Analysis of Raw Water Availability for Downstream Needs in Geunang Uyat Small Dam Panton Reu Sub-district West Aceh District

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Abstract: Panton Reu Sub-district is one of area in Aceh province located in West Aceh district, which has potential of lack of raw water if the dry season or drought comes . The number of residents of Panton Reu sub-district in 2015 according to Central Bureau of Statistics (BPS) of West Aceh is 6,146 people with an area of 83.04 km2. the majority of local people are farmers. Total rice field in this area is ± 515 hectares with a level of water needs large enough. Geunang Uyat small dam can be utilized for clean water and irrigation needs in Panton Reu. The purpose of this research to analyze the amount of downstream requirement ie for irrigation and domestic and non domestic needs. The result of this research is the total discharge of Geunang Uyat small dam is 0,174 m^3, The maximum requirement for plants is 1.331 /s/ ha and the irrigation water requirement is 2.04 l/s/ha. Domestic and non-domestic water requirements planned for this Geunang Uyat embung can not be met due to very limited discharge. So the existing discharge capacity in Geunang Uyat small dam only able to fulfill the needs of rice fields water.

1 BACKGROUND

Water as a basic necessity for living will always increase as the population grows. Increasing water demand is often not accompanied by adequate water supply. Limitations of raw water, both surface, rain and ground water caused by lack of development in water resources sector for example in water resources

Indonesia located in the tropics is a country that has a sufficient level of water availability. However, Indonesia has a real constraint in meeting the needs of water due to distribution and coupled with uneven distribution patterns of the population, so that the available water does not always meet the needs of the community, both in terms of quantity and quality. The Earth has a huge potential that is about 1.454 million km, with a composition of 97.5% of sea water and 2.5% of fresh water, water in the form of surface water (rivers and lakes) and 0.4% of ground water (wells and springs).

Panton Reu Sub-district is one of area in Aceh province located in West Aceh district, which has potential of lack of raw water if the dry season or drought comes . The number of residents of Panton Reu sub-district in 2015 according to Central Bureau of Statistics (BPS) of West Aceh is 6,146 people with an area of 83.04 km2. the majority of local people are farmers. Total rice field in this area is ± 515 hectares with a level of water needs large enough. Geunang Uyat small dam can be utilized for clean water and irrigation needs in this area.

2 LITERATURE REVIEW

2.1 Irrigation Water Requirement

The irrigation water requirement is the amount of water volume required to meet evaporation needs, water loss, water requirements for plants with respect to the amount of water provided by nature through rainfall and ground water contributions. Rice water requirement for rice is determined by the following factors: land preparation, consumptive use, percolation and seepage, effective change of water layer and rainfall.

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2.2 Hydrological Analysis

The calculation of the rainfall plan used to predict the amount of rain with a certain repeat period. Based on the rainfall the plan is then searched for the intensity of rain used to look for flood discharge plans. To predict the rainfall plan is done by frequency analysis of rain data.

Log Type III method when described on logarithmic probability paper will form a straight line equation, so it can be expressed as mathematical model with the following equation :

$$Y = Y + k \,.S \tag{1}$$

2.2.1 Chi-Square Test Alignment

To determine the pattern of distribution of the most appropriate average rainfall data from several statistical distribution methods that have been done, the alignment test is conducted. The chi-square alignment test uses the formula:

$$X^2 = \sum_{i=0}^{n} \frac{(Oi - Ei)^2}{Ei} \tag{2}$$

2.2.2 Potential Evapotranspiration

Evapotranspiration is evaporation of the land surface overgrown with plants. related to the plant, evapo-transpiration is consumptive water requirement defined as the total evaporation of the land and water required by the plant..

$$ET_0 = c\left[W.\,Rn + (1-W).f(u).(e_a - e_d)\right] \tag{3}$$

$$Rn = (1-\alpha)Rs - Rn_1 \tag{4}$$

$$Rs = Ra(0{,}25 + 0{,}5\,n/N) \tag{5}$$

$$Rn_1 = f(T).f(e_d).f(n/N) \tag{6}$$

$$f(u) = 0{,}27\left(1 + \frac{U}{100}\right) \tag{2.13}$$

$$e_d = e_a \times \frac{RH}{100} \tag{7}$$

2.2.3 Effective Rainfall

Effective rainfall is the rainfall that plummets in area and used for crops to growth. Determination of effective rainfall is based on every half monthly, that is 70% rain from rainy chance fulfilled 80% or chance to fail 20% :

$$R_{ef} = \frac{R_{80\%}\,(setengah\ bulan)}{15}\ x\,70\,\% \tag{8}$$

$$P_r = \frac{m}{n+1} \times 100\% \tag{9}$$

2.2.4 Affiliations

The equations used to determine the net field requirment (NFR) and irrigation water needs (DR) are as follows (Yulianur, 2005):

$$NFR = ET_c + P - R_e + WLR \tag{10}$$

$$DR = \frac{NFR}{e \times 8{,}64} \tag{11}$$

2.3 Projection of Population Growth

Predicted population can be obtained by population projection. Population projection based on population census. Here the population projection is not only a few years after the census but may be several decades after the census. Taking into account the rate of development of the population of the past, the statistical method is the closest approach to estimating the number of people in the future.

There are several methods that can be used to analyze future population growth.

2.3.1 Arithmetic Method

This method is usually referred to as an average loss. This method used when the data periodically shows the same number of additions each year. This occurs in cities with small area, low economic growth rate and city development is not too fast.

$$P_n = P_0 + \{\, P_0 .Ka(r.n)\} \tag{12}$$

2.3.2 Geometric Method

For the purposes of population projection, this method is used when data shows a rapid increase over time. Thus population growth where growth rates are the same or constant for each year.

$$Pn = Po\ (\ 1 + r\ )^n \tag{13}$$

2.4 Raw Water

Raw water is water used as a source for water treatment. Raw water can come from a variety of water resources. Understanding clean water is water that is free from substances dissolved and have qualified quality so that can be consumed as drinking water. But not always clean water can be interpreted as water that can be directly consumed or drunk, because the water used to support activities such as bathing, washing, irrigation, livestock, industry, and fisheries need clean water whose water quality is not necessary such as drinking water. Sources of raw water that can be used for the provision of clean water that is rain water, surface water, and ground water.

The need for clean water is an unlimited and sustainable need. While the need for water supply and service from time to time is increasing, which is sometimes not matched by service capability. This increase in demand is due to the increase of population, the increasing of citizen life status and the development of city/service area or things related to the improvement of socio-economic condition of the people.

2.4.1 Domestic Water Requirement

The clean water needed for daily activities is referred to as domestic demand in this case including water for drinking, cooking, cleaning the toilets and so on.

The basic needs of the domestic is the need for clean water for the residents of the housing environment are limited to household necessities such as bathing, drinking, cooking, and others (Ministry of Public Works, "Maximum Water Requirements Day").

To estimate the current and future amount of domestic water demand is calculated based on population, population growth rate and per capita water requirement. The per capita water requirement is influenced by physical activity and habit or welfare level. Therefore, in estimating the amount of domestic water needs to distinguish between the needs of water for urban residents (urban areas) and rural areas (rural). The differentiation of water demand is done with the consideration that people in urban areas tend to use more water than the population in the rural area. The amount of water consumption can refer to the various standards that have been published.

2.4.2 Non Domestic Water Requirement

The non-domestic basic water requirement is a water requirement for residents outside the housing environment (Ministry of Public Works, "Maximum Water Requirements Day"). The need for non domestic water is often also called urban water needs (municipal). The need for clean water is determined by the number of non-domestic consumers that include office facilities (government and private), places of worship (mosque, church, etc.), education (schools), commercial (shop, hotel), public (market, terminals) and Industry (Ikhsan, 2013).

Non-domestic sector analysis is conducted by holding on to the latest growth data analysis of existing socio-economic facilities in the planning area. Non-domestic water requirements for cities can be divided into several categories:

1. City Category I (Metro)
2. Category City II (Big City)
3. City Category III (Medium City)
4. City Category IV (Small Town)
5. Cities Category V (Village)

The amount of urban water demand can be obtained by a percentage of the total household needs, ranging from 25-40% of household water needs. The 40% rate applies specifically to metropolitan cities with very high population density such as Jakarta.

Meanwhile, to obtain the amount of water demand in a region, the equation is used to multiply the number of users with the standard water requirement for each type of use (Ikhsan, 2013).

$$Qy = dy \times Py \quad (13)$$

2.5 Study Area

This study was conducted at the location of development of small dam Geunang Uyat District Panton Reu Sub district West Aceh district, as shown in Figure 1.

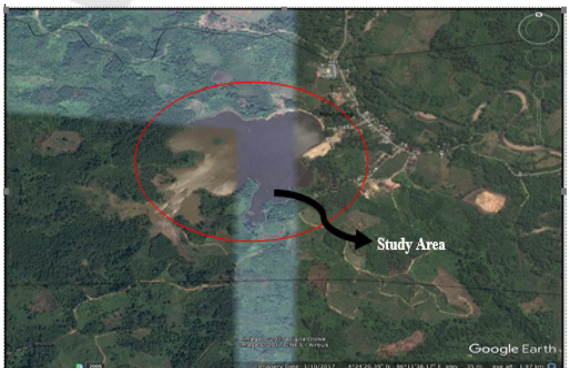

Figure 1: Study area

3 RESULT AND DISCUSION

3.1 Maximum Monthly Rainfall

The rainfall data used is the maximum monthly rainfall data each year from the rain gauge station. The maximum monthly rainfall for 10 years is from 2005-2014.

Table 1: Maximum monthly rainfall

No	Year	Max
1	2005	343
2	2006	538
3	2007	318.3
4	2008	398
5	2009	276
6	2010	260
7	2011	336.4
8	2012	309
9	2013	468
10	2014	265

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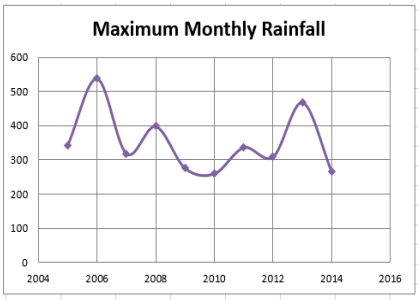

Figure 1: Maximum monthly rainfall

3.2 Potential Evapotranspiration

This calculation is done by using climatology data, result of calculation can be seen in table 2.

Table 2. Potential Evapotranspiration

No	Mounth	mm/day	mm/month
1	January	3.937	115.338
2	February	4.119	115.338
3	March	4.804	148.927
4	April	4.111	123.321
5	Mei	3.667	113.671
6	June	3.638	109.136
7	July	3.718	115.265
8	August	4.158	128.892
9	September	4.289	128.660
10	October	4.450	137.962
11	November	3.716	111.470
12	December	3.466	107.453

We can see the magnitude of potential evapotranspiration (ETo) that occurred in the District of Panton Reu, West Aceh regency. Maximum evapotranspiration value (ETo) occurs in March, reaching 4,804 mm/day or 148,927 mm/ month. Evapotranspiration occurs when there is enough water (from participation or irrigation) to meet optimum growth. The greater the area of watered agriculture the greater the need for water for evapotranspiration.

3.3 Effective Rainfall

Determination of effective rainfall is based on every half monthly, that is 70% rain from rainy chance fulfilled 80% or 20% chance of failure. For that can be seen in table 3

Table 3. Effective rainfall

No	Month	Re (80%)		Re (50%)	
		I	II	I	II
1	Januari	6.89	3.69	5.65	3.66
2	Februari	6.21	3.97	1.70	3.13
3	Maret	5.75	1.61	1.07	1.03
4	April	2.43	3.01	2.43	3.01
5	Mei	4.41	2.78	4.41	2.78
6	Juni	6.97	1.25	1.17	1.26
7	Juli	2.13	1.83	1.21	0.98
8	Agustus	5.41	2.69	1.00	3.13
9	September	1.70	5.69	1.21	3.10
10	Oktober	2.97	7.53	1.98	1.66
11	Nopember	5.62	11.30	3.30	6.66
12	Desember	3.73	8.40	1.82	5.65

3.4 Rice and Irrigation Water Requirement

Irrigation water demand is the amount of water volume required to meet evaporation needs, water

loss, water requirements for crops with respect to the amount of water provided by nature through rainfall and groundwater contribution. In this study the water source used to meet the needs of water irrigation water that is in embung Geunang To meet the needs of irrigation water in the District of Panton Reu West Aceh district. The calculation of irrigation water demand can be seen in Table 4.

Table 4. Rice and irrigation water requirement

No	Month	(NFR) l/s/ha		(DR) l/s/ha	
		I	II	I	II
1	Juli	-0.07	0.04	-0.11	0.07
2	Agustus	0.21	0.06	0.33	0.08
3	September	0.36	0.14	0.56	0.22
4	Oktober	0.11	-0.03	0.17	-0.04
5	November	0.33	-0.51	0.51	-0.78
6	Desember	1.03	-0.48	1.58	-0.75
7	Januari	-0.02	0.43	-0.03	0.66
8	Februari	0.07	0.07	0.11	0.11
9	Maret	0.72	1.33	1.11	2.04
10	April	1.17	0.53	1.80	0.81
11	Mei	0.43	0.47	0.66	0.72
12	Juni	-0.17	0.22	-0.26	0.34

Irrigation water demand is the amount of water volume required to meet evaporation needs, water loss, water requirements for crops with respect to the amount of water provided by nature through rainfall and groundwater contribution.

3.5 Population Projection

Population projection based on population census, here population projection not only a few years after census but maybe until several decades after census. With regard to the rate of population growth in the past, the statistical method is the closest method to estimate the population in the future. In research conducted in this Panton Reu dikecamatan this population projection will calculated using arithmetic method with 10 year scale. The available data is the number of population in 2015 which amounted to 6146 people, This data is taken from the West Aceh District Statistics Agency. Next will look for the number of residents in the future from 2016 - 2024.

Table 5: projected number of people of 10 years

No	Year	Number of People	Population/Year (%)
1	2015	6146	1.85
2	2016	6373	1.85
3	2017	6727	1.85
4	2018	7225	1.85
5	2019	7893	1.85
6	2020	8769	1.85
7	2021	9905	1.85
8	2022	11371	1.85
9	2023	13264	1.85
10	2024	15718	1.85

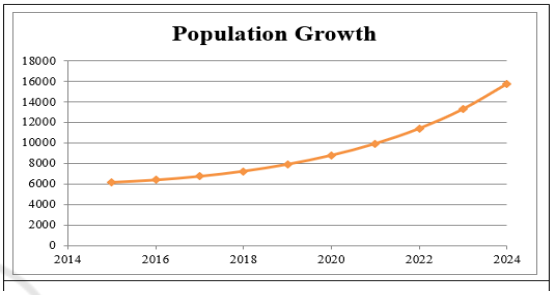

Figure 2. graph of population increase each year

explains the graph of population increase each year in the District of Panton Reu, West Aceh regency for a 10-year period from 2015 to 2024. Panton Reu district has a population density of 1.85% every year. This number continues to increase in the next few years as time goes by.

3.6 Domestic Water Demand

The basic needs of the domestic is the need for clean water for residents of the housing environment is limited to household needs such as bathing, drinking, cooking, and others. To estimate the current and future amount of domestic water demand is calculated based on population, population growth rate and per capita water requirement. The per capita water requirement is influenced by physical activity and habit or welfare level. Therefore, in estimating the amount of domestic water needs to distinguish between the needs of water for urban residents (urban areas) and rural areas (rural). The existence of different water needs was done with the consideration that people in urban areas tend to use more water than the population in the rural area.

Table 4. Domestic Water Requirement of 10 year

No	Year	Number of person	Water need Standard (Person/day)	Water need (L)	Water need (m^3)
1	2015	6146	80	491680	492
2	2016	6373	80	509872	510
3	2017	6727	80	538170	538
4	2018	7225	80	577995	578
5	2019	7893	80	631459	631
6	2020	8769	80	701551	702
7	2021	9905	80	792402	792
8	2022	11371	80	909677	910
9	2023	13264	80	1061139	1061
10	2024	15718	80	1257449	1257

large discharge needed to meet domestic water needs every year. While the remaining debit that existed in Geunang Uyat Embung after meeting the needs of rice and irrigation water is only 0.159 m3. While the debit that must be met to meet the needs of domestic water for one year alone for example in 2015 amounted to 429 m3. The huge amount of domestic water demand in each year, it can be concluded that the Geunang Uyat embungs are unable to meet domestic and non-domestic water needs due to the insufficient capacity of the planned capacity.

4 CONCLUSION

1. From the analysis of the frequency of rain data with some distribution of gumbel, normal, normal log and log person III then obtained the suitable distribution used was the distribution of log person III with Cs ≠ 0 and the calculation Cs = 0.7884 for this distribution log person III is eligible.
2. The planned cropping pattern in Panton Reu area is Palawija - Padi - Rice with planting planning July 1st. This planning is based on the needs of wetland water and the requirement for maximum irrigation water occurs in July with NFR = 1.33 l/ s/h and DR = 2.04 l /s/ h.
3. The number of residents in Kecamatan Panton Reu if it is predicted in the 10 year period from 2015-2024 amounted to 93392,43 people with a growth rate of 1.85% / year.
4. Domestic water needs are planned by utilizing Geunang Uyat embungs can not be realized because the debit that must be met to meet the domestic water needs for one year only in 2015 amounted to 429 m3 while the residual debit existing in Geunang Uyat embung only 0.166 m3. So the existing water capacity in Geunang Uyat small dam only can fulfill the needs of field rice water.

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