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Study of Water Balance for Irrigation in Coastal Areas Jember District

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Abstract

The drastic increase of groundwater exploitation in Coastal Coastal Areas is the Ambulu, Wuluhan and Puger Districts of Jember Regency. This can be seen from the increasing number of new housing developments which can result in a decrease in groundwater rechectaresrge so that it is necessary to study the potential or groundwater reserves so that the extraction of groundwater that hectaress been carried out is balanced with groundwater filling. If this balance does not occur, the coastal areas in the long term will be prone to drought and sea water intrusion. Long-term drought disasters cause a decrease in the soil layer or sink, while long-term seawater instrution causes the groundwater in the coastal area to become salty so that it cannot be used anymore. A study requirement to be done so that the water balance is balanced. Then it is necessary to calculate the amount of water requirement and the availability of water. Requirement include domestic, irrigation, industry and other requirement. The availability is calculated from surface water and groundwater. Based on the results of the analysis in the previous section, the total water availability in the 3 coastal districts reached 532,843 m^3/sec, while the water requirement for irrigation and other purposes amounted to 132,679 m^3/sec and a surplus of 400,165 m^3/sec.

Keyword: Groundwater, coastal area, water balance, requirement and availability.

I. INTRODUCTION

Exploitation of groundwater in Coastal Areas in Jember Regency increased shectaresrply from 150 liters/sec in 2000 to 750 liters/sec in 2014 (Source: 2015 Jember Regency Industry and Trade Office). Exploitation is carried out through groundwater drilling at several points both by individuals, private and government agencies. As a result, the current tendency of a decrease in water discharge and a decrease in groundwater at several drilling points is one of the wells belonging to the Fish Port of Puger District, Jember Regency, from a discharge of 15 liters / sec to 25 liters / sec while the water level hectaress decreased by 1.00 meters in the year 2014 [1].

Likewise, population growth also increased quite dramatically in Coastal Coastal Areas, namely Ambulu, Wuluhan and Puger Districts, Jember Regency. This can be seen from the increasing number of new housing developments, educational and tourism facilities, new industrial centers and fishing ports. In 2003 the population density in Ambulu Subdistrict was 905 population/km^2 while in 2013 it was 1,452 population/km^2, in Wuluhan Subdistrict in 2003 the population density was 811 population/km^2 while in 2013 it was 1,232 population/km^2, while in Puger District in 2003 the population density was 587 population/km^2 while in 2013 it was 1,093 population/km^2 [2].

The number of housing areas increased from 12 residential areas in 2003 to 97 residential areas in 2013 (Source of Jember Regency Cipta Karya) while the number of infrastructure (education, social, industrial) increased from 64 Institutions in 2003 to 185 institutions in 2014 [2]. Based on the description above, the consequent increase in groundwater exploitation will increase even though housing development and institutions are increasing. This will result in a decrease in groundwater rechectaresrge so that it is necessary to study groundwater potential or reserves so that the extraction of groundwater that hectaress been carried out is balanced with groundwater filling. If this balance does not occur, the coastal areas in the long term will be prone to drought and sea water intrusion. Long-term drought disasters cause a decrease in soil layers or sinks, while long-term seawater instrution causes salty groundwater in the coastal area to become unusable.

In 1950, the system dynamics method was officially created by J. W. Forrester at the Massachusetts Institute of Technology [11], which hectaress proven useful for simulating any system that can be thought of in the form of surface flow or groundwater. This approach is often used for water resources management planning as part of a comprehensive decision-making process [10]. The system dynamics approach facilitates understanding of complex system behectaresvior over time. Thus, the use of system dynamics in planning water resources was accelerated in the 1990s [9], [12], [15].

Description of alternative methods of estimating groundwater filling for various climates is presented by Lerner et al. [5]. Subsequent publications [8] focus on a detailed review of the principles and practicality of assessing refilling of rainfall, from intermittent flows and from permanent water bodies. Appropriate techniques for semi-arid zones must accommodate highly variable climatic chectaresracteristics, such as high proportions of indirect absorption and large spatial and infiltration temporal variability [8]. Understanding the refilling mechectaresnism and water flow in this system is very important for sustainable management of water resources. However, groundwater rechectaresrge is one of the most difficult components to measure the hydrological cycle, so there is no direct measurement method. Various techniques are described in the literature [2], [7] but all hectaresve limitations and uncertainties, making comparisons with estimates of the various methods needed. Among other things, the water balance seems beneficial, because it is not limited to only one of the soil zones [4]. Computational modeling of refilling and flow mechectaresnisms allows understanding of the process, and provides information that can be used in decision making processes [14] and [18]. However, estimates of refilling and flow simulations must be validated for the effective conditions of the Aquifer System.This document is a template. An electronic copy can be downloaded from the conference website.

II. METHODOLOGY

The location of the study was carried out in Balung, Puger and Wuluhan Districts, Jember Regency, East Java Province. In this study used descriptive analysis method based on the assessment of technical aspects and environmental aspects. The discussion carried out is to calculate the water balance by using the concept of the balance of water inflow and outflow. The practical application of the groundwater model for urban water management can be hectaresmpered by the lack of complex urban knowledge on groundwater refill patterns [17]. In the case of vegetable planting intensive aquifer production is taking place near or even in protected groundwater zones, a threat to groundwater quality [20]. In recent years, lysimetry hectaress evolved significant and improved techniques, allowing accurate water flow measurements and water balance parameters [8] and can be used to investigate hydrological processes such as rainfall, infiltration, or in percolation of groundwater. In connection with the above, then in this study the components are also taken into account, with the equation:

$$I = O \pm \Delta S \quad (1)$$

By:

I = input (mm / month)

O = output (mm / month)

Inflow comes from surface runoff and groundwater flow while outflow comes from the use of water for irrigation, community consumption and industrial groundwater use. In this study the data collection process was carried out in the form of primary and secary data. Furthermore, the preparation stage includes licensing, initial literature study, initial site survey, and problem identification. Licensing is done to facilitate researchers in obtaining primary and secary data.

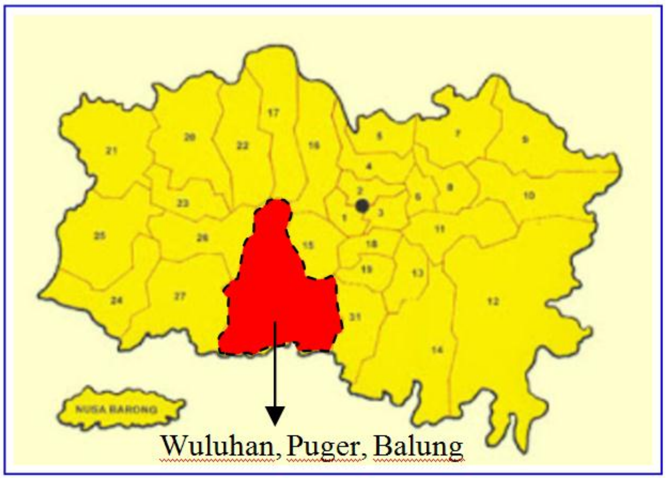

Fig. 1. Map of location of research activities

The results of similar studies will be used as a comparison of the methods and results obtained. The initial survey was conducted to determine the existing condition in general at the research location. Problem identification is the determination of problems that occur at the research location. Field observations in the study area as well as conducting surveys in Puger, Wuluhan, Ambulu Districts for the purpose of knowing groundwater use in free aquifers, namely domestic requirement. While data on the use of confined aquifers is obtained through secary data, namely permits to use groundwater through the Ministry of Energy and Mineral Resources of the Province of East Java. Relevant data is also related to research, namely hydrological data by BMKG.

III. RESULTS AND DISCUSSION

The study of groundwater potential in the area of Jember Regency is determined by geological conditions, morphology and local hydrogeological conditions. The aquifer studied is Puger Subdistrict, Wuluhan, Ambulu which hectaress free aquifer and confined aquifer groups. The results of groundwater condition assessment in the area hectaresve been carried out and the results obtained based on geoelectric tests in 3 (three) spreads are estimated to estimate 1,477 liters of groundwater in confined aquifer / sec [13]. The average production capability with reference to the Indonesian Hydrogeological Map hectaress been calculated in this study of 9,667 liters/sec, the full results are presented in Table 1. The groundwater production is greater thectaresn the geoelectric test results. This is because the amount of groundwater in the free aquifer is also calculated and the amount of groundwater is greater.

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Table 1. Availability of average groundwater

No	Districts	Area (Km^2)	Aquifer Area (Km^2)			Groundwater Potential (liter/sec)
			High Productive	Medium Productive	Low Productive	
1	Puger	148.990	44.697	44.697	74.495	7.250
2	Wuluhan	137.180	82.308	20.577	34.295	9.250
3	Balung	47.120	47.120	-	-	12.500
	Amount	333.290	174.125	65.274	108.790	29.000
	Average	111.097	58.042	21.758	36.263	9.667

However, if referring to Groundwater Reserve Map (GRM) for the Jember and Lumajang Districts, the results are presented in Table 2. The table shows the number of groundwater potential both in shallow and deep conditions. The amount of shallow groundwater potential is 51,035 m3 / year and deep groundwater is 2,547 m^3 /year. Detailed results for the Puger, Wuluhan, and Balung Districts are presented in Table 2.

Table 2. Potential GRM of the research area

No	Districts	Area (Km^2)	Coefficient Area (Km^2)	Shallow Groundwater Potential (liter/sec)	Deep Groundwater Potential (liter/sec)	Total (liter/sec)
1	Puger	148.990	0.0261	68.443	3.416	71.858
2	Wuluhan	137.180	0.0240	63.018	3.145	66.162
3	Balung	47.120	0.0082	21.646	1.080	22.726
	Amount	333.290	0.058	153.106	7.641	160.747
	Average	111.097	0.019	51.035	2.547	53.582

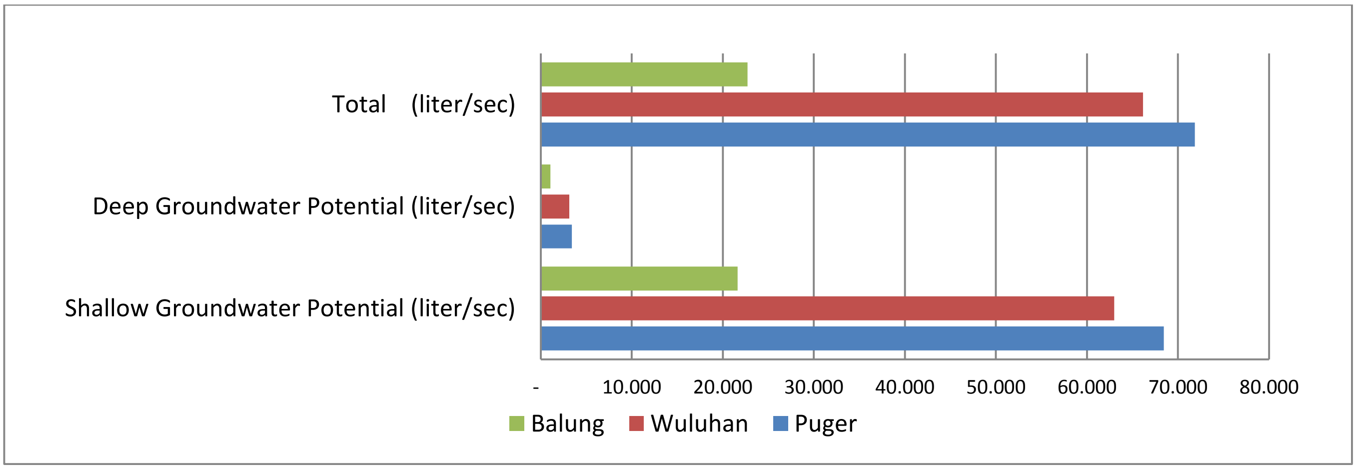

Fig. 2. Groundwater Reserve Map (GRM) in Wuluhan, Puger and Balung Districts

If compared with groundwater availability from geoelectric, Hydrogeological Map and GRM results, there is a difference, from the CAT map the amount of water availability is greater. So in this study determined the amount of available availability is 29 liters/sec. The availability of water which is quite a lot is obtained from surface groundwater, namely the flow from the Bedadung River, which is supplied through Bedadung Weir to the irrigation area in Balung, Puger and Ambulu areas. In calculating the availability of groundwater is carried out from the AWLR records of the East Java Provincial Irrigation Office starting from 2013 to 2017. Then the data is averaged every month, the results are presented in table 3.

Table 3. Discharge in Bedadung Weir

No	Month	Discharge (m^3/sec)					
		2013	2014	2015	2016	2017	Average
1	January	106.08	87.97	62.92	31.58	95.29	76.77
2	February	80.32	68.28	66.43	80.02	66.15	72.24
3	March	65.85	43.31	103.38	54.28	72.05	67.77
4	April	60.81	56.61	55.97	38.71	74.53	57.33
5	May	37.20	24.25	23.49	33.04	29.10	29.42
6	June	48.85	16.75	16.29	34.03	32.06	29.60
7	July	17.08	13.99	10.93	27.13	16.41	17.11
8	August	12.03	10.77	11.92	16.07	4.81	11.12
9	September	11.23	7.82	9.41	25.60	3.71	11.55
10	October	11.16	7.89	12.64	46.83	25.57	20.82
11	November	30.98	18.58	14.77	69.98	72.16	41.29
12	December	81.03	109.12	22.95	82.61	104.85	80.11

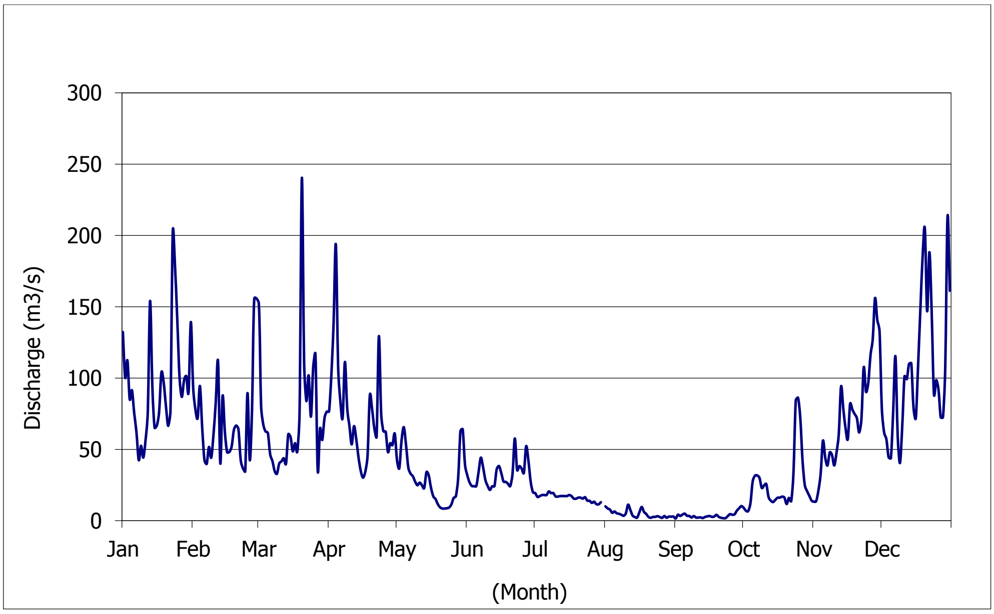

Fig 3. Fluctuations Discharge in Bedadung Weir
At January to December 2017

From table 3, the maximum availability in December is 80.11 m^3/sec while the lowest in May is 29.47 m^3/ sec. Fluctuations tend to be high from December to April, and the trend decreases from May to November. The flow fluctuations are presented in Figure 3.

The amount of outflow is calculated from the water utilization factor for irrigation and industry. Most of the irrigation uses surface water while the industry uses ground water. So the calculation of irrigation water requirement refers to the pattern of planting in the research location. From the results of the calculation of the water requirements, the total requirement for the three areas are calculated, which refers to the area of the rice fields which irrigation water requirement. For Puger Subdistrict 2,065 hectares, Balung District 1,000 hectares and Wuluhan District 6,278 hectares. The most requirement are in Wuluhan and Puger Districts. Some parameters needed for this purpose include soil data, sun brightness, wind velocity, air humidity and so on. The results of the calculation of evaporation values are presented in table 4, while the results of the calculation of the need for irrigation water are presented in table 5.

In table 4 it can be seen that the highest fluctuation in evaporation value occurred in October, which was 144 mm/month while the lowest occurred in January, which was 93 mm/day, this was possible because of the high humidity and low sun brightness. The high evaporation value in October was partly due to low humidity as well as a rather high wind speed factor. Furthermore, the results of evaporation calculations every month will be used to calculate the requirement of irrigation water in the Puger, Wuluhan and Balung Districts of Jember Regency as presented in table V.

Table 4. Calculation of evaporation at the study site

No	Discription	Not	Unit	Note	Month											
					Jan	Peb	Mar	Apr	May	Jun	Jul	Augt	Sep	Oct	Nop	Dec
1	Average temperature	t	°C	Data	26.3	31.1	31.7	31.5	31.3	31.1	25.4	25.4	26.2	26.4	27.6	26.7
2	Water Steam Pressure		m bar	Table	34.1	44.0	45.2	44.8	44.4	44.0	32.5	30.6	34.1	32.5	36.8	34.9
3	Relative humidity	RH	%	Data	84.0	86.2	87.0	87.6	84.6	82.1	86.0	86.8	91.0	86.6	86.2	90.8
4	Steam Pressure Actually	Ed	m bar	Ea (RH / 100)	28.7	37.9	39.3	39.3	37.6	36.1	27.9	26.6	31.0	28.2	31.7	31.7
5	(Ea-Ed)		m bar	Count	5.5	6.1	5.9	5.5	6.8	7.9	4.6	4.0	3.1	4.4	5.1	3.2
6	Wind velocity	U2	Km / day	Data	58.5	76.7	56.0	43.2	49.7	50.9	63.7	64.7	73.8	0.0	32.6	25.5
7	Wind velocity	Uday	m / sec	Count	0.7	0.9	0.6	0.5	0.6	0.6	0.7	0.7	0.9	0.0	0.4	0.3
8	Wind Speed Function	f(u)	Km / day	Count	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.3	0.4	0.3
9	Interpolation	W	-	Table	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8
10	(1-W)		mm / day	Count	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2
11	Radiation	Ra	mm / day	Table	16.1	16.1	15.5	14.4	13.1	12.4	12.7	13.7	14.9	15.8	16.0	16.0
12	Sunlighting	n/N	%	Data	0.0	0.4	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.3	0.3
13	(0.25 + 0.54n / N)	-	-	Count	0.3	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.5	0.4	0.4
14	Rs = Ra (0.25 + 0.54n / N)	Rs	mm / day	Count	4.0	7.4	7.8	7.9	7.6	7.0	7.5	7.8	8.2	8.2	6.6	6.6
15	Temperature Function	f(t)	-	Table	15.9	17.0	17.1	17.1	17.0	17.0	15.7	15.7	15.9	16.0	16.2	16.0
16	Steam Pressure Function	f(ed)	-	Count	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
17	Radiation Function	f(n/N)	-	Count	0.1	0.5	0.5	0.6	0.7	0.6	0.7	0.6	0.6	0.5	0.4	0.4
18	Rn1 = f(t) f(ed) f(n/N)	-	-	Count	0.2	0.5	0.6	0.7	0.8	0.8	1.1	1.1	0.9	0.9	0.5	0.6
19	C	-	-	Table	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.2
20	ETo* = W.(0.75Rs - Rn1) + (1-w) f(u) (Ea-Ed)	-	mm / day	Count	2.7	4.6	4.8	4.7	4.5	4.2	3.9	4.0	4.3	4.2	3.8	3.6
21	ETo = C*ETo*	-	mm / day	Count	3.0	5.1	4.8	4.7	4.3	4.0	3.9	4.0	4.8	4.7	4.4	4.2
22	Number of days		Day	Count	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0
23	Evaporation		mm / month	Count	93.0	142.5	147.7	140.1	133.2	119.8	120.4	123.5	142.5	144.5	130.7	129.5

Table 5. Calculation of irrigation water requirements

Discription	Unit	October		November		December		January		Pebruary		March		April		May	
		I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Planting pattern						PADI									PADI		
Plant Coefficient:																	
C1		*LP*	*LP*	1.30	1.27	1.33	1.30	1.30	0.00	*LP*	*LP*	1.30	1.27	1.33	1.30	1.30	0.00
C2		*LP*	*LP*	*LP*	1.30	1.27	1.33	1.30	1.30	0.00	*LP*	*LP*	1.30	1.27	1.33	1.30	1.30
C (on average)		*LP*	*LP*	1.30	1.29	1.30	1.32	1.30	0.65	*LP*	*LP*	1.30	1.29	1.30	1.32	1.30	0.65
Evapotranspiration (ETo)	mm/day	4.66	4.66	4.36	4.36	4.18	4.18	3.00	3.00	5.09	5.09	4.76	4.76	4.67	4.67	4.30	4.30
Percolation (P)	mm/day	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Consumptive Use (ETc) = k	mm/day mm/day	*LP*	*LP*	5.66	5.60	5.43	5.49	3.90	1.95	*LP*	*LP*	6.19	6.12	6.07	6.14	5.59	2.79
Water Layer Replacement:	mm/day																
WLR1				1.67	1.67	1.67	1.67					1.67	1.67	1.67	1.67		
WLR2					1.67	1.67	1.67	1.67					1.67	1.67	1.67	1.67	
WLR (on average)				1.67	1.67	1.67	1.67	1.67				1.67	1.67	1.67	1.67	1.67	
Total Water Ruquirements	mm/day	13.70	13.70	11.33	11.26	11.10	11.16	9.57	5.95	14.06	14.06	11.86	11.79	11.74	11.81	11.25	6.79
Effective Rain	mm/day	0.00	0.00	0.60	0.60	1.31	1.31	2.04	2.04	2.11	2.11	1.49	1.49	0.55	0.55	1.00	1.00
Netto Water Requirements	mm/day	13.70	13.70	10.73	10.66	9.78	9.85	7.52	3.91	11.95	11.95	10.37	10.30	11.19	11.26	10.25	5.79
Irrigation Requirements	lt/s/hec	1.59	1.59	1.24	1.23	1.13	1.14	0.87	0.45	1.38	1.38	1.20	1.19	1.30	1.30	1.19	0.67
Flow Area	hectare	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343
Irrigation Requirements	lt/sec	14,818	14,818	11,603	11,532	10,581	10,649	8,135	4,224	12,922	12,922	11,217	11,139	12,101	12,177	11,082	6,260
Irrigation Requirements	m^3/sec	14.82	14.82	11.60	11.53	10.58	10.65	8.14	4.22	12.92	12.92	11.22	11.14	12.10	12.18	11.08	6.26

Discription	Unit	April I	April II	May I	May II	June I	June II	July I	July II	August I	August II	September I	September II	Oktober I	Oktober II
Planting pattern				PADI								PALAWIJA			
Plant Coefficient:															
C1		1.33	1.30	1.30	0.00	*LP*	*LP*	1.10	1.10	1.05	1.05	0.95	0.00	*LP*	*LP*
C2		1.27	1.33	1.30	1.30	0.00	*LP*	*LP*	1.10	1.10	1.05	1.05	0.95	*0.00*	*LP*
C (on average)		1.30	1.32	1.30	0.65	*LP*	*LP*	1.10	1.10	1.08	1.05	1.00	0.95	*LP*	*LP*
Evapotranspiration (ETo)	mm/day	4.67	4.67	4.30	4.30	3.99	3.99	3.88	3.88	3.98	3.98	4.75	4.75	4.66	4.66
Percolation (P)	mm/day	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Consumptive Use (ETc) = k	mm/day mm/day	6.07	6.14	5.59	2.79	*LP*	*LP*	4.27	4.27	4.28	4.18	4.75	4.51	*LP*	*LP*
Water Layer Replacement:	mm/day														
WLR1		1.67	1.67												
WLR2		1.67	1.67	1.67											
WLR (on average)		1.67	1.67	1.67											
Total Water Ruquirements	mm/day	11.74	11.81	11.25	6.79	13.24	13.24	8.27	8.27	8.28	8.18	8.75	8.51	13.70	13.70
Effective Rain	mm/day	0.55	0.55	1.00	1.00	0.12	0.12	0.22	0.22	0.00	0.00	0.00	0.00	0.00	0.00
Netto Water Requirements	mm/day	11.19	11.26	10.25	5.79	13.12	13.12	8.05	8.05	8.28	8.18	8.75	8.51	13.70	13.70
Irrigation Requirements	lt/s/hec	1.30	1.30	1.19	0.67	1.52	1.52	0.93	0.93	0.96	0.95	1.01	0.99	1.59	1.59
Flow Area	hectare	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343
Irrigation Requirements	lt/sec	12,101	12,177	11,082	6,260	14,187	14,187	8,710	8,710	8,957	8,849	9,463	9,206	14,818	14,818
Irrigation Requirements	m^3/sec	12.10	12.18	11.08	6.26	14.19	14.19	8.71	8.71	8.96	8.85	9.46	9.21	14.82	14.82

In calculating irrigation water requirements, planting tana patterns follow the standards of the Regional Government of Jember Regency, namely: Rice-Crops and Palawija. All factors are taken into account, starting from percolation values, effective rainfall, tillage to puddles. The results of the calculation of irrigation water requirement are expressed in liters/sec/hectares then multiplied by the area of irrigated land in the Puger, Wuluhan and Balung Subdistricts so that the results are obtained as in table V. The highest irrigation water requirements in October were 14.82 m^3/sec while the lowest in January was 4.22 m^3/sec.

In this calculation, domestic requirement are ignored because most of them already use surface water from the amount that is very abundant compared to the need so that it is not taken into account. Surface water reserves amount to 153,607 million/m^3. The calculation of the requirement and use of groundwater for irrigation is presented in table 6.

Table 6. Amount calculation results
Groundwater Irrigation

No	Districts	Area (Km^2)	Area of groundwater irrigation (Hectares)	Water requirements (liter/second/hectares)	Water requirements (m^3/sec)
1	Puger	148.990	86	1.590	0.137
2	Wuluhan	137.180	20	1.590	0.032
3	Balung	47.120	75	1.590	0.119
	Total	333.290	181	4.770	0.288
	Average	111.097	60	1.590	0.096

From table 6 it can be seen that the most use of groundwater for irrigation in Puger District is 0.137 m^3/sec while the smallest in Wuluhan District is 0.082 m^3/sec. So that the total groundwater requirement for irrigation is 0.159 m^3/sec or the average is 0.096 m^3/sec.

To do the water balance calculation is done by comparing the value of the flow and inflow. Outflow comes from the use of surface water and groundwater for irrigation while Inflow comes from the availability of river water in Bedadung Weir and groundwater reserves. The calculation results are presented in table 7.

Table 7. Water balance at the study site

No	Months	Inflow			Outflow			Increase (+)
		Discharge AWLR	Ground water Potential	Total	Irirgation water	Irrigation groundwater	Total	Descrease (-)
		(m^3/sec)	(m^3/sec)	(m^3/sec)	(m^3/sec)	(m^3/sec)	(m^3/sec)	(m^3/sec)
1	January	76.766	1.477	78.243	6.180	0.288	6.468	71.776
2	February	72.239	1.477	73.716	12.922	0.288	13.210	60.506
3	March	67.771	1.477	69.248	11.178	0.288	11.466	57.783
4	April	57.327	1.477	58.804	12.139	0.288	12.427	46.376
5	May	29.417	1.477	30.894	8.671	0.288	8.959	21.936
6	June	29.597	1.477	31.074	14.187	0.288	14.475	16.599
7	July	17.106	1.477	18.583	8.710	0.288	8.997	9.586
8	August	11.118	1.477	12.595	8.903	0.288	9.191	3.404
9	September	11.553	1.477	13.030	9.335	0.288	9.622	3.408
10	October	20.819	1.477	22.296	14.818	0.288	15.105	7.191
11	November	41.293	1.477	42.770	11.568	0.288	11.855	30.915
12	December	80.112	1.477	81.589	10.615	0.288	10.903	70.687

Based on table VII, it can be seen that the fluctuations in January to December trend of water requirement tend to be fixed or stable. While groundwater availability increased in November to April and decreased in May to October. This effect is influenced by the rain factor and the ability of the soil to store water. In each month the availability of ground water is quite safe even in the dry months like August and increase of 3.392 m^3/sec. The full description results are presented in Figure 4.

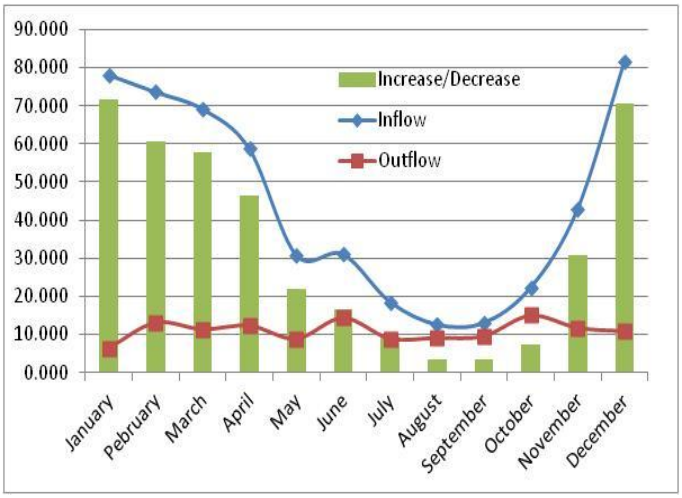

Fig. 4. Water balance at the research location

IV. CONCLUSION

Based on the results of the analysis in the previous section, the total water availability in the 3 coastal districts reached 532,843 m^3/sec, while the water requirement for irrigation and other purposes amounted to 132,679 m^3/sec and increased of 400,165 m^3/sec. So that the total groundwater balance is still safe, while the deficit occurs in June to August. There is a need for conservation efforts so that the availability of land is increasing in line with the increasing need for irrigation water.

The results of the above calculation hectaresve not considered other aspects, such as 80% mainstay discharge and industrial groundwater utilization. With 80% mainstay discharge, the calculation of groundwater availability will decrease. Likewise, in line with the growth of the dining area in the future there will be industrial estate development. So that in the future the water balance must be calculated up to the prediction of the next 20 years so that the recommendations given for water conservation activities can be carried out properly and appropriately.

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