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Integrated Water Resources Management in the Bukian Irrigation Area at Badung Regency

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Abstract

Management of Water Resources to meet the needs of living things is very important. Management of Water Resources that are not integrated will cause various problems, including drought, conflicts of interest between water users. The Bukian Irrigation Area is an irrigation area that utilizes surface water for its agricultural activities. Currently, the Bukian Irrigation Area obtains irrigation water from the Bukian I weir and Bukian II weir as a supply weir to increase the need for water discharge required in the irrigation area. In the utilization of surface water that is used to meet irrigation needs at this time, less attention is paid to a good water management system, such as a lack of control over water use. Water management can be carried out properly if the condition of the water balance in the system is known. Related to this, additional discharge and integrated water management are needed to avoid conflicts of interest between water users. The method in this study is a quantitative analysis with the mainstay discharge variable in the Bukian I and II weirs and irrigation water demand based on the existing cropping pattern. This research gives the result that the potential availability of water in the Bukian I and Bukian II weirs has a fluctuating magnitude in each semi-monthly period, where the maximum discharge is 0.458 m3/second and 0.130 m3/second which occurs in the February I period, the minimum discharge respectively each of 0.051 m3/second occurred in November I and 0.050 m3/second in September II and October II. The potential of each average discharge is 0.197 m3/second and 0.079 m3/second where all of them are analyzed with a reliability level of 80%. The need for irrigation water is following the existing cropping pattern in D.I. Bukian is 1.57 liters / second / hectare. The condition of the water balance in the Bukian II Dam without any supplementation indicates a water deficit condition and after adding the discharge through the supplementation from the Bukian I Dam, the result is that the available discharge increases significantly and the water balance indicates a water surplus condition. To obtain a good water resources management system in the Bukian Irrigation Area, arrangements must be made regarding the time and amount of water to be supplied to the Bukian II

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Dam following the conditions of the water balance. Excess water in the Bukian I Dam can be channelled directly downstream to meet the water needs of other users to maintain the sustainability and balance of an integrated water utilization system.

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1 Introduction

Water is one of the resources needed to support the life of living things and is an important element in a sustainable life. Based on the place where it is contained, water is divided into two, namely surface water and groundwater or water that is in the layers of soil or rock below the surface of the soil (Undang-Undang (UU) Nomor 17 Tahun 2019). Excessive use of water to support all human life will cause damage to water resources if it is not accompanied by policies in integrated management (Zulyanti et al., 2022). The use of surface water in the Bukian Irrigation Area currently pays little attention to a good water management system, such as a lack of control over water use which can be seen from the lack of operation of the weir according to needs (Sutikno, 2014). Following Law No. 17 of 2017 concerning Water Resources, it is explained that the main priority is to fulfil water for the basic needs of clean water and the second priority is to fulfil water for agricultural irrigation (Suni & Legono, 2021).

The imbalance between water supply and demand must be known in advance, as is especially the case for farmers who often experience excess water in the rainy season, but experience water shortages during the dry season (Kustana & Setiawan, 2020). The most important factor in the continuity and sustainability of the agricultural system is the availability of water, where agriculture is an important sector in improving the local economy, which requires the participation of the community and government as managers of agricultural production businesses (Dwiwana, 2019). Based on data from the Bali-Penida River Basin Office (2015), the utilization of surface water in the Tukad Ayung Watershed is very complex. There are 33 intake buildings in the form of irrigation weirs to meet agricultural needs and 2 collection buildings in the form of weirs to fulfil the supply of clean water in Badung Regency and Denpasar City. To avoid various problems regarding water resources related to quantity and quality, all parties must be aware that water management needs to be carried out with the right actions to produce an optimal solution because of the existing water balance conditions (Sun et al., 2006; Bouman et al., 2007).

From the explanation above, it can be seen that Integrated Water Resources Management is required. Therefore it is very important to carry out scientific research by considering the necessary analyzes that aim to analyze and evaluate the water balance that occurs in the Bukian Irrigation Area (Wang et al., 2012; Chen et al., 2014). Knowing the water balance that occurs will make it easier to manage water fairly and make efficient use of water. Through this research, it is hoped that findings/innovations will be obtained that a good water management system can improve regional irrigation services (Prajogo & Olhager, 2012; Pahl-Wostl, 2007).

Problem formulation

Based on the background described above, the formulation of the problem in this study is:

1) What is the potential availability of water in the Bukian I and II Dams for the current conditions?
2) What is the need for irrigation water in the Bukian Irrigation Area using the Net Field Requirement (NFR) method based on the application of the existing cropping pattern?
3) What is the balance or water balance that occurs in the Bukian II Dam for conditions without any suppletion and after there is suppletion from the Bukian I Dam?
4) How is the integrated water resources management system in the Bukian Irrigation Area seen from the water balance obtained?

Research Purposes:

1) Analyze and determine the potential availability of water in the Bukian I and II weirs.
2) Analyze the amount of irrigation water needed in the Bukian Irrigation Area using the Net Field Requirement (NFR) method based on the application of the existing Cultivation Pattern.
3) Analyze and evaluate the water balance that occurs in the Bukian II Dam for conditions without any supply and after there is a supply from the Bukian I Dam.
4) Determining an integrated water resources management system in the Bukian Irrigation Area is seen from the water balance obtained.

Literature review

Irrigation

Irrigation is an activity of providing water to agricultural land by taking water from surface water and groundwater (Akmal & Mellianda, 2014). One of the main factors in the agricultural production process is water. Therefore, in the context of providing agricultural water for irrigation, investment is very important and strategic. Arrangements of water (irrigation) must be given in the right amount, time and quality, to meet the needs of water for various farming purposes. If this is not done properly, plant growth will be disrupted which will ultimately affect agricultural production (Assagaf et al., 2018).

Cropping pattern

Islami et al. (2011), explain that cropping patterns or what is known as cropping systems are attempts to regulate cropping patterns on a plot of land that interacts with land resources and plant cultivation technology applied within a certain period (Huda et al., 2012).

Effective rainfall

Effective rainfall is rainfall that can be used directly for plant growth. Effective rainfall is determined by the amount of R80, which means that the amount of rainfall can be exceeded by as much as 80%. Calculation of effective rainfall for rice plants refers to the USDA (SCS) (1696), which is taken 70% of the minimum rainfall of 15 days (midmonth) with a probability of 80% of the period (Arridha, 2017), which is expressed by the following formula:

$$Re\ Paddy = \frac{R_{80}\ \times 0{,}7}{observation\ period}$$

with description:
Re Paddy = effective rainfall for paddy (mm/day)
R80 = precipitation with 80% probability (mm)

The amount of effective rain for crops can also be formulated by the following equation:

$$Re\ crops = \frac{R_{50}\ \times 0{,}7}{observation\ period}$$

with description:
Re Paddy = effective rainfall for crops (mm/day)
R50 = precipitation with 50% probability (mm)

Irrigation water needs

The need for irrigation water is the volume of water needed to meet evaporation needs, water loss, and water needs for plants by taking into account the amount of water provided by nature through rain and the contribution of groundwater (Sosrodarsono & Takeda, 2003).

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Evapotranspiration

To calculate the amount of evapotranspiration of a particular plant, a crop coefficient is needed which is highly dependent on the type and period of plant growth (Doorenbos & Pruitt, 1981). Calculation of the amount of plant evapotranspiration can be calculated as follows:

$$Etc = Kc \times Eto$$

with description:
Etc = plant-specific evapotranspiration (mm/day),
Kc = crop coefficient which depends on the type and period of plant growth,
Eto = potential evapotranspiration or reference plant (mm/day).

The Net Field Water Requirement (NFR)

The Net Field Water Requirement (NFR) is an estimate of the amount of water for irrigation based on factors such as plant type, soil type, method of water supply, soil processing method, amount of rainfall, time of planting, climate, canal maintenance and dam buildings and so on. According to the Irrigation Planning Criteria (KP-01) (K. Dirjen Sumber Daya Air, 2013), the amount of water for irrigation in paddy fields can be formulated as follows:

$$NFR = ETc + P + WLR - Re$$

with description:
NFR = Net Field Water Requirement (mm/day)
ETc = Plant evaporation (mm/day)
P = Percolation (mm/day)
WLR = Replacement of water layer (mm/day)
Re = Effective rainfall (mm/day)

Irrigation efficiency

Quantitatively, the irrigation efficiency of an irrigation network is very little known and is a parameter that is difficult to measure. Loss of irrigation water in rice plants is related to: (a) loss of water in primary, secondary and tertiary canals through seepage, evaporation, and water withdrawal without permits, (b) losses due to operations including excessive water supply (Kalsim, 2002).

Analysis of water availability

In analyzing the available water discharge in a catchment area, it is determined by the presence of low flow rates. In this study, the mainstay discharge analysis is carried out using the FJ method. Mock. The Mock Method was developed by Dr FJ. Mock. The Mock method for estimating the amount of discharge of a watershed is based on the concept of water balance. Evapotranspiration in the Mock Method is evapotranspiration which is influenced by the type of vegetation, soil surface and number of rainy days (Suhartanto et al., 2012).

Regional rainfall

Rainfall data used is semi-monthly rainfall data. The rainfall station used is a station that is considered to represent the rain conditions in the area which have previously gone through regional rain analysis.

Analysis of the transformation of rain data into discharge data using the F.J. Mock

Dr. F.J. Mock in 1973 introduced a simple model to simulate monthly water balances for flows from rainfall data. In this case, there must be a balance between falling rain and evapotranspiration, surface runoff and infiltration as soil moisture and groundwater recharge. Flow in a river is the amount of flow that is directly on the ground surface and baseflow [16]. Mock describes a method for estimating river flow discharge with the following stages:

1) Limited evapotranspiration (Et)
2) Area of Watershed
3) Soil Moisture Capacity
4) Water balance on the ground surface
5) Ground Water Content
6) Groundwater Flow and Storage
7) Percolation and Infiltration
8) River Flow

The water flowing in the river is the sum of direct runoff, interflow and base flow.
Interflow = Infiltration - Groundwater volume (mm),
Direct Run Off = Water Surplus - Infiltration (mm),
Base Flow = River flow that is always there throughout the year (m3/s),
Run Off = Interflow + Direct Run Off + Base Flow (m3/s).
Mainstay discharge = (River Flow x Watershed Area) / 15 days (in seconds).
The Mock method of rain-discharge simulation analysis was carried out based on FAO, 1973.

Water Balance

The water balance illustrates that the total water input is equal to the total water output plus the change in reserve water over a certain period. The reserve water change value can be positive or negative (Suhartanto et al., 2012). In general, the water balance equation is formulated as follows (Harto, 1993):

$$I = O \pm \Delta S$$

with information:
I = input
O = output
ΔS = change in water reserves

The concept of integrated water resources management

Integrated water resources management is a process aimed at improving and developing the management of water resources, land and related resources in a coordinated manner by looking at the characteristics of the region to achieve community welfare (Minghua et al., 2009; Collings & Mellahi, 2009). Integration that is carried out takes into account various interests coupled with the ability and carrying capacity of the environment wisely which in the end can improve people's welfare (Jaya, 2004).

The management approach is mostly sectoral, each sector (household utilization, agriculture, industry, environmental protection, and others) is managed separately with limited coordination between sectors. This approach causes fragmented and uncoordinated development of water resources (Qadir et al., 2007; Davies & Simonovic, 2011). Many uses of water have spillover effects on other uses and sometimes have unintended social and environmental consequences (Sudana, 2016).

In research conducted by Yekti (2017), a study was carried out on the pattern of dam operation in fulfilling sustainable water for the Subak irrigation network in the Tukad Yeh Hoo Watershed in Tabanan Regency. The results of this study show that the system of providing irrigation water in the area is a natak-tiyis system where the wastewater (drain) from rice fields is reused to irrigate the fields downstream. Excess irrigation water that occurs will be reused for activities downstream so that there will be a pattern of water use repeatedly (reuse). Such a pattern is a return flow in a river system or watershed (Triadi et al., 2023).

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2 Materials and Methods

Research design

This research was designed for 6 months starting with field studies related to the location of the study area and the current conditions. The method in this study is quantitative by using primary data analysis and secondary data to solve problems. To achieve the objectives of this study, it was started by collecting primary data based on field surveys and collecting secondary data obtained from related agencies. Briefly, the stages in carrying out the research to be carried out are as follows:

1) Field survey to determine the existing condition of the object and research location.
2) Measure the instantaneous discharge at the Bukian I and II weirs.
3) Collect secondary data from several related agencies such as rain data, climatological data, cropping patterns and others.
4) Analyse the potential availability of water and the need for irrigation water.
5) Conduct analysis and evaluation of the water balance that occurs.
6) Determine an integrated water resources management system in the Bukian Irrigation Area in terms of the water balance obtained.

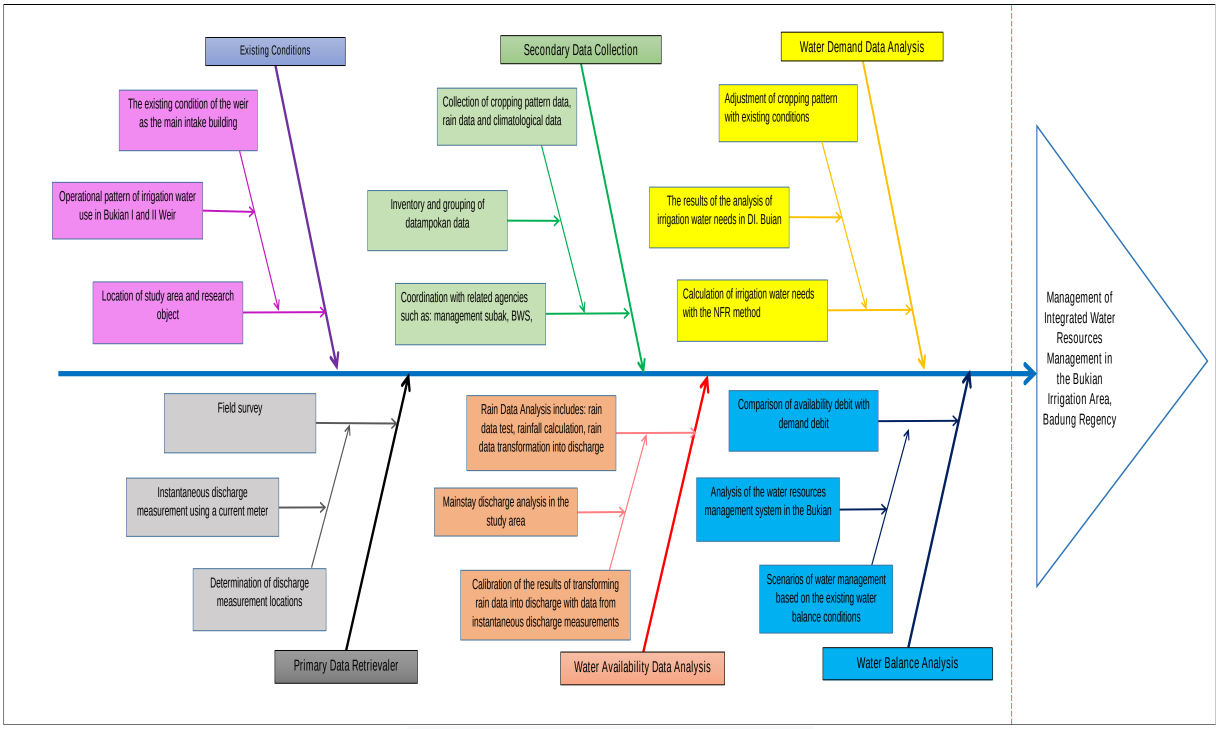

Figure 1. Fishbone Research Diagram

3 Results and Discussions

3.1 Momentary discharge measurement results

Measurements were taken 6 (six) times for each weir within the period during which the research took place from May to June 2023. Measurements were made using a current meter measuring instrument and using the mean section method.

Table 1
Momentary discharge measurement results

No	Measurement Time	Discharge at Bukian I weir (m3/second)	Discharge at Bukian II weir (m3/second)
1	6 Mei 2023	0,185	
2	7 Mei 2023		0,078
3	13 Mei 2023	0,180	
4	14 Mei 2023		0,077
5	27 Mei 2023	0,140	
6	28 Mei 2023		0,065
7	3 Juni 2023	0,108	
8	4 Juni 2023		0,065
9	10 Juni 2023	0,101	
10	11 Juni 2023		0,061
11	17 Juni 2023	0,091	
12	18 Juni 2023		0,059
Average discharge		0,101	

From the data obtained, it can be seen that the discharge generated by the Bukian Weir is relatively constant with a discharge range between 0.185 m3/second to 0.059 m3/second. The average discharge from the Bukian Weir is 0.101 m3/second.

3.2 Hydrological Analysis

Regional rainfall analysis

Table 2
Probability of half-monthly mainstay rain in the Tukad Ayung watershed basic month method

Prob. %	JAN		PEB		MAR		APR		MEI		JUN		JUL		AGT		SEP		OKT		NOP		DES		Total
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
11,11%	404,9	171,3	238,6	114,8	159,0	191,2	64,5	92,4	48,3	43,7	34,1	43,0	61,4	26,7	14,2	9,1	31,8	53,1	79,4	73,6	104,6	158,8	222,0	202,0	2642,5
22,22%	184,1	160,5	116,6	113,5	127,2	140,4	59,8	80,3	38,9	41,6	22,2	37,0	50,8	25,8	11,4	8,4	19,8	18,2	70,6	50,1	70,2	116,9	174,1	184,4	1923,0
33,33%	183,7	120,5	102,3	102,2	109,9	113,6	58,0	67,9	38,6	35,3	20,0	25,2	14,4	16,8	9,0	4,2	19,3	13,1	56,0	46,5	69,9	70,1	163,9	173,8	1634,5
44,44%	151,9	117,6	97,2	100,2	100,4	103,5	46,3	64,5	30,0	30,0	19,2	24,6	13,5	14,9	5,7	2,7	15,0	4,7	52,2	44,0	60,3	65,2	150,5	173,3	1487,4
55,56%	149,9	115,4	93,6	76,5	93,0	98,3	45,6	62,0	28,7	21,7	16,3	20,4	11,2	12,3	5,2	2,4	6,0	4,0	39,7	30,5	52,6	63,6	138,4	145,2	1332,8
66,67%	119,5	113,1	89,7	74,5	92,1	97,6	39,2	50,7	24,2	16,2	12,1	10,8	2,8	10,9	1,9	0,6	2,4	1,4	29,4	27,7	51,5	38,1	136,8	143,3	1186,6
77,78%	117,0	107,3	87,0	73,0	82,7	75,4	28,5	34,7	24,2	15,9	6,8	8,5	2,0	8,3	0,4	0,1	2,1	0,2	4,7	18,9	30,9	37,2	128,9	132,8	1027,2
88,89%	103,1	99,3	76,0	71,8	76,2	74,3	27,8	24,3	17,6	15,3	2,5	2,3	1,7	7,1	0,0	0,0	0,0	0,0	3,7	4,9	25,9	14,5	78,1	98,2	824,7
100,00%	91,7	90,7	73,1	57,6	69,8	55,1	20,0	8,1	16,6	1,7	2,0	0,0	0,3	3,3	0,0	0,0	0,0	0,0	0,2	2,1	17,2	12,7	47,0	30,5	599,7
R80	**114,2**	**105,7**	**84,8**	**72,8**	**81,4**	**75,2**	**28,4**	**32,6**	**22,9**	**15,8**	**6,0**	**7,3**	**2,0**	**8,1**	**0,3**	**0,1**	**1,7**	**0,2**	**4,5**	**16,1**	**29,9**	**32,7**	**118,8**	**125,9**	**986,7**
R50	**150,9**	**116,5**	**95,4**	**88,3**	**96,7**	**100,9**	**46,0**	**63,3**	**29,4**	**25,9**	**17,7**	**22,5**	**12,4**	**13,6**	**5,5**	**2,6**	**10,5**	**4,4**	**46,0**	**37,2**	**56,4**	**64,4**	**144,5**	**159,2**	**1410,1**
R20	**228,3**	**162,6**	**141,0**	**113,8**	**133,6**	**150,6**	**60,8**	**82,8**	**40,8**	**42,0**	**24,6**	**38,2**	**52,9**	**26,0**	**12,0**	**8,5**	**22,2**	**25,2**	**72,4**	**54,8**	**77,1**	**125,3**	**183,7**	**187,9**	**2066,9**
Rerata	**167,3**	**121,8**	**108,2**	**87,1**	**101,2**	**105,5**	**43,3**	**53,9**	**29,7**	**24,6**	**15,0**	**19,1**	**17,6**	**14,0**	**5,3**	**3,1**	**10,7**	**10,5**	**37,3**	**33,1**	**53,7**	**64,1**	**137,7**	**142,6**	**1406,5**

3.3 Analysis of water availability

In this study, the mainstay discharge analysis is carried out using the FJ method. Mock. The Mock Method was developed by Dr FJ. Mock. The Mock method for estimating the amount of discharge in a watershed is based on the concept of water balance. Rainwater that falls (precipitation) will experience evapotranspiration according to the vegetation that covers the catchment area. Evapotranspiration in the Mock Method is evapotranspiration which is influenced by the type of vegetation, soil surface and number of rainy days.

Table 3
Recapitulation of potential semi-monthly mock inflow models in the Cachment Area of the Bukian I weir (m3/s)

No	Tahun	Jan		Feb		Mar		Apr		Mei		Jun		Jul		Agust		Sep		Okt		Nop		Des	
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
1	2007	0,60	0,47	0,49	0,43	0,40	0,38	0,31	0,27	0,22	0,16	0,13	0,15	0,12	0,09	0,08	0,06	0,06	0,05	0,08	0,10	0,19	0,19	0,41	0,48
2	2008	0,61	0,62	0,62	0,54	0,46	0,44	0,36	0,33	0,27	0,22	0,18	0,16	0,11	0,08	0,07	0,06	0,06	0,05	0,13	0,16	0,23	0,26	0,44	0,58
3	2009	1,06	0,77	0,93	0,75	0,68	0,68	0,48	0,43	0,31	0,20	0,14	0,10	0,08	0,07	0,07	0,06	0,06	0,07	0,10	0,10	0,11	0,09	0,14	0,14
4	2010	0,29	0,33	0,40	0,34	0,32	0,31	0,30	0,29	0,25	0,20	0,17	0,14	0,11	0,10	0,09	0,08	0,09	0,15	0,23	0,26	0,26	0,27	0,40	0,45
5	2011	0,48	0,46	0,46	0,40	0,40	0,38	0,36	0,27	0,21	0,17	0,13	0,13	0,09	0,07	0,06	0,06	0,05	0,05	0,09	0,14	0,18	0,22	0,37	0,50
6	2012	0,63	0,61	0,54	0,52	0,51	0,51	0,38	0,26	0,19	0,14	0,11	0,09	0,09	0,10	0,08	0,07	0,06	0,06	0,13	0,16	0,21	0,19	0,38	0,45
7	2013	0,54	0,50	0,47	0,46	0,40	0,31	0,23	0,16	0,14	0,16	0,14	0,17	0,20	0,15	0,12	0,09	0,12	0,09	0,07	0,08	0,24	0,42	0,64	0,65
8	2014	0,66	0,55	0,52	0,43	0,36	0,32	0,29	0,31	0,23	0,14	0,10	0,08	0,15	0,12	0,09	0,07	0,06	0,06	0,05	0,05	0,05	0,22	0,28	0,46
9	2015	0,45	0,43	0,46	0,40	0,41	0,40	0,36	0,32	0,28	0,20	0,19	0,14	0,10	0,07	0,06	0,06	0,05	0,05	0,05	0,05	0,05	0,05	0,26	0,32
Rerata		**0,593**	**0,527**	**0,544**	**0,477**	**0,437**	**0,417**	**0,341**	**0,295**	**0,232**	**0,177**	**0,144**	**0,127**	**0,116**	**0,096**	**0,080**	**0,067**	**0,067**	**0,071**	**0,105**	**0,122**	**0,167**	**0,212**	**0,368**	**0,446**

Table 4
Inflow potential probability semi-monthly mock model in the Cachment Area of the Bukian I weir (m3/s)

No	Prob.	Jan		Feb		Mar		Apr		Mei		Jun		Jul		Agust		Sep		Okt		Nop		Des	
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
1	10%	1,058	0,773	0,931	0,755	0,680	0,684	0,481	0,434	0,313	0,223	0,188	0,167	0,196	0,145	0,120	0,090	0,115	0,149	0,232	0,257	0,256	0,422	0,640	0,646
2	20%	0,661	0,618	0,624	0,544	0,507	0,511	0,375	0,328	0,281	0,204	0,183	0,157	0,146	0,116	0,094	0,076	0,086	0,089	0,132	0,163	0,236	0,265	0,440	0,580
3	30%	0,630	0,610	0,538	0,518	0,458	0,438	0,358	0,325	0,267	0,202	0,166	0,149	0,118	0,104	0,090	0,073	0,063	0,073	0,127	0,156	0,227	0,260	0,412	0,496
4	40%	0,614	0,549	0,524	0,458	0,414	0,404	0,358	0,312	0,246	0,200	0,145	0,140	0,114	0,101	0,084	0,067	0,060	0,057	0,102	0,137	0,206	0,221	0,399	0,477
5	50%	0,600	0,497	0,494	0,435	0,399	0,384	0,356	0,290	0,225	0,172	0,140	0,138	0,110	0,093	0,076	0,063	0,057	0,055	0,094	0,104	0,190	0,218	0,375	0,458
6	60%	0,542	0,471	0,468	0,429	0,398	0,384	0,313	0,274	0,218	0,161	0,131	0,125	0,098	0,080	0,067	0,059	0,057	0,054	0,080	0,098	0,180	0,192	0,372	0,453
7	70%	0,485	0,458	0,463	0,405	0,397	0,325	0,302	0,274	0,208	0,156	0,127	0,099	0,093	0,074	0,065	0,058	0,055	0,053	0,071	0,082	0,110	0,186	0,277	0,446
8	80%	0,453	0,431	0,458	0,403	0,361	0,315	0,288	0,261	0,187	0,140	0,114	0,091	0,088	0,074	0,064	0,057	0,054	0,052	0,054	0,052	0,051	0,094	0,258	0,319
9	90%	0,290	0,331	0,400	0,343	0,324	0,308	0,235	0,157	0,141	0,138	0,102	0,078	0,076	0,072	0,063	0,056	0,054	0,052	0,051	0,051	0,050	0,050	0,144	0,142
Q80%		**0,453**	**0,431**	**0,458**	**0,403**	**0,361**	**0,315**	**0,288**	**0,261**	**0,187**	**0,140**	**0,114**	**0,091**	**0,088**	**0,074**	**0,064**	**0,057**	**0,054**	**0,052**	**0,054**	**0,052**	**0,051**	**0,094**	**0,258**	**0,319**
Q50%		**0,600**	**0,497**	**0,494**	**0,435**	**0,399**	**0,384**	**0,356**	**0,290**	**0,225**	**0,172**	**0,140**	**0,138**	**0,110**	**0,093**	**0,076**	**0,063**	**0,057**	**0,055**	**0,094**	**0,104**	**0,190**	**0,218**	**0,375**	**0,458**
Q20%		**0,661**	**0,618**	**0,624**	**0,544**	**0,507**	**0,511**	**0,375**	**0,328**	**0,281**	**0,204**	**0,183**	**0,157**	**0,146**	**0,116**	**0,094**	**0,076**	**0,086**	**0,089**	**0,132**	**0,163**	**0,236**	**0,265**	**0,440**	**0,580**

Table 5
Recapitulation of potential semi-monthly mock inflow models in the Cachment Area of the Bukian II weir (m3/s)

No	Tahun	Jan		Feb		Mar		Apr		Mei		Jun		Jul		Agust		Sep		Okt		Nop		Des	
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
1	2007	0,16	0,13	0,14	0,12	0,12	0,12	0,10	0,09	0,08	0,07	0,07	0,07	0,06	0,06	0,06	0,05	0,05	0,05	0,06	0,06	0,08	0,08	0,12	0,13
2	2008	0,16	0,16	0,16	0,15	0,13	0,13	0,11	0,10	0,09	0,08	0,08	0,07	0,06	0,06	0,05	0,05	0,05	0,05	0,07	0,07	0,08	0,09	0,13	0,15
3	2009	0,25	0,19	0,22	0,19	0,17	0,17	0,13	0,12	0,10	0,08	0,07	0,06	0,06	0,05	0,05	0,05	0,05	0,05	0,06	0,06	0,06	0,06	0,07	0,07
4	2010	0,10	0,10	0,12	0,11	0,10	0,10	0,10	0,10	0,09	0,08	0,07	0,07	0,06	0,06	0,06	0,06	0,06	0,07	0,09	0,09	0,09	0,09	0,12	0,13
5	2011	0,13	0,13	0,13	0,12	0,12	0,12	0,11	0,09	0,08	0,07	0,06	0,06	0,06	0,05	0,05	0,05	0,05	0,05	0,06	0,07	0,08	0,08	0,11	0,14
6	2012	0,16	0,16	0,15	0,14	0,14	0,14	0,11	0,09	0,08	0,07	0,06	0,06	0,06	0,06	0,06	0,05	0,05	0,05	0,07	0,07	0,08	0,08	0,11	0,13
7	2013	0,15	0,14	0,13	0,13	0,12	0,10	0,09	0,07	0,07	0,07	0,07	0,07	0,08	0,07	0,06	0,06	0,06	0,06	0,05	0,06	0,09	0,12	0,17	0,17
8	2014	0,17	0,15	0,14	0,13	0,11	0,10	0,10	0,10	0,08	0,07	0,06	0,06	0,07	0,06	0,06	0,05	0,05	0,05	0,05	0,05	0,05	0,08	0,09	0,13
9	2015	0,13	0,12	0,13	0,12	0,12	0,12	0,11	0,10	0,10	0,08	0,08	0,07	0,06	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,09	0,10
Rerata		**0,156**	**0,143**	**0,147**	**0,133**	**0,126**	**0,122**	**0,107**	**0,098**	**0,085**	**0,075**	**0,068**	**0,065**	**0,063**	**0,059**	**0,056**	**0,053**	**0,053**	**0,054**	**0,061**	**0,064**	**0,073**	**0,082**	**0,112**	**0,127**

Table 6
Inflow potential probability semi-monthly mock model in the Cachment Area of the Bukian II weir (m3/s)

No	Prob.	Jan		Feb		Mar		Apr		Mei		Jun		Jul		Agust		Sep		Okt		Nop		Des	
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
1	10%	0,247	0,191	0,222	0,188	0,173	0,174	0,134	0,125	0,101	0,084	0,077	0,073	0,079	0,069	0,064	0,058	0,063	0,069	0,086	0,091	0,090	0,123	0,165	0,166
2	20%	0,169	0,161	0,162	0,146	0,139	0,140	0,114	0,104	0,095	0,080	0,076	0,071	0,069	0,063	0,059	0,055	0,057	0,058	0,066	0,072	0,086	0,092	0,126	0,154
3	30%	0,163	0,159	0,145	0,141	0,130	0,126	0,110	0,104	0,092	0,080	0,073	0,069	0,063	0,061	0,058	0,054	0,053	0,055	0,065	0,071	0,085	0,091	0,121	0,137
4	40%	0,160	0,148	0,142	0,130	0,121	0,119	0,110	0,101	0,088	0,079	0,068	0,068	0,063	0,060	0,057	0,053	0,052	0,051	0,060	0,067	0,080	0,083	0,118	0,133
5	50%	0,157	0,137	0,137	0,125	0,118	0,115	0,110	0,097	0,084	0,074	0,068	0,067	0,062	0,058	0,055	0,053	0,051	0,051	0,059	0,060	0,077	0,083	0,114	0,130
6	60%	0,146	0,132	0,132	0,124	0,118	0,115	0,101	0,094	0,083	0,072	0,066	0,065	0,059	0,056	0,053	0,052	0,051	0,051	0,056	0,059	0,075	0,078	0,113	0,129
7	70%	0,135	0,130	0,131	0,119	0,118	0,104	0,099	0,094	0,081	0,071	0,065	0,059	0,058	0,055	0,053	0,051	0,051	0,051	0,054	0,056	0,062	0,077	0,094	0,127
8	80%	0,129	0,124	0,130	0,119	0,111	0,102	0,097	0,091	0,077	0,068	0,062	0,058	0,057	0,055	0,053	0,051	0,051	0,050	0,051	0,050	0,050	0,059	0,091	0,102
9	90%	0,097	0,105	0,118	0,107	0,103	0,100	0,086	0,071	0,068	0,067	0,060	0,055	0,055	0,054	0,052	0,051	0,051	0,050	0,050	0,050	0,050	0,050	0,068	0,068
Q80%		**0,129**	**0,124**	**0,130**	**0,119**	**0,111**	**0,102**	**0,097**	**0,091**	**0,077**	**0,068**	**0,062**	**0,058**	**0,057**	**0,055**	**0,053**	**0,051**	**0,051**	**0,050**	**0,051**	**0,050**	**0,050**	**0,059**	**0,091**	**0,102**
Q50%		**0,157**	**0,137**	**0,137**	**0,125**	**0,118**	**0,115**	**0,110**	**0,097**	**0,084**	**0,074**	**0,068**	**0,067**	**0,062**	**0,058**	**0,055**	**0,053**	**0,051**	**0,051**	**0,059**	**0,060**	**0,077**	**0,083**	**0,114**	**0,130**
Q20%		**0,169**	**0,161**	**0,162**	**0,146**	**0,139**	**0,140**	**0,114**	**0,104**	**0,095**	**0,080**	**0,076**	**0,071**	**0,069**	**0,063**	**0,059**	**0,055**	**0,057**	**0,058**	**0,066**	**0,072**	**0,086**	**0,092**	**0,126**	**0,154**

Results of rain-discharge simulation analysis of the F.J. Mock in Cachment Area Bukian I weir

Table 7
FJ's Mock mainstay rain-debit simulation for the Cachment Area of the Bukian I Weir

Q80%	**0,45**	**0,43**	**0,46**	**0,40**	**0,36**	**0,31**	**0,29**	**0,26**	**0,19**	**0,14**	**0,11**	**0,09**	**0,09**	**0,07**	**0,06**	**0,06**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,09**	**0,26**	**0,32**
Q50%	**2,31**	**1,86**	**1,75**	**1,69**	**1,51**	**1,34**	**1,16**	**0,91**	**0,58**	**0,44**	**0,34**	**0,29**	**0,12**	**0,11**	**0,04**	**0,02**	**0,02**	**0,01**	**0,01**	**0,17**	**0,30**	**1,08**	**1,56**	**2,17**
Q20%	**3,11**	**2,26**	**2,83**	**2,63**	**2,79**	**2,29**	**2,29**	**1,84**	**1,39**	**1,44**	**1,02**	**1,00**	**0,53**	**0,28**	**0,15**	**0,11**	**0,07**	**0,04**	**0,04**	**0,64**	**1,76**	**1,83**	**2,76**	**2,40**
R80	**114,19**	**105,66**	**84,77**	**72,75**	**81,37**	**75,16**	**28,37**	**32,58**	**22,87**	**15,76**	**5,96**	**7,28**	**1,98**	**8,07**	**0,33**	**0,05**	**1,65**	**0,15**	**4,46**	**16,07**	**29,93**	**32,65**	**118,76**	**125,87**
R50	**150,90**	**116,55**	**95,36**	**88,35**	**96,71**	**100,90**	**45,97**	**63,26**	**29,36**	**25,87**	**17,75**	**22,50**	**12,36**	**13,59**	**5,45**	**2,57**	**10,52**	**4,39**	**45,97**	**37,25**	**56,43**	**64,41**	**144,46**	**159,21**
R20	**228,25**	**162,65**	**140,98**	**113,79**	**133,60**	**150,55**	**60,77**	**82,75**	**40,81**	**42,05**	**24,56**	**38,18**	**52,92**	**25,96**	**11,97**	**8,51**	**22,22**	**25,20**	**72,36**	**54,83**	**77,10**	**125,30**	**183,67**	**187,94**

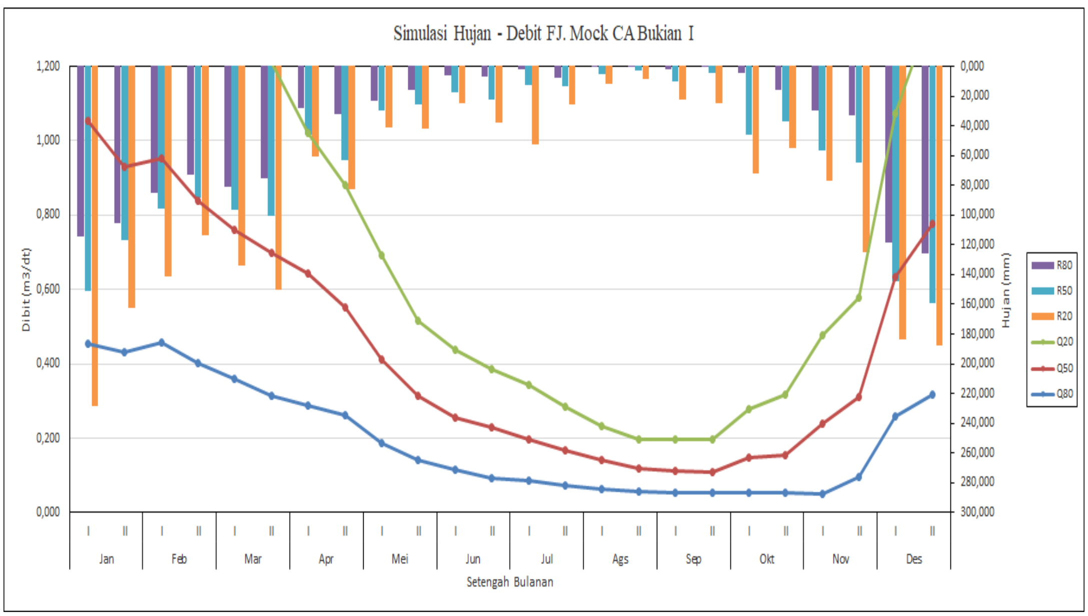

Figure 2. FJ Mock rain-discharge simulation graphics for the Cachment Area of the Bukian I weir

Results of rain-discharge simulation analysis of the F.J. Mock in Cachment Area Bukian II weir

Table 8
FJ's Mock mainstay rain-debit simulation for the Cachment Area of the Bukian II Weir

Q80%	0,13	0,12	0,13	0,12	0,11	0,10	0,10	0,09	0,08	0,07	0,06	0,06	0,06	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,06	0,09	0,10
Q50%	2,31	1,86	1,75	1,69	1,51	1,34	1,16	0,91	0,58	0,44	0,34	0,29	0,12	0,11	0,04	0,02	0,02	0,01	0,01	0,17	0,30	1,08	1,56	2,17
Q20%	3,11	2,26	2,83	2,63	2,79	2,29	2,29	1,84	1,39	1,44	1,02	1,00	0,53	0,28	0,15	0,11	0,07	0,04	0,04	0,64	1,76	1,83	2,76	2,40
R80	114,19	105,66	84,77	72,75	81,37	75,16	28,37	32,58	22,87	15,76	5,96	7,28	1,98	8,07	0,33	0,05	1,65	0,15	4,46	16,07	29,93	32,65	118,76	125,87
R50	150,90	116,55	95,36	88,35	96,71	100,90	45,97	63,26	29,36	25,87	17,75	22,50	12,36	13,59	5,45	2,57	10,52	4,39	45,97	37,25	56,43	64,41	144,46	159,21
R20	228,25	162,65	140,98	113,79	133,60	150,55	60,77	82,75	40,81	42,05	24,56	38,18	52,92	25,96	11,97	8,51	22,22	25,20	72,36	54,83	77,10	125,30	183,67	187,94

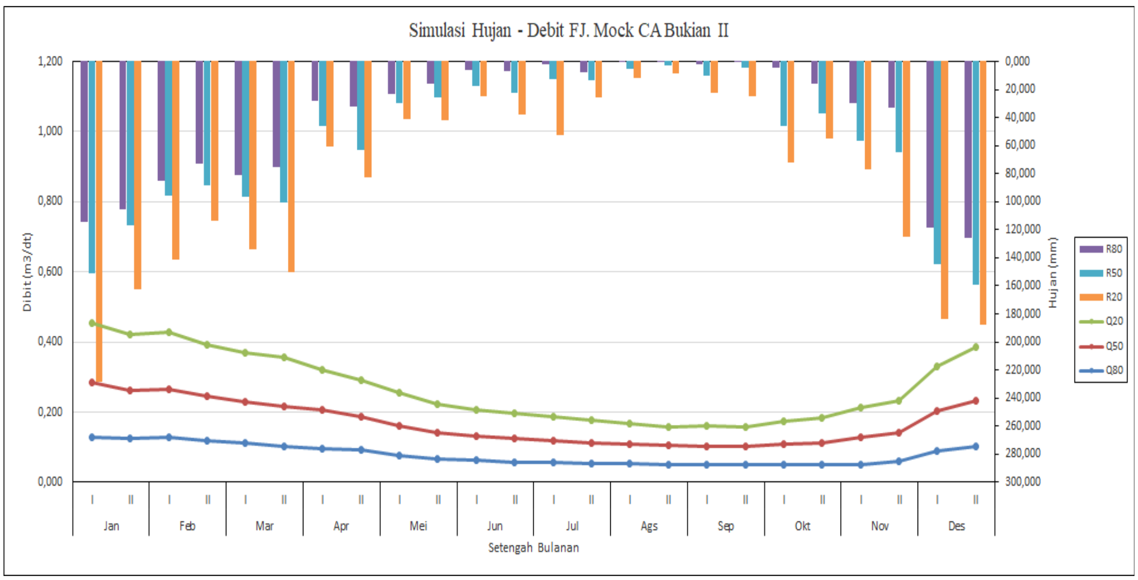

Figure 3. FJ rain-discharge simulation graphics. Mock for the Cachment Area Of the Bukian II weir

Comparison of momentary measurement discharge with F.J Mock discharge simulation method

To validate the results of the Mock method analysis that has been carried out, it will then be compared with the instantaneous discharge measurement data in the same period, namely May I, May II, June I and June II. This is done to ensure that the results of the calculation of discharge by the Mock method are following the results of measurements in the field.

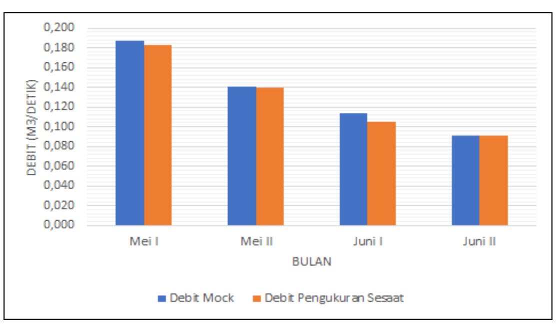

Figure 4. Comparison of the Mock Method of Discharge Discharge with the Momentary Discharge at the Bukian I weir

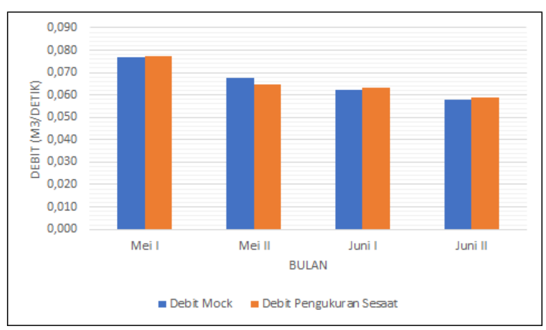

Figure 5. Comparison of the Mock Method of with the Momentary Discharge at the Bukian II weir

3.4 Analysis of irrigation water needs

Cropping pattern

The cropping pattern that applies in the Bukian Irrigation Area is Paddy I – Paddy II – Paddy III/Palawija. Based on data obtained from the Public Works and Spatial Planning Office of Badung Regency, it is known that the Planting Intensity (IP) for the Bukian Irrigation Area is an average of 280% overall.

The following shows a recapitulation of cropping patterns in the Bukian Irrigation Area:

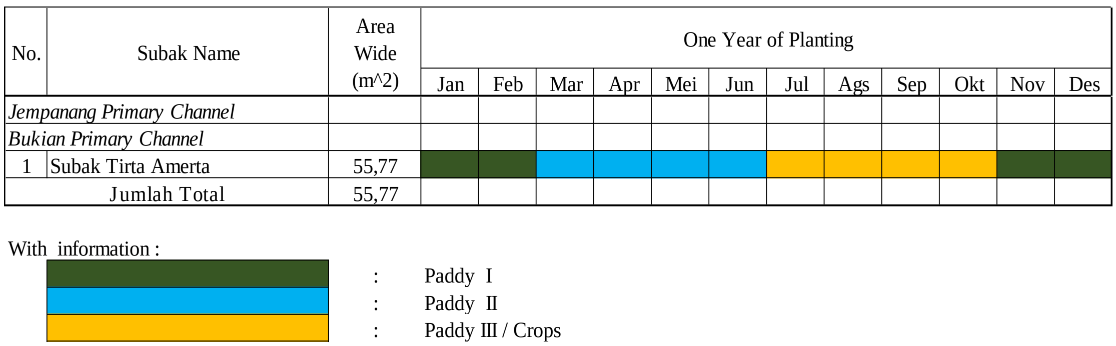

Figure 6. Planting Pattern of the Bukian Irrigation Area
Source: Public Works and Spatial Planning Office of Badung Regency, 2023

Analysis of effective rainfall

Based on the explanation of the calculation of effective rainfall for rice and secondary crops, the results of the analysis for the effective rainfall of the two types of plants can be explained.

Table 9
Effective rainfall calculation results (Re) for paddy and palawija

Month	R80 (mm)	Re = 0,7 x R80 (mm)	Re Paddy (mm/day)	R50 (mm)	Re = 0,7 x R50 (mm)	Re Crops (mm/day)
January I	114,19	79,93	5,33	150,9	105,63	7,04
January II	105,66	73,96	4,62	116,55	81,59	5,1
February I	84,77	59,34	4,24	95,36	66,75	4,77
February II	72,75	50,93	3,64	88,35	61,85	4,42
March I	81,37	56,96	3,8	96,71	67,70	4,51
March II	75,16	52,61	3,29	100,9	70,63	4,41
April I	28,37	19,86	1,32	45,97	32,18	2,15
April II	32,58	22,81	1,52	63,26	44,28	2,95
May I	22,87	16,01	1,07	29,36	20,55	1,37
May II	15,76	11,03	0,69	25,87	18,11	1,13
June I	5,96	4,17	0,28	17,75	12,43	0,83
June II	7,28	5,10	0,34	22,5	15,75	1,05
July I	1,98	1,39	0,09	12,36	8,65	0,58
July II	8,07	5,65	0,35	13,59	9,51	0,59
August I	0,33	0,23	0,02	5,45	3,82	0,25
August II	0,05	0,04	0	2,57	1,80	0,11
September I	1,65	1,16	0,08	10,52	7,36	0,49
September II	0,15	0,11	0,01	4,39	3,07	0,2
October I	4,46	3,12	0,21	45,97	32,18	2,15
October II	16,07	11,25	0,7	37,25	26,08	1,63
November I	29,93	20,95	1,4	56,43	39,50	2,63
November II	32,65	22,86	1,52	64,41	45,09	3,01
December I	118,76	83,13	5,54	144,46	101,12	6,74
December II	125,87	88,11	5,51	159,21	111,45	6,97

Net irrigation water requirement (NFR) in the Bukian Irrigation Area

Table 10
Calculation of the NFR method of irrigation water needs in Bukian Irrigation Area

Pola Tanam : Padi - Padi - Palawija
Efisiensi Total : 0,65

Early Planting: November I

No.	Description	Measure	Jan		Feb		Mar		Apr		Mei		Jun		Jul		Ags		Sep		Okt		Nov		Des	
			I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
1	Cropping Pattern			PADDY I				Land Preparation				PADDY II							CROPS					Land Preparation		
2	Number of days	day	15	16	14	14	15	16	15	15	15	16	15	15	15	16	15	16	15	15	15	16	15	15	15	16
3	Evapotranspiration (ETo)	mm/day	9,10	9,10	8,39	8,39	6,74	6,74	5,48	5,48	5,03	5,03	5,65	5,65	5,95	5,95	6,62	6,62	7,59	7,59	8,05	8,05	8,14	8,14	6,93	6,93
4	Evaporation during Land Preparation (Eo, 1,1xETo)	mm/day					7,42	7,42	6,03	6,03													8,95	8,95	7,63	7,63
5	Percolation (P)	mm/day	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50	1,50
6	Additional Water Needs (M, Eo+P)	mm/day					8,92	8,92	7,53	7,53													10,45	10,45	9,13	9,13
7	k = M*T/S						1,07	1,07	0,90	0,90													1,25	1,25	1,10	1,10
8	Land Preparation (LP)	mm/day					13,57	13,57	12,66	12,66													14,63	14,63	13,71	13,71
9	Area Factor to Land Preparation						0,13	0,38	0,38	0,13													0,13	0,38	0,38	0,13
10	Effective Rainfall to Paddy	mm/day	5,33	4,62	4,24	3,64	3,80	3,29	1,32	1,52	1,07	0,69	0,28	0,34	0,09	0,35	0,02	0,00	0,08	0,01	0,21	0,70	1,40	1,52	5,54	5,51
11	Effective Rainfall to Crops	mm/day	7,04	5,10	4,77	4,42	4,51	4,41	2,15	2,95	1,37	1,13	0,83	1,05	0,58	0,59	0,25	0,11	0,49	0,20	2,15	1,63	2,63	3,01	6,74	6,97
12	Water Layer Replacement (WLR) :	mm/day	2,20	2,20	1,10	1,10					2,20	2,20	1,10	1,10												
13	Plant Coeffisient																									
-	c1	-	1,05	1,05	0,95	0,00			1,10	1,10	1,05	1,05	0,95	0,00											1,10	1,10
-	c2	-	1,10	1,05	1,05	0,95	0,00			1,10	1,10	1,05	1,05	0,95	0,00											1,10
-	c3	-	1,10	1,10	1,05	1,05	0,95	0,00			1,10	1,10	1,05	1,05	0,95	0,00										
-	c1	-													0,50	0,59	0,96	1,05	1,02	0,95						
-	c2	-														0,50	0,59	0,96	1,05	1,02	0,95					
-	c3	-															0,50	0,59	0,96	1,05	1,02	0,95				
	Avarage Plant Coeffisient	Paddy	1,08	1,07	1,02	0,67	0,48	0,00	1,10	1,10	1,08	1,07	1,02	0,67	0,48	0,00									1,10	1,10
		Crops													0,50	0,55	0,68	0,87	1,01	1,01	0,99	0,95				
14	ET crop = kc x Eto	mm/day	9,86	9,71	8,53	5,59	3,20	0,00	6,03	6,03	5,45	5,36	5,74	3,77	2,97	3,24	4,52	5,74	7,67	7,65	7,93	7,65	0,00	0,00	7,63	7,63
15	Use of Paddy Consumption	mm/day	9,86	9,71	8,53	5,59	3,20	0,00	6,03	6,03	5,45	5,36	5,74	3,77	2,82	0,00	0,00	0,00					0,00	0,00	7,63	7,63
16	Use of Crops Consumption	mm/day													2,97	3,24	4,52	5,74	7,67	7,65	7,93	7,65	0,00	0,00		
17	Net Water Requirement NFR 1	mm/day	8,23	8,79	6,89	4,55	0,91	0,00															1,65	4,91	3,06	1,03
18	NFR 2	mm/day					1,22	3,86	4,25	1,39	8,08	8,37	8,07	6,03	4,38	4,39										
19	NFR 3	mm/day													2,40	2,65	4,27	5,62	7,18	7,44	5,79	6,02	0,00	0,00		
20	Net Water Requirement NFR 1	Liters/sec/ha	0,95	1,02	0,80	0,53	0,10	0,00															0,19	0,57	0,35	0,12
	NFR 2	Liters/sec/ha					0,14	0,45	0,49	0,16	0,94	0,97	0,93	0,70	0,51	0,51										
	NFR 3	Liters/sec/ha													0,28	0,31	0,49	0,65	0,83	0,86	0,67	0,70	0,00	0,00		
	Total Net Field water Requirement	Liters/sec/ha	0,95	1,02	0,80	0,53	0,25	0,45	0,49	0,16	0,94	0,97	0,93	0,70	0,78	0,81	0,49	0,65	0,83	0,86	0,67	0,70	0,19	0,57	0,35	0,12
21	Water Requirements in Intake DR1	Liters/sec/ha	1,47	1,57	1,23	0,81	0,16	0,00															0,30	0,88	0,55	0,18
	DR2	Liters/sec/ha					0,22	0,69	0,76	0,25	1,44	1,50	1,44	1,08	0,78	0,78										
	DR3	Liters/sec/ha													0,43	0,47	0,76	1,00	1,28	1,33	1,03	1,08	0,00	0,00		
	Total D R	Liters/sec/ha	1,47	1,57	1,23	0,81	0,38	0,69	0,76	0,25	1,44	1,50	1,44	1,08	1,21	1,26	0,76	1,00	1,28	1,33	1,03	1,08	0,30	0,88	0,55	0,18

Source : Calculation Results

3.5 Analysis of water balance (water balance)

The calculation of the water balance will be carried out at the Bukian II weir by looking at the conditions without supplementation or after supplementation from the Bukian I weir. This is done to see the ability of the weir to provide a reliable discharge according to the area of each catchment area. Based on the results of this calculation, it can be seen that the condition of the water balance that occurs in the Bukian II Weir if no flow supplementation is carried out from the Bukian I Weir, as well as the water balance condition that occurs after the drainage supplementation is carried out from the Bukian I weir.

Table 11
Water balance calculation at Bukian Weir II
(Without supplement from Bukian I Weir)

Month		Qmainstay	Q demand	DR			Remaining Water	Information
		liter/sec	liter/sec	Paddy I	Paddy II	Crops		
Functional Area (Ha)			55,77	55,77	55,77	55,77	Liter/sec	
Jan	I	128,66	82,00	1,47			46,66	Enough
	II	124,49	87,53	1,57			36,96	Enough
Feb	I	129,65	68,62	1,23			61,03	Enough
	II	118,95	45,37	0,81			73,58	Enough
Mar	I	110,74	21,20	0,16	0,22		89,54	Enough
	II	101,71	23,05	0,00	0,69		78,66	Enough
Apr	I	96,53	25,40		0,76		71,13	Enough
	II	91,24	8,32		0,25		82,92	Enough
May	I	76,70	48,29		1,44		28,41	Enough
	II	67,61	50,05		1,50		17,56	Enough
Jun	I	62,44	48,20		1,44		14,24	Enough
	II	58,00	36,02		1,08		21,98	Enough
Jul	I	57,33	45,28		0,78	0,43	12,05	Enough
	II	54,77	47,31		0,78	0,47	7,46	Enough
Aug	I	52,74	34,02			0,76	18,72	Enough
	II	51,38	44,82			1,00	6,56	Enough
Sep	I	50,79	57,21			1,28	-6,42	Not Enough
	II	50,43	59,30			1,33	-8,87	Not Enough
Oct	I	50,73	46,12			1,03	4,61	Enough
	II	50,37	47,98			1,08	2,39	Enough
Nov	I	50,21	16,47	0,30		0,00	33,74	Enough
	II	58,67	48,94	0,88			9,73	Enough
Dec	I	90,55	30,52	0,55			60,03	Enough
	II	102,48	10,22	0,18			92,26	Enough
Amount		1887,17	1032,24				854,93	
Max				1,57	1,50	1,33	Success Period	92%
Average		78,63	43,01					

Source : The Calculation Result

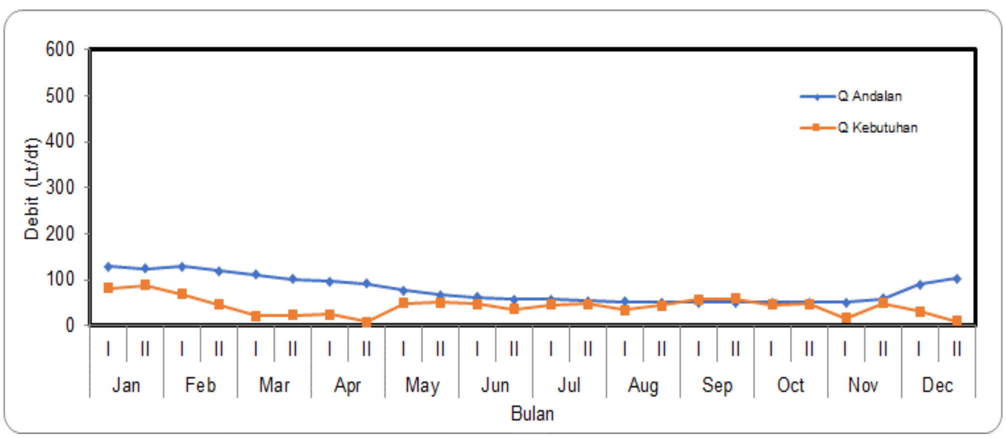

Figure 7. Graph of water balance at Bukian II Weir
(Without supplement from Bukian I Weir)

Table 12
Water balance calculation at Bukian Weir II
(After receiving supplement from Bukian I Weir)

Month		Q mainstay	Q Demand	DR			Remaining water	Information
		Liter/sec	Liter/sec	Paddy I (100%)	Paddy II (100%)	Crops (80%)		
Function Area (Ha)			55,77	55,77	55,77	44,616	lt/dt	
Jan	I	581,54	82,00	1,47			499,53	Enough
	II	555,97	87,53	1,57			468,44	Enough
Feb	I	587,60	68,62	1,23			518,97	Enough
	II	522,07	45,37	0,81			476,70	Enough
Mar	I	471,82	21,20	0,16	0,22		450,62	Enough
	II	416,52	23,05	0,00	0,69		393,47	Enough
Apr	I	384,85	25,40		0,76		359,45	Enough
	II	352,45	8,32		0,25		344,13	Enough
May	I	263,45	48,29		1,44		215,16	Enough
	II	207,77	50,05		1,50		157,73	Enough
Jun	I	176,17	48,20		1,44		127,96	Enough
	II	148,96	36,02		1,08		112,94	Enough
Jul	I	144,87	45,28		0,78	0,43	99,59	Enough
	II	129,21	47,31		0,78	0,47	81,90	Enough
Aug	I	116,76	34,02			0,76	82,74	Enough
	II	108,45	44,82			1,00	63,63	Enough
Sep	I	104,85	57,21			1,28	47,63	Enough
	II	102,61	59,30			1,33	43,31	Enough
Oct	I	104,47	46,12			1,03	58,35	Enough
	II	102,25	47,98			1,08	54,27	Enough
Nov	I	101,29	16,47	0,30		0,00	84,82	Enough
	II	153,07	48,94	0,88			104,13	Enough
Dec	I	348,24	30,52	0,55			317,72	Enough
	II	421,23	10,22	0,18			411,01	Enough
Amount		6606,44	1032,25				5574,20	
Max				1,57	1,50	1,33	Success Period	100%
Average		275,27	43,01					

Source : The Calculation Result

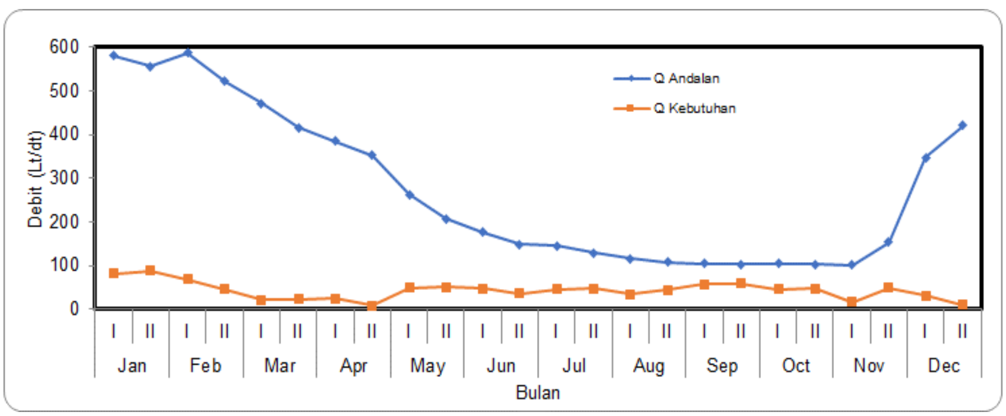

Figure 8. Graph of water balance at Bukian II Weir
(With supplement from Bukian I Weir)

3.6 Analysis of water resources management system in the Bukian Irrigation Area

By looking at the water balance that occurs in the Bukian II Weir with no supplementation from the Bukian I Weir, it can be seen the potential for water shortages in the Bukian Irrigation Area which has the potential to occur in May to November. Based on the results of the analysis after supplementation from the Bukian I Weir, the water balance that occurred in the Bukian II Weir showed a surplus condition. To anticipate water shortages in the Bukian II Weir, it is necessary to have additional flow (suppletion) from the Bukian I Weir. To obtain a good water resources management system in the Bukian Irrigation Area, arrangements must be made regarding the time and amount of water to be supplied to the Bukian I Weir. From May to November by opening the intake of the Bukian I Weir.

The amount of water flowing must be following the needs. When the water balance condition in Bukian II Weir is in a surplus condition, the flow from Bukian I Weir must be stopped, namely from December to April by closing the intake gate of Bukian I Weir. Excess water in Bukian I Weir can be channelled directly downstream to the river to meet the water needs of other users. This is done to maintain the sustainability and balance of an integrated water utilization system.

4 Conclusion

Based on the results of the field review and data analysis that was carried out at the 70% progress report stage, the researcher can conclude several things, including:

1) Based on the results of discharge analysis using the FJ method. The mock result is that the potential availability of water in the Bukian I and Bukian II weirs has a fluctuating magnitude in each semi-monthly period. Each maximum discharge of 0.458 m3/second and 0.130 m3/second occurred in the first February period, the minimum discharge was 0.051 m3/second each in the November I period and 0.050 m3/second in September II and October II. The average discharge potential of each is 0.197 m3/second and 0.079 m3/second which are all analyzed with a reliability level of 80%.
2) Based on the results of the calculation of the net irrigation water requirement (NFR), the amount of irrigation water needed according to the existing cropping pattern is 1.57 liters/second/hectare.
3) The condition of the water balance in the Bukian II Dam without any supply shows the water deficit condition that occurred in September I and II, where the remaining water is shown to be negative, respectively -6.42 liters/second and -8.87 liters/ second. The water balance also shows the potential for water shortages that occur in the period from May to November or predominate in the third planting season. After adding the discharge through the supplementation of the Bukian I Dam, the result was that the availability discharge increased significantly and the water balance indicated a surplus of water, which was indicated by the remaining water which was entirely positive.
4) To obtain a good water resources management system in the Bukian Irrigation Area, arrangements must be made regarding the time and amount of water to be supplied to the Bukian II Weir. The supplement can only be done when the water balance is experiencing a deficit or when there is a potential for water shortages, namely from May to November. The amount of water that is channelled must be following the needs, where if the water balance conditions in the Bukian II Dam are in a surplus condition, the flow from the Bukian I Dam must be stopped, namely from December to April. Excess water in the Bukian I Dam can be channelled directly downstream to meet the water needs of other users to maintain the sustainability and balance of an integrated water utilization system.

Conflict of interest statement
The authors declared that they have no competing interests.

Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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