Analysis of Surface Water Potentials of Noongan River For Rice Irrigation on Agriculture

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Abstract— **It is expected that in the long run, the productivity of rice plant crop in the Noongan plantation area can increase, knowing the surface water flow potential in each month and the rice plant planting season for the farmers to adjust with water availability. To achieve this goal requires information on the availability of surface water flow in the Noongan rice plant agriculture area. The method for measuring surface water flow discharge was by using the Q formula. The expected outcome of this study is the availability of information on the surface water flow discharge for the needs of irrigated rice plant in the research locations.**

Keywords—Surface Water, Potentials, Irrigation on Agriculture

I. INTRODUCTION

The development that we have known so far has a very high impact on water availability, both surface water, and subsurface water. With this development, there are positive impacts felt and enjoyed by humans, while the negative impact is water availability. We know that water is a natural resource that must be well protected because it is the source of human life on this earth [1].

The total volume of water on our planet has remained the same for two billion years. It is due to the water cycle or circulation, which is known as the process of rainfall. All the water on the surface of the earth vapored because of the sunray, then it is vapored to form a group of clouds, the difference in wind pressure and air temperature makes the water condenses to form clumps of vapors, then moved by the wind, water molecules gradually detach from the clouds and fall to earth in the form of drops of water, therefore, we must be wise when using water and preserving its purity. The amount of water volume will remain, but due to pollution, the amount of pure water will decrease over time [2].

Nationally, water availability in Indonesia reaches 1,957 billion m3 per year. With a population of around 250 million people, this potential reaches 8,800 m3 per capita per year, still above the world average of only 8,000 m3 per capita per year. However, if reviewed by region and time, the conditions that occur will vary. There are more than 83% of surface water is concentrated in Sumatra, Kalimantan and Papua, 17% in Java-Bali, Sulawesi and Nusa Tenggara. Java Island, with an area of 7% of the total land area of Indonesia, only has a potential of 4.5% of the total national freshwater. The island is inhabited by approximately 65% of the total population of Indonesia. The above conditions illustrate that a very high potential for water scarcity will occur in Java with the carrying capacity of water resources that has reached a crisis point [3].

If we look at the availability of water per capita per year, there are only 1,750 m3 in Java, still below the adequacy standard of 2,000 m3. Until 2020, it is estimated that there will only be 1,200 m3 per capita per year available in Java. This potential water crisis also occurs in other regions such as East Nusa Tenggara, Bali, West Nusa Tenggara, and South Sulawesi. Of the total water availability per year, around 80% is available in the rainy season which lasts 5 months, while the other 20% are available in the dry season with a duration of 7 months. In the rainy season, the amount volume of water flows directly into the downstream areas, namely because of topographic contours, reduced land vegetation cover, and also a decrease in water catchment areas due to land use rates. This direct flowing water has deviated from the original hydrological cycle, which can be called a combination of sub-surface flow and surface flow into the dominant surface flow without any meaningful use. This change has even become the threat of routine flooding in some areas as well as the threat of drought in the dry season that has been felt on the island of Java [3].

Water is a basic human need, and all living things need it. The reality today is, besides being a natural resource it is also a valuable commodity that has a high economic value. Therefore water resources management is essential and needs to be done [4].

Water is one of the determining factors in the process of crop production. Therefore, the investment in irrigation is significant and strategic, in the framework of water availability for the crop production process to meet the water requirements for various agricultural businesses then irrigation water must be provided in adequate volumes [5]. The right time, if not, then the growth of crops will be disturbed, which in turn will affect production (Water Management Directorate, 2007) in reference, Therefore, water for crop using must meet certain hygiene requirements, according to the type of crops: for example meeting certain degree of the temperature, which it should not be either in too high or too low temperature [5].

To meet the water requirements, various ways and efforts are made by humans, for example, by finding new sources of

water, building a dam, purifying dirty water, desalinating seawater and creating artificial rain.

The water irrigation from upstream to downstream requires the following facilities and infrastructures;

1. A dam;

2. Weir

3. Primary channels and secondary channels

4. Box building

5. Measuring buildings and,

6. Other tertiary channels,

The disruption or damage to one of the irrigation structures will affect the performance of the existing system, which results in decreased efficiency and irrigation activities. If this condition is left unchecked and not to be overcome, then it will have an impact on the decrease of production as well as having negative implications on farmer's income and their socio-economic conditions.

The plant cultivation model by adjusting the climate conditions, precisely the amount of rainfall, days and its distribution applied lately has been generally less effective and efficient, because the intensity, frequency, and duration of climate anomaly tends to increase. Moreover, the pattern of production distribution will usually be in tune with the rainfall pattern (season) but often not in line with the relatively fixed market demand. To meet the needs of irrigation water to adjust with the crop season and market demand, the implementation of water management through surface water irrigation is needed, especially during the dry season.

Based on irrigation water sources, the irrigation is divided into two categories, namely surface water irrigation, and groundwater irrigation. Due to the relatively limited amount of water in certain places, while the demand for water continues to increase, there will naturally be competition in its use between sectors among regions and time.\

In addition to producing rice, the Paddy field can also be used by farmers to raise the fish with high potential and economic value. Moreover, it also produces several types of plants such as types of beans, corn, vegetables and other plants of high economic value. However, at certain times, for example, in the dry season, this type of plant is not maximally productive due to the lack of irrigation water needed. As a result, the income of farmers decreased.

The problem in this study was only delimited to the measurement of surface water flow discharges in the Noongan river for the need for irrigation of paddy crop in Noongan paddy field of the Langowan City of Minahasa Regency.

II. RESEARCH METHOD

The method used in this research was Map interpretation, analysis of data, provided by relevant agencies to qualitatively determine the surface water flow discharge of the Noongan

River and its probabilities for irrigation of paddy field, and its balance based on time and space.

To obtain data related to the research object, the following materials are needed:

1. Meter, Stopwatch, and Buoy.
2. A base map on a scale of 1: 50,000
3. A topographic map of 1: 200,000 scale
4. Hydrological data especially quantitative data
5. Meteorological data to determine the type of climate at the research locations, and to determine the potential river water.

Surface water flow in the Noongan river. The potential river water is in quantitative form or river water discharge of an area in providing water for irrigation of paddy fields.

Balance of the river water potential needed for irrigating paddy fields. It is a balance in the use of existing river water resources according to space (area) and time. To achieve the research objectives, the data, obtained from the relevant institutions of analysis were as follows:

River water discharge data, combined on a landform map, then it was made the comparisons to identify the potential of river water that could be used for irrigation needs.

Data of required irrigation of paddy crop in utilizing water, then comparing with the discharge of river water.

By comparing the data, it could be observed river water flow used for the irrigation of paddy fields. To find out the water required, the following equation was used:

- Average of water/plot/day requirement
- The volume of required river water for irrigating paddy fields
- The total area of paddy fields

= Required water average for paddy field irrigation/day x /width. To calculate the discharge, the Buoy method was employed, with the following formula:

$Q = A \times V$

Where:

Q = Channel Discharge

A = Wet Cross-sectional Area

V = Mean of Buoy Velocity (m / sec)

The wet cross-sectional area is the width multiplied by the depth of river water based on the length of the measurement area.

III. RESEARCH AND DISCUSSION

A. Climate

Climate is a general nature of the atmosphere that exists at a place in a certain period. Factors that influence climate are rainfall, air temperature, humidity, wind speed, and solar radiation. Climate is one of the factors that shape the soil and is also one of the determining factors in the success of agricultural activities, both on dryland and wetlands. Therefore, climate information is essential to be examined in order to find out the potential that exists in the area. Rainfall data were obtained from the data that was available at weather

station records in the research locations. The weather stations are Tompaso, Langowan, Noongan and Kakas.

To show the climate conditions, the mean calculation for each climate factor was employed, so that the information obtained was sufficiently accurate in describing the fluctuations of climate conditions in the surveyed area.

a) Rainfall

The data on average monthly rainfall is presented in table 4.2. The average monthly rainfall data ranges from 76 - 281.3 mm. The rainfall data were used to calculate the irrigation water requirements of paddy in the soil. The data were made for every 10-days period to be more accurate, and the data were also used in the calculation of useful rain.

Therefore, the classification was made for every 10-day by taking the following limitations:
a. Rainfall of day 1 to the 10 for the first 10-days period.
b. Rainfall of day 11 to the 20 for the second 10-days period.
c. Rainfall of day 21 to the end of the month for the third 10-days period.

The mean value for one decade in a 10-days period of rainfall can be seen in table 4.3. The highest mean value was 84.75 mm in December of the Decade I, while the lowest one was in August of Decade III by 30.0 mm.

b) Air Temperature

There was no air temperature information in the survey area, only at Kawangkoan station close to the survey area in the West.

Table 4.2. The Average Monthly Rainfall in Two Rainfall Stations of Research locationsin 2000-2015.

MONTH	RAINFALL STATIONS	
	NOONGAN	KAKAS
January	204.5	207.9
February	155.0	139.0
March	155.4	185.1
April	176.1	170.0
May	241.7	193.0
June	220.6	153.0
July	176.4	129.0
August	108.4	76.0
September	150.4	142.5
October	148.3	151.2
November	235.2	239.3
December	206.6	157.8

Source : Meteorology and Climatology Station of Kayuwatu, Manado and the calculation results.

Tabel 4.3. CALCULATION OF AVERAGE RAINFALL FOR 10-DAYS PERIOD IN RESEARCH LOCATIONS USING ARITHMATIC METHOD

Months	Decade	Rainfall Values	Months	Decade	Rainfall Values
January	I	71.9	July	I	60.0
	II	60.0		II	55.8
	III	82.8		III	39.2
February	I	50.25	August	I	32.25
	II	73.0		II	30.95
	III	50.25		III	30.00
March	I	81.0	Septem	I	49.5
	II	74.25		II	46.8
	III	50.0		III	49.7
April	I	58.0	October	I	50.0
	II	65.0		II	48.0
	III	50.75		III	50.0
May	I	71.42	Novem	I	83.75
	II	72.83		II	67.5
	III	70.0		III	100.0
June	I	68.0	Decemb	I	84.75
	II	59.17		II	71.5
	III	50.33		III	68.0

Sources: Calculation Results, and table 4.2

To determine the climate type of the research locations, the climate classification by Koppen was used, while the rainfall type was based on Schmit and Ferguson's classification.

Koppen classifies four main types of climate, (Schmidt-Ferguson, 1951), as follows:
1. Type A Climate or tropical rain forest Climate has the following characteristics:
   a. The air temperature in the coldest month is 18 ° C
   b. Total annual rainfall (r), shown in millimeters, is greater than 20t (t = annual average of air temperature).
   c. If it rains in the summer, then the value of r> 20 (t + 14).
2. Type B Climate or dry climate has properties, as follows:
   a. R> 20t for most frequent rainfalls in winter.
   b. R> 20 (t + 14), for the most frequent rainfalls in summer.
3. Type C Climate or Warm Temperate Rainy Climate has the following characteristics:

a. The temperature in the coldest month is between 18 ° - 3 ° C.
b. The temperature in the warmest month> 10 ° C.
c. R> 20 (t + 14), for most frequent rainfalls is in summer.
4. Type D Climate or Cold Snowfall Climate has the following properties:
a. The temperature in the coldest season <-3 ° C.
b. R> 20 (t + 14), for most frequent rainfalls in summer.
5. Type climate E or polar climate has properties.
a. The warmest month temperature <10 ° C.

Based on the climate types above, the rainfall station in the research locations, namely in Kakas, Langowan, Noongan, and Tompaso, were included in Type A climate. Determination of climate type can be seen in Table 4.6.

According to Koppen, type A climate, which is based on the driest monthly value and the value of annual rainfall is divided into three:
1. Am, Tropical Rain forest
2. Aw, Tropical savanna
3. Af, Tropical Moist

Determination of climate A type distribution by entering the data of the amount of the driest month and the amount of annual rainfall into the climate type A distribution diagram according to Koppen. The explanation can be seen in Figure 4.1.

Table 4.4. KOPPEN'S TYPES OF CLIMATE IN RAINFALL STATIONS IN RESEARCH LOCATIONS

Rainfall Stations	Coldest Month of Weather Temperature (°C)	Total Annual Rainfall (mm)	Average Annual Weather Temperature (°C)	Type of Climate
Kakas	21.9	1912.5	23.57	A
Langowan	21.6	2302.6	22.18	A
Noongan	21	2239.6	21.66	A

Source: Table 4.2 and Calculation Results.

For the classification of climate types according to Schmidt and Ferguson, based on the Q value, which is the ratio between the dry month and the wet month's average. Q values were obtained from the equation below.

$$Q = \frac{\text{The average score of dry months}}{\text{The average score of wet months}} \times 100\% \ldots\ldots (15)$$

Table 4.5 SCHMIDT AND FERGUSON'S CLASSIFICATION OF CLIMATE TYPE IN RESEARCH LOCATIONS

Location	Average Number of Months		Q Value (%)	Classification
	Wet	Dry		
Kakas	11	0	0	A
Langowan	11	2	0	A
Noongan	12	1	0	A

Source : Calculation Results.

Based on the data above, it turns out that all stations were classified as Very Wet (A) category. The classification of wet and dry months based on criteria suggested by Mohr (Mock, 1973), as follows:
1. Dry months are months that have less than 60 mm rainfall.
2. Humid months are months that have rainfall between 60 mm to 100 mm.
3. Wet months are months that have rainfall greater than 100 mm.
Based on the Q value, Shcmidt and Ferguson determine the type of climate, as follows:
Group A 0,000 <Q <0.143 Very Wet
Group B 0.143 <Q <0.333 Wet
Group C 0.333 <Q <0.600 Slightly Wet
Group D 0.600 <Q <1,000 Medium
Group E 1,000 <Q <1,670 Slightly Dry
Group F 1,670 <Q <3,000 Dry
Group G 3,000 <Q <7,000 Very Dry
Group H 7,000 <Q <- Extremely Dry.
The lowest the Q value, the wetter the area is. The calculation results of the value at each rainfall station in the research locations can be seen in table 4.5.

1. Irrigation Water Requirement of Paddy Fields
The amount of irrigation water requirement in the research locations was influenced by the age of the crop, water absorption by the soil (percolation), and the amount of rainfall. In calculating the consumptive water requirement, the water requirement of a paddy field, and then the amount of irrigation water, the three stages above were sequentially specified below.

a. Consumptive Water Requirements (CWR) of the Crop.
Consumptive Water Requirement (CWR) is the amount of water that is potentially used to meet the requirements of the evapotranspiration of a crop area so that it can grow normally (Sitanala Arsyad, 1982). Consumptive use or crop water requirement is the amount of water used for transpiration or the plant or natural vegetation tissue expansion, together with evaporating water of land, snow or which prevents the fall of rainwater (Van Dam, 1972).
To find out the number of consumptive water requirements or crop water requirements, it is required the parameters of evaporation (Eo) and factors of crop (Fc) of each type of crops. The evaporation value (Eo) can be seen in

table 4.11, while the value of the paddy crop factor was used to calculate the consumptive requirements.

The data of paddy growth in the research locations were obtained from the Agriculture Office of Minahasa Regency, in which the tillage and seedbed took 25 days, vegetative growth took 60 days, and generative to mature growth took 40 days.

Tabel 4.6 FACTOR OF PADDY CROP (FC)

Crop	Periods of Crop Growth	Crop Factor	Water Requirement (mm)
Paddy	a. Cultivation for and transplanting seedlings	-	200
	b. seedbed	-	100
	c. Vegetative Growth	1.10	
	d. Generative growth until flowering	1.35	
	e. Fertilization to mature.	0.08	

Source: Abdulrachim (1974) in Sudibyakto (1981)

The results of the consumptive water requirements calculation of paddy crop in the research locations for every 10 days ranged from 31.28 mm to 50.49 mm.

The highest 10-day period of consumptive water requirements was from the period of generative growth to flowering, for more details, see Table 4.17. b.

b. Field Water Requirements (FWR)

Field Water Requirement (FWR) of the paddy field is the amount of water used for plants, plus the loss of water in the agricultural land area in the form of surface drainage, percolation, and evapotranspiration (Acmadi Partowiyoto, 1975). In calculating the amount of water in a paddy field, we must consider the amount of consumptive water, for plants, percolation, submergence, and saturation. The formula used was the equation no.8 on page 32.

1) Percolation, Submergence, and Saturation

In calculating the paddy crop water requirement agrohydrologically, the average submergence is 100 mm / 125 days or 0.8 mm / day, while the saturation of the land requires water of 1.2 mm / day (Achmadi Partowiyoto, 1975). Furthermore, the percolation value is influenced by soil structure and texture, groundwater level, and sand-textured permeability less than 50 mm/day.

Lee, (1990) suggested that the average infiltration capacities correlated with the physical properties of the soil: the correlation was positive for soil porosity and organic matter content and negative for clay content and soil weight content. The typical infiltration capacity for sandy-textured soil and vegetated soil is 40 - 50 mm.

The type of soil in the research locations was regosol with coarse-textured, which was the loamy sand to sandy loam, red-yellow podzolic soil and *glei humus* with sandy loam textures, thus the percolation value was 50 mm/day

2) Calculation Results of Field Water Requirement (FWR) of Paddy Field

Having known the consumptive water requirements for plants (CWR), percolation, submergence and saturation, the water requirements in paddy fields in the research locations can be seen in Table 4.18. Based on the table, FWR score was between 447,161 - 622.49 mm / day. The largest FWR score was in March, when the paddy crop grew from generative to flowering periods.

Tabel 4.7 FIELD WATER REQUIREMENT IN 10-DAYS PERIOD OF PADDY CROP IN RESEARCH LOCATIONSS

Month, Period		CWR (mm/h)	Pe (mm/h)	Pg (mm/h)	Pj (mm/h)	FWR (mm/hari)
1		2	3	4	5	6 2+3+4+5
September	I	-	500	8	12	520
	II	-	500	8	12	520
	III	-	500	8	12	520
October	I	40,15	500	8	12	560,15
	II	40,15	500	8	12	560,15
	III	44,165	550	8,8	13,2	616,16
November	I	38,995	500	8	12	558,99
	II	47,857	500	8	12	567,86
	III	47,857	500	8	12	567,86
December	I	47,965	500	8	12	567,96
	II	28,424	500	8	12	548,42
	III	31,28	550	8,8	13,2	603,28
January	I	-	500	8	12	520
	II	-	500	8	12	520
	III	-	500	8,8	13,2	520
February	I	-	500	8	12	520
	II	38,951	500	8	12	558,95
	III	31,161	400	6,4	9,6	447,16
March	I	37,4	500	8	12	553,34
	II	37,4	500	8	12	557,40
	III	50,49	550	8,8	13,2	622,49
April	I	47,25	500	8	12	567,25
	II	45,90	500	8	12	565,90
	III	47,25	500	8	12	567,20
May	I	65,7	500	8	12	585,70
	II	-	500	8	12	520
	III	-	550	8,8	13,2	520
June	I	-	500	8	12	520
	II	-	500	8	12	520
	III	37,73	500	8	12	557,73
July	I	40,15	500	8	12	560,15
	II	40,15	500	8	12	560,15
	III	44,165	550	8	13,2	616,17
August	I	44,01	500	8	12	564,01
	II	44,01	500	8	12	564,01
	III	48,411	550	8	13,2	620,41

Source: Calculation Results

Where :

Pe   = Percolation

Pg   = Submergence

Pj   = Saturation
CWR   = Crop Consumptive Water Requirement
FWR   = Paddy Field Water Requirement

c.   Irrigation Water Requirement (PWR)

Irrigation Water Requirement (PWR) is the amount of water required to meet the overall requirements for irrigating a paddy field. The value of irrigation water requirement in the research locations was affected by the type of crops, age, water infiltration in the soil (percolation), water loss during conveyance, and rainfall in the research locations.

To calculate the irrigation water requirement (PWR), the amount of water requirement in a paddy field, effective rainfall, and the amount of channel efficiency, must be previously known.

1) Effective Rainfall

Effective rainfall is the rainfall during the crop growth that can be used to meet the Crop Consumptive Water Requirements (Sitanala Arsyad, 1989). The calculation of effective rainfall used equation No. 12 Page 34.

The calculation results of effective rainfall for 10-days period of paddy field in the research locations ranged from 22.40 mm/10 days to 62.37 mm/10 days. The highest effective rainfall transpired in the third period of November, and the lowest one was in the third period of August. The results were presented in Table 4.19.

Tabel 4.8 EFFECTIVE RAINFALL AVERAGE IN 10-DAY PERIODS OF PADDY CROP

Month, Period		Rainfall (mm)	CWR (mm)	Effective Rainfall (mm)
1		2	3	4
	I	44,50	3	-
September	II	46,80	-	-
	III	49,70	-	-
	I	50,50	-	33,13
October	II	48,00	40,150	31,71
	III	50,00	40,150	33,76
	I	83,75	44,165	50,53
November	II	47,50	38,995	44,73
	III	100,00	47,857	62,37
December	II	71,50	47,857	32,50
	II	68,00	28,424	-
	I	71,90	-	-
January	II	60,00	-	-
	III	82,80	-	-
	I	50,25	38,951	32,71
February	II	73,00	31,161	42,64
	III	50,25	37,400	32,37
	I	81,00	37,400	48,55
March	II	74,25	50,490	49,40
	III	50,00	47,250	34,51
	I	58,00	45,900	38,82
April	II	65,00	47,250	43,16
	III	50,75	65,700	39,68
	I	71,42	-	-
May	II	72,83	-	-
	III	70,00	-	-
	I	68,00	-	-
June	II	59,17	37,730	35,59
	III	50,33	37,730	32,44
	I	60,00	40,150	38,33
July	II	55,80	40,150	36,11
	III	39,20	44,165	27,37
	I	32,25	44,010	23,11
August	II	30,95	44,000	34,20
	III	30,00	48,411	22,40

Source: Calculation Results of Table 4.3

Conveyance Efficiency (Ec) of Irrigation Water

Conveyance efficiency is a comparison between the ratio of water that is useful to the crop farmed and the amount of water available and useful for irrigation. The irrigation efficiency of an irrigated area is determined by the efficiency of the water user from the dam through the channel, and to the paddy field.

During the conveyance, water losses can be in the form of evaporation in the irrigated channel, percolation in the channel, which can be used by people for household needs (Sudjawardi, 1987).

The value of the irrigation water conveyance efficiency, as pointed out by Istraelsen and Hansen (1979), can be calculated using the formula of no. 10 on page 33.

Irrigation water loss is the deviation of the discharge channel that flows to the paddy fields and the river water discharge. The data used to calculate the efficiency of water conveyance was the measurement results in the research locations obtained from the North Sulawesi Department of Public Works in Irrigation DPP 05 Langowan. The most significant water loss was in the Noongan irrigated area with a value of 624.5 mm/sec, while the efficiency of the water channel ranged from 2.42 percent to 100 percent. The average channel efficiency was 74.53% (Table 4.20).

This channel efficiency score was used to calculate the irrigation water requirement in irrigation channels (Project Water Requirements)

Tabel 4.9   THE EFFICIENCY VALUE OF WATER CHANNEL IN RESEARCH LOCATIONS

Irrigation Area	Area (Ha)	Discharge It/dt		Eff. Channel (%)
		River	Channel	
Noongan				
Sina I	15	640	15,5	2,42
Sina II	80	620	82,4	13,30
Sarewow	30	535	33,6	6,30
Nogan kiri	386,5	509	180	98,23
Nogan	430,5		320	
kanan	60	60	58	96,66
Kinalawiren	47	35	30	85,71
Kaliabang	18	45	43	95,55
Impit	58	35	31	88,57
Toliang	97	23	20	86,95
Mimbegen	91	46	46	100
Timbukar				
Mean				74,53

Source: Irrigation Area of DPP 05 Langowan

The calculation results

After the value of the channel efficiency in the locations of research was obtained, the irrigation water requirement (PWR) can be calculated using equation No. 9 Page 32. The calculation results obtained were 55,816 mm/h to 78,144 mm/day. The highest PWR transpired in October of the third period. The PWR results can be read in Table 4.21.

Table 4.12 IRRIGATION WATER REQUIREMENTS (PWR) FOR PADDY CROP IN RESEARCH LOCATIONS

Month, Decade	FWR-Re (m/10h)	Eff Irrigation	PWR		
			mm/10 h	mm/h	mm/h/Ha
1	2	3	4	5	6
	-	74,53	-	-	-
	-	74,53	-	-	-
	-	74,53	-	-	-
I	527,020	74,53	707,121	70,712	707,121
September	528,440	74,53		70,903	709,029
II	582,405	74,53	709,02	78,144	781,437
III	508,405	74,53	781,347	68,223	682,228
I	523,127	74,53		71,090	710,901
October II	505,487	74,53	682,228	67,823	678,232
III	513,665	74,53		68,920	689,105
I	520,000	74,53	710,901	69,770	697,705
November	572,000	74,53		76,747	767,476
II	-	74,53	678,232	-	-
III	-	74,53		-	-
I	-	74,53	689,205	-	-
December	-	74,53		-	-
II	520,000	74,53	697,705	69,770	697,705
III	416,000	74,53		55,816	558,164
I	515,600	74,53	767,476	69,180	619,801
January II	520,00	74,53		69,770	697,705
III	575,240	74,53	-	77,823	771,823
I	520,000	74,53	-	69,770	697,705
February	520,000	74,53	-	69,770	697,705
II	519,950	74,53	697,705	69,764	697,708
III	520,000	74,53		69,770	697,705
I	-	74,53	558,164	-	-
March II	-	74,53		-	-
III	-	74,53	691,801	-	-
I	-	74,53		-	-
April II	520,000	74,53	697,705	69,770	697,705
III	520,000	74,53		69,770	697,705
I	520,000	74,53	771,823	69,700	697,705
May II	572,003	74,53		76,748	767,480
III	520,000	74,53	697,705	69,770	697,705
I	520,000	74,53		69,770	697,705
June II	572,001	74,53	697,705	76,748	767,477
III			697,705		
I			697,638		
July II			697,705		
III			-		
I			-		
August II			-		
III			-		
			-		

Table continuation (top right):

			697,705		
			697,705		
			667,705		
			767,480		
			697,705		
			697,705		
			767,47		

Source: Table 4.7, 4.8 Calculation Results

IV. CONCLUSION

Based on the results of the study as described in chapter IV, the following conclusions and suggestions were put forward:

1. Irrigation areas with surface water shortages need to be made shallow groundwater wells to supply less water area. Thus, the farmers can cultivate their paddy fields for 3 (three) times a year. Relatively, the production of rice in the research locations will increase.

2. Areas where shallow groundwater wells can be made. Based on river water discharge, channel water discharge and command area that can be seen in Appendix Figure 5, the location of dug wells for irrigation in the research locations were: 2 (two) wells of Noam Kanam irrigation area, 1(one) well of Kinalawiren irrigation, Kaliabang irrigation are with 2 (two) wells, 2 (two) wells of Toliang irrigation area, and 8 (eight) wells of Maimbengen irrigation area, Assuming each well can irrigate paddy fields covering an area of 10 ha/day.

3. River water discharge for irrigation areas of Sina I, II, Noongan Kiri, Impit, and irrigation areas according to its command area can on average meet the surface water requirements for irrigated paddy fields.

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