2017 6 structures have been fixed. With the increased of the O&P budget the damaged structures and canals should be fixed/maintained immediately.

5.2. RECOMMENDATION

1. Data collection regarding Salamdarma irrigation network, i.e the data of discharge, rainfall, planting plan, cultivation realization, condition of structures and canals and the amount of human resources is important to be stored both in hardcopy and softcopy to facilitate the search if it will be needed to use, also to minimize loss and destruction of the documentation/data.
2. The structures and canals in Salamdarma irrigation require maintenance/handling based on the level of the damage. It is necessary because the damaged structures and canals could inhibit the conveyance of the irrigation water from the intake to the tertiary blocks so that the available discharge couldn't be used optimally. Thererefore, the damaged structures and canals in Salamdarma irrigation network has a major impact to the performance of the irrigation network. Thus the right handling should be implemented immediately.
3. The existence of P3A in Salamdarma irrigation is important to optimize the distribution water, hence the activation of P3A is needed to establish coordination between irrigation personel with the farmer group to regulate water distribution and water usage so it can optimize the available discharge.
4. The abundance of water condition in MT I and MTII could be harnessed with construction of strorage reservoir

REFERENCE

Komarudin, Ichsan. 2014. *Bahan Ajar Mata Kuliah Irigasi dan Bangunan Air I.*

Purwanto, dan Ikhsan Jazaul. *Analisis Kebutuhan Air irigasi Pada Daerah Irigasi Bendung MRICAN1*. Yogyakarta: Universitas Muhammadiyah Yogyakarta.

Priyoguhroho, Anton. *Analisis Kebutuhan Air Irigasi (Studi Kasus Pada Daerah Irigasi Sungai Air Keban Daerah Kabupaten Empat Lawang).* Fakultas Teknik Universitas Sriwijaya.

Irigasi dan Bangunan Air. Universitas Gunadarma. Jakarta.

Peraturan Menteri Pekerjaan Umum Nomor 32/PRT/M/2007. Pedoman Operasi dan Pemeliharaan Jaringan Irigasi.

Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Nomor 12/PRT/M/2015. Tentang Eksploitasi dan Pemeliharaan Jarigan Irigasi

Kementrian Pekerjaan Umum Direktorat Jenderal Sumber Daya Air. 2013. KP-01 Design Criteria of Irrigation.

Perda Kabupaten Indramayu No. 1 Tahun 2012. Rencana Tata Ruang Wilayah Kabupaten Indramayu Tahun 2011-2031.

Salman M. 2017. ANALISIS KINERJA JARINGAN IRIGASI DAERAH IRIGASI PEMALI**.** Fakultas Teknik Universitas Swadaya Gunung Jati

Jaya, Rifan H**.** *Analysis of Water Allocation between Irrigation Area Ciwaringin And Walahar Irrigation Area In Majalengka Regency*. Engineering Faculty Swadaya Gunung Jati University.

Joni, Ade Alfian. *Evaluation of Operation and Maintenance of Cangkuang Weir Babakan District Cirebon Regency*. Engineering Faculty Swadaya Gunung Jati University.

Mahsun, Mohamad, 2006. *Pengukuran Kinerja Sektor Publik*, Yogyakarta : Penerbit BPFE.

Hasibuan, Malayu S.P. 2001. *Manajemen Sumber Daya Manusia*. Jakarta : PT. Bumi Aksara.

Sosrodarsono, S., dan K. Takeda, 2003. *Hidrologi untuk pengairan*. Pradnya Paramita, Jakarta.

Salim, Peter dan Yenny Salim. 2002. *Kamus Bahasa Indonesia Kontemporer*. Jakarta: Modern English Press.

Retnoningsih, A. dan Suharso. 2011. *Kamus Besar Bahasa Indonesia, Pusat Bahasa. Edisi Lux*. Semarang: Tim Redaksi Widya Karya.

Arsyad, Lincolin. 2010. *Ekonomi Pembangunan*. Yogyakarta: UPP STIM YKPN

Nawawi, Hadari, 2010. *Manajemen Sumber Daya Manusia*, Gadjah Mada University Press, Yogyakarta.

Triatmodjo, Bambang.2008. *Hidrologi Terapan*. Beta Offset, Yogyakarta.