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Research Paper

Analysis of Water Processing Management System for Clean Water Necessity and Availability at Ngalah Islamic School of Sengoagung Village, Purwosari District of Pasuruan Regency

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ABSTRACT : *The availability of clean water supply at the complex of Darut Taqwa Foundation comes from several water sources located around the area. Water distribution from these sources is used to supply all buildings inside the Ngalah Islamic Schools in Sengonagung, including all residences from the caretakers, dormitories consisted of 15 buildings (students dormitories, school buildings for earliest education level (PAUD), Senior High School, and Yudharta University) as well as local people houses around Ngalah Islamic School. With a large number of buildings that must be provided with clean water supply and current number of students exceeding 5000 pupils which may continue to grow in number, it is essential to conduct a proper management analysis to ensure the optimal distribution of clean water into this area undisrupted. Method and analysis research applied in this study is Fj.Mock method, employed to analyze clean water availability and calculate dependable flow in the river's watershed area related to this study. Fj.Mock method uses data of rainfall, evapotranspiration and hydrological characteristics. The result of this research indicates: (1) clean water demand for the next 10 years is able to be fulfilled by amount of 2,336,365 liters/year until 2030, (2) result analysis of available dependable flow at water sources around research location obtained several numbers of: the first water source has 1,736 liters/second, the second water source has 1,385 liters/second, the third water source has 1,553 liters/seconds, and the fourth water source has 4,386 liters/second.*

KEYWORDS: *clean water necessity, clean water availability, clean water management, management system*

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I. INTRODUCTION

Water is a primary means to improve the level of public health since water is one of media that able to transmit various types of diseases. Clean water must have clear, colorless, fresh and odorless appearance. Through clean water provision which also functions as a fulfillment for daily needs, the community build artesian wells by self-help fund. Capability in providing clean water for daily life necessity plays crucial act because water, land and human are inseparable union. [1,2,3]

Water role inside human body is very profound since 50-70 % of total body weight composes from water. Like 22 % weight of bones contains of water and 83 % of blood and kidneys contains of water. Moreover, water prominent role is visible from water amount inside body organ where 80 % of blood is water, 25 % of bones is water, 75 % of nerves system is water, 80 % of kidney is water, 70 % of liver is water, and 75 % of muscles is water. Water insufficiency inside human body causes illness such as kidney and bladder stones due to crystallization elements in body fluids. Losing water to 15 % of body weight resulted in death. Therefore, adults need to drink water at minimum of 1.5 – 2 liters in a day. [4]

Aside from the importance of water for human body, it also needed for livelihood both in daily and living needs such as for domestic household necessity or others in agriculture, industry, fisheries, hydroelectric power generation, navigation as well as recreation purpose. [5]

Islamic Boarding School is one of educational system in Indonesia that managed by Indonesian Ministry of Religion. It holds significant role in preparing competent and high moral virtues of the young Islamic generation. Islamic schools practicing a complex education system for its learning method. Their learning method is a complex educational system where Islamic Boarding schools provide all knowledge and application to build

independent character for their students where students are taught to have excellent abilities in science and technology along with strong faith to God.

Darut Taqwa Sengoagung foundation is an expansion of Darut Taqwa Carat Islamic Boarding School. It built in 1985 by the founding father, K.H Sholeh Bahruddin Kalam as ordered by his father. K.H Bahrudin Kalam. Darut Taqwa Sengoagung foundation establishment began with construction of Ngalah Islamic Boarding School, where its education system managed by Darut Taqwa foundation in a form of mixed/complex education where the formal education starts from kindergarten (PAUD) to University level along with non-formal education such as Madrasah Diniyah. Apart from its service to be a field of education, this foundation provides several community facilities such as information center, shopping center, clothing manufacture service, also conduct routine religious studies for attendants that coming from so many regions of Indonesia, and other related social activities. By plenty of offerings inside its complex education systems where supported by sufficient public facilities that available in here, the number of people interested in entering Ngalah Islamic Boarding School is predicted to grow along years. Moreover, constant development to fulfill facilities and infrastructure continues and manages optimally to ensure readiness in serving students and community in a professional way. In relation to the demand of facility and infrastructure, clean water availability is inseparable demand, since water is one basic support that always put into consideration. One from many water resources that widely used is spring water source comes from the mountain.

Clean water supply at Darut Taqwa foundation comes from several sources around its location, where the water distribution from these sources are used to fill all buildings in Ngalah Sengoagung Islamic Boarding School including all caretaker residences, student buildings (15 buildings functioning as dormitory, school buildings from kindergaten, Senior High School, Yudharta University, and several houses of residents around the Ngalah Islamic Boarding School). With those number of buildings, water distribution must be large because number of students at the current time is more than 5000 students with possibility of increasing number in the future. Therefore, it is necessary to carry out a good management analysis to secure water distribution to run optimally for the next 10 years.

So far, any discussion related to management analysis about water management system for clean water necessity and its availability at *Ngalah Sengonagung* Islamic Boarding School in Purwosari Pasuruan has not been widely carried out by researchers, therefore, study problems raised are: (1) how much the clean water necessity for Ngalah Islamic Boarding School?, (2) how much the availability of clean water in Ngalah Islamic Boarding School? (3) What is the suitable clean water network management system that able to meet the clean water demand for the next 10 years in Ngalah Islamic Boarding School?

II. LITERATURE REVIEW

2.1. Water Management

2.1.1. Definition of Clean Water

In the environmental health program, there are two water types existing based on health aspect which used by community to meet daily living needs; (a) drinking water and (b) clean water. By Minister of Health regulation number 416/Menkes/Per/IX/1990 regarding the supervision and requirement of water quality, type of water referred as drinking water is water that meets health requirements which can be consumed directly, while clean water is water that meets health requirement but must be boiled first before consumed. Health requirement of water in this matter have physical, chemical, microbiological and radioactive conditions. [6]

2.1.2. Hydrology Cycle

Hydrology or water cycle is a type of cycle showing water movement on the earth's surface. In the hydrological cycle, water input in the form of rainfall will be distributed on earth through several ways: throughfall, steamflow, and rainwater which penetrating the ground surface directly and later separated into several water output: runoff, evaporation, and infiltration. Combination of water vapor evaporation as the result of transpiration and interception processes called as evapotranspiration, meanwhile water runoff and water infiltration go into the river as water discharge. [7]

Part of the stored water as groundwater will occur to the earth surface as water runoff which characterized into surface runoff, interflow and groundwater runoff and later collected in rivers and ends or flowing back into the sea to experience evaporation process again, following the hydrological cycle.

The broad-scope and complex concept of hydrological cycle is modeled in the following (figure 1).

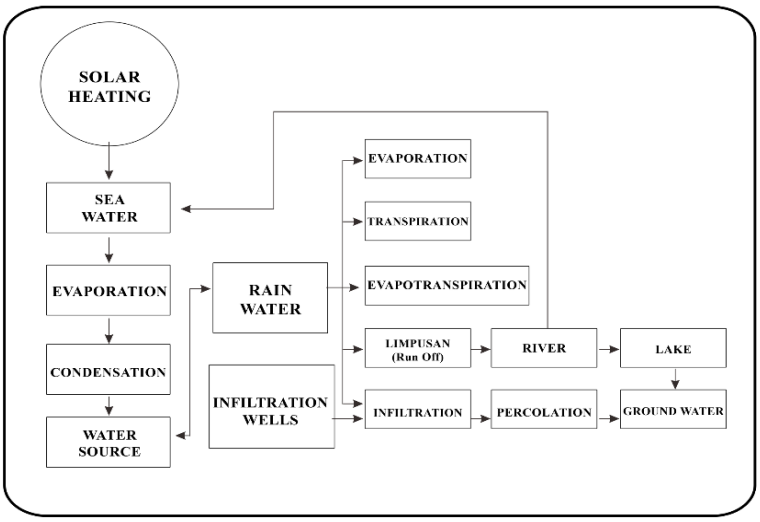

Figure 1. The hydrological cycle

2.1.3. Rainfall

Type of rainfall required in preparation stage of making isohyet map for water utilization and flood control design are amount of average rainfall throughout the focused area, rainfall distribution pattern in the region or area (regional distribution), or the intensity of rainfall distribution, and calculated by referring to rainfall measurement using certain method from meteorological stations. [7]

Regional rainfall are estimated from several rainfall observation points. While the methods for calculating regional rainfall in those points can use three method listed below.

1. Algebraic Mean method.
2. Thiessen Polygon method.
3. Isohyet method.

2.1.4. Water Cycle

Water volume relatively constant but it stays in motion or circulating, never motionless due to weather influence, so that hydrological cycle occur. This cycle is important because it supplies land areas with water. Water evaporates due to sun heat, and evaporation occurs in surface water inside the upper soil layer (wevaporation), water inside the plants (transpiration), water inside animal and human (transpiration, respiration). Water vapor also enters atmosphere and creating clouds where under certain weather condition, water vapor can go cold and changing its shape into water droplets and fall back to the earth's surface as rain. Some rainwater flows directly into the surface water (runoff), other seeps into soil (percolation) and becomes groundwater, both in shallow and deep water, while some others are absorbed by plants. Deep groundwater will emerge into surface as water spring and become surface water. Then, the surface water along with shallow groundwater and body water will evaporate again to form clouds, and the hydrological cycle repeats itself. [4]

2.1.5. Influence of Water for Life

Water has substantial influence for life, whether for human life, animal and plant life. Water is vital material for life and also becomes a basic source for life continuity on earth. It is basic need for life since human always need water throughout their lives. So, the higher human population rate and the growth rate, water utilization rate also escalates. In brief, water has prominent part within the physical environment, not only for life processes, but also in other processes such as in industry, agriculture, firefighting and others areas. Moreover, human body composed of water under percentage of 60-70% of its body weight and for its survival, human body needs water with amount depends on the body weight. Adults require water intake approximately 2.200 grams every day. [4,8]

2.1.6. Clean Water Availability

The system of clean water provision is a capability to provide sufficient water for community needs in one area. In clean water supply system, important characteristics that must be met is quality and quantity of the water. According to Sidharta, basic criteria that must be completed in the clean water supply system include [9]:

1. Qualitative Criteria

Qualitative requirements describe the quality of raw clean water. These requirements include physical, chemical, biological and radiological requirements.

2. Quantitative Criteria
   In the provision of clean water, quantitative criterion has close relation to the amount of raw water availability, meaning that water availability can fulfill the amount of water necessity required in that region.
3. Continuity Criteria.
   This criterion is closely related to the availability of water according to continuous needs, meaning that in rainy season or dry season the availability of water continues to meet the amount of water needed according to quantitative and qualitative requirements.

2.1.7. Clean Water Source

There are many water sources can be utilized as raw water for clean water, such as rainwater, surface water, groundwater or seawater. According to Minister of Energy and Mineral Resources, Law No.17 of 2019 regarding water resources, water sources are a place or container of natural and or artificial water located above or below ground surface as conforming the explanation of water definition (all water above or below the surface of the ground). [10]

1. Rain water
   Water source utilization taken from rainwater can be applied in areas without or cannot use groundwater. This type of water source contains of so many materials coming from the air such as gases (oxygen, nitrogen, and carbon dioxide), strong acids as the side product of certain industrial exhaust gases, also radioactive particles. Rainwater source although not pure still included into soft water category and can be utilized as drinking water after boiling or disinfected processes. [11,12]
2. Surface water
   Surface water is all types of water positioning above the earth's surface such as water in ditches, gutters, rivers, or lakes. In general, surface water have many dirt of floating objects from the surrounding environment, solid objects suspended by bacteria, chemical waste, and others. These arrays of impurities causing many different odors and taste, so, if the water want to be used for human needs, it must be treated with complete cleaning stages, where the cleaning technique depends on types and amount of dirt it carried. [11,12]
3. Ground water
   Groundwater is type of water found inside the ground located precisely below the groundwater surface. In general, groundwater contains of dissolved mineral materials of cations and anions. Level of these ions are vary, depending on the nature and conditions of the local soil. As a rule of thumb, the deeper the groundwater is taken, the higher the level of these ions. Groundwater is widely used for various purposes since this type of water is not contaminated by the surrounding environment. The cleaning treatment for groundwater which sometimes needed is a softening process to remove water hardness, and aeration to eliminate unwanted odors and taste. [12,13]
4. Sea water
   Seawater occupies 97 % of total water on earth where the largest part located in the southern hemisphere. In general, purity level of sea water is relatively pure to be functioned for chemical solvent, both in solid, liquid, and gas forms. Seawater utilization as a source of fresh water carries out when clean water sources such as rainwater, surface water or groundwater are no longer exists by desalination through several ways of distillation, electrodialysis, osmosis or hyperfiltration or others. According to Kristia (2016) sources of clean water also can be found from water springs. [12,14]
5. Water Spring
   Water spring is source of raw water emerges from the ground. The water discharge released by spring is relatively same for every time because the water discharge is not directly affected by rainwater that falls onto the ground.

2.1.8. Clean Water Necessity

Demand for clean water is the amount of water needed by the community to fulfill their needs and divided into two classifications of domestic water needs and non-domestic water needs.

1. Domestic Necessity
   Domestic needs focused on the clean water necessity to fulfill daily or household activities such as: drinking water, cooking, individual health (bath, wash, and others), plant watering, yard watering, transporting waste water (kitchen and toilet waste). Domestic water necessity for cities is divided into several categories of:
   - City in category i (metropolitan city)
   - City in category ii (big city)
   - City in category iii (medium city)
   - City in category iv (small city)

- City in category v (village)

Criteria of clean water management and standards for domestic water necessity is displayed in the following table (Table 1).

Table 1. Criteria for clean water management and standards for domestic water necessity

No	Criteria Description	City Category				
		> 1.000.000	500.000 - 1.000.000	100.000 - 500.000	20.000 - 100.000	< 20.000
		Metropolitan	Big City	Medium City	Small City	Village
1	Consumption rate per house unit (litre/indiv./day)	> 150	150 – 120	90 – 120	80 – 120	60 – 80
2	Consumption rate per public hydrant unit (litre/indiv./day)	20 – 40	20 – 40	20 – 40	20 – 40	20 - 40
3	Maximum day factor	1.15 – 1.25 *daily	1.15 – 1.25 *daily	1.15 – 1.25 * daily	1.15 – 1.25 * daily	1.15 – 1.25 * daily
4	Peak Hour factor	1.75 – 2.0 * max/day	1.75 – 2.0 * max/day	1.75 – 2.0 * max/day	1.75 – 2.0 * max/day	1.75 – 2.0 * max/day
5	Number of Individual per house unit (people)	5	5	5	5	5
6	Number of Individual per Public Hydrant Unit (people)	100	100	100	100 – 200	200
7	Push remain in distribution supply (meter)	10	10	10	10	10
8	Operational hour (hour)	24	24	24	24	24
9	Volume reservoir (% max day demand)	15 – 25	15 – 25	15 – 25	15 – 25	15 - 25
10	House Unit:Public Hydrant Unit	50 : 50 to 80 : 20	50 : 50 to 80 : 20	80 : 20	70 : 30	70 : 30

Source: Minister of Health Regulation No.416/Menkes/PER/IX/1990 [6]

2. Clean Water Supply System.

According to Joko in Yuliani & Rahdriawan, a good clean water supply system must have purpose for [16]:

- Providing water with safe quality and healthy for its users, whether individual or community users.
- Providing water with sufficient quantity.
- Providing water in continuous cycle, easy to access, also inexpensive to support the health condition of individual or community.

Table 2. Criteria and standards for non-domestic water necessity

No	Facility (Non-domestic)	Water Usage	Unit
1	Dormitory	120	Ltr/occupant/day
2	Kindergaten building	10	Ltr/student/day

3	Elementary Sc.building	40	Ltr/student/day
4	Junior High Sc.building	50	Ltr/student/day
5	Senior High and Higher Education building	80	Ltr/student/day
6	Hospital	500	Ltr/patient bed/day
7	Community Health Center	500 – 1000	Ltr/unit/day
8	Sub Health Center	500 – 1000	Ltr/unit/day
9	Integrated Health Post	500	Ltr/unit/day
10	Religious facility	500 – 2000	Ltr/unit/day
11	Office building	100	Ltr/officers and teachers/day
12	Store building	100 – 200	Ltr/unit/day
13	Restaurant or Diners	1000	Ltr/unit/day
14	Hotel / Guest House	250 – 300	Ltr/unit/day
15	Market	6000 – 12000	Ltr/unit/day
16	Factory/ Industry building	60 – 100	Ltr/orang/day
17	Port/ Terminal	10.000 – 20.000	Ltr/unit/day
18	Gas Station	5000 – 20.000	Ltr/unit/day
19	Garden	25.000	Ltr/unit/day

Source: Cipta Karya Public Works Unit SK-SNI for Drinking Water, 2010:5 in Krisnayanti. [17]

2.2 Fj. Mock Method

The Mock method was developed by Dr.Fj,Mock in 1973 with a water balance concept. The process components within this model are divided into three parts: (a) rainfall and evapotranspiration, (b) water balance on the land surface, and (c) Mock groundwater recharge (Mock, 1973). The Mock method is a type of lumped model or a model that does not calculate the spatial variability of both input variables and parameters of the watershed system (*Daerah Aliran Sungai/*DAS).

2.2.1. Actual Evapotranspiration (Ea) & Limited Evapotranspiration (Et)

The actual evapotranspiration is calculated from Penman method evaporation (ETo), where the relationship between potential evaporation and actual evapotranspiration will be tabulated by formula 1 equation. [19,20,21,22]

$$Ea = ETo - \Delta E \rightarrow (Ea = Et) \quad \text{..... (1)}$$

$$\Delta E = ETo \times (m/20) \times (18 - n) \rightarrow (E = \Delta E) \quad \text{..... (2)}$$

Where:

Ea = Actual evapotranspiration (mm/day)
Et = Limited evapotranspiration (mm/day)
ETo = Potential evaporation Penman method (mm/ day)
m = Land percentage that uncovered by plants as estimated from land use map
m = 0 for land with thick forest
m = 0 for land with secondary forest at the end of rainy season and increase of 10 % for the next dry months
m = 10 – 40 % for eroded land
m = 30 – 50 % for cultivated farms
n = amount of rainy days in a month

2.2.2. Water Balance in Ground Surface

Rainfalls that reaches to the ground surface can be put into formulation through the following equation:

$$Ds = P - Et \quad \text{..... (3)}$$

Where:

Ds = rainfalls reaches to the ground surface (mm/day)
P = rainfall rate (mm/day).
Et = limited evapotranspiration (mm/day)

Based on positive Ds value (P>Et), water will enter the ground if soil moisture capacity has not been fulfilled, or vice versa, when the soil condition is saturated the water will overflow. If the Ds value is negative (P < Et), some groundwater will emerge and soon there will be water shortage or groundwater deficit.

III. RESEARCH METHOD

3.1. Research Location

Research location was in Kembang Kuning sub-village, Sengonagung Village, Purwosari District of Pasuruan Regency, with a specific location in area of Darut Taqwa foundation, Ngalah Purwosari Pasuruan Islamic Boarding School.

3.2. Data Collection Stages.

Data collection in this study came from related parties in relation to the analysis of clean water necessity and clean water availability. The data collected are include:

1. Data of number of facilities/buildings of Darut Taqwa Foundation and Kembangkuning sub-village that receive water distribution from water spring/water source.
2. Data of clean water source and distribution flow.
3. Data of water discharge from each clean water source.
4. Flow map of clean water distribution.

3.3. Data Tabulation Stages

Data tabulation for this study is a process to analyze all data obtained to be used as initial data for conducting analysis and calculation related to the clean water necessity and clean water availability. The analysis and calculation are related to several matters stated in the following explanation:

1. Clean water necessity, including domestic and non-domestic necessity at current time and for the next 10 years.
2. Population projection, by finding out population number during the last five years.
3. Clean water availability, by finding out the amount of water discharge from each water source/water spring at current time until the next ten years.

3.4. Data Analysis and Discussion

At analysis and discussion stage through analyzing data which has been processed by Fj.Mock Method, it can provide results of analysis of clean water necessity and clean water availability in Ngalah Islamic Boarding school of Kembang Kuning sub-village. Stages of method used in the study analysis are:

1. Analysis of Clean Water Necessity
   For analysis the clean water necessity, there are several calculations employed in this study to obtain profound result about the amount of clean water necessity of the community, as listed below:
   - Non-domestic necessity
   - Education and office facilities necessity
   - Water loss
   - Peak hour water necessity
   - Clean water necessity in total
   - Maximum amount of water necessity

2. Analysis of Population Projection
   For the calculation of population prediction, there are three calculation methods were used, and from the result of these calculation, result that have the biggest correlation will be taken. This analysis used to calculate the population prediction for the next 10 years, where the methods employed in this study are:
   - Arithmetic Method
   - Geometric Method

- Exponential Method

3. Analysis of Clean Water Availability
   - Water discharge at the water source.
   - Climate data.
   - Rainfall data.
   - Dependable flow data.
   - Water Balance data.

IV. RESULT AND DISCUSSION

4.1. Clean Water Availability

4.1.1. Secondary Data Collection

The secondary data collection in this study are data collection of hydrological data, watershed area data, river length, and land usage systems in Sengonagung Pasuruan catchment area. Form of hydrological data used in this study is rainfall data in Sengonagung Catchment area that taken from three rainfall stations of Sengongagung station, Purwosari station, and Purwodadi station (Table 3).

The latest data about source water discharge availability can be found by making a direct measurement in source area through manual measurement. The current available data about water discharge is listed in the following table (Table 3).

Table 3. Water discharge at the water source

No	Source	Water Discharge (L/dt)
1	I	1,736
2	II	1,385
3	III	1,535
4	IV	4,386
Total		9,06

Table 4. Inflow discharge in water tank

No	Source	Water Discharge (L/dt)
1	Ground water tank A	0,029
2	Ground water tank B1	0,828
3	Ground water tank B2	7,937
Total		8,794

4.1.2. Hydrology Analysis

Type of hydrological analysis in this study is a calculation of average rainfall over a period of 10 years (2009-2019) at three rainfall stations. The average rainfall data was obtained from Water Resources and Spatial Planning Unit of Pasuruan Regency, so that, method for calculating average daily rainfall was processed and conducted by Water Resources and Spatial Planning Unit of Pasuruan Regency. Data of average rainfall at three rainfall stations that affects Jempinang Watershed area is displayed in the following table (Table 5).

Table 5. Average rainfall data from 3 rainfall stations

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des
2009	400,67	380,67	261,33	140,33	219,33	110,33	1,00	-	29,00	-	82,00	218,67
2010	491,36	448,34	405,33	375,34	287,01	185,67	179,00	94,67	242,00	251,67	258,00	381,34
2011	407,01	260,67	438,00	411,01	230,33	67,33	6,33	-	13,33	47,67	323,34	342,34
2012	341,68	473,35	246,70	211,01	142,67	23,33	-	-	-	34,33	88,33	314,36
2013	326,00	317,67	399,68	244,67	158,67	406,00	142,00	-	2,67	42,33	319,00	507,67
2014	392,67	324,67	209,67	254,00	126,00	58,00	14,67	-	-	-	39,67	526,37
2015	390,68	502,00	290,33	267,67	173,00	-	-	-	-	-	54,67	265,68

Year	Month											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Des**
2016	300,01	613,34	198,00	255,67	224,33	283,67	66,00	100,00	37,33	300,67	282,33	419,00
2017	695,33	479,67	415,67	374,00	110,00	93,33	-	-	11,00	53,00	585,67	402,33
2018	447,67	481,33	327,33	124,00	55,67	84,33	-	-	-	-	189,33	223,67
2019	450,67	481,00	326,67	127,67	56,67	87,67	-	-	-	-	190,00	225,00
Mean Value	**422,16**	**432,97**	**319,88**	**253,21**	**162,15**	**127,24**	**37,18**	**17,70**	**30,48**	**66,33**	**219,30**	**347,86**
Max	**695,33**	**613,34**	**438,00**	**411,01**	**287,01**	**406,00**	**179,00**	**100,00**	**242,00**	**300,67**	**585,67**	**526,37**
Min	**300,01**	**260,67**	**198,00**	**124,00**	**55,67**	**-**	**-**	**-**	**-**	**-**	**39,67**	**223,67**
∑ Total	**4643,74**	**4762,70**	**3518,71**	**2785,35**	**1783,68**	**1399,67**	**409,00**	**194,67**	**335,33**	**729,67**	**2412,34**	**3826,43**

Source: Public Work Unit of Water Resources amd Spatial Planning Pasuruan Regency

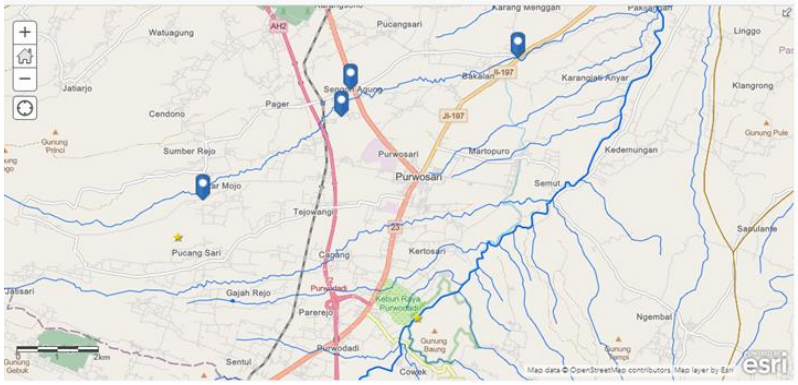

Figure 2. Sub Watershed Area of Jempinang River

As displayed from the map site, the size area which becomes the area of research point, nearest rain post also Jempinang river and influences the water availability of these areas is 31.03 km^2.

4.1.3. Hydrology Analysis

The analysis of water availability was conducted to determine amount of available water discharge in Sengonagung Catchment area because of the absence of water discharge regular data recording. Type of data that used in the analysis through Fj.Mock method are stated below:

1. Data of Monthly rainfall data for 2009-2019 that has been analyzed by Water Resources and Spatial Planning Unit of Pasuruan Regency.
2. Climate data such as temperature, sun exposure and other related data. The climate data used in this study is the recorded data from nearest climate station of Pasuruan Geophysical and Climatology station located in Tretes.

The result of evapotranspiration data is listed in the following table (Table 6).

Table 6. Monthly evapotranspiration data at Sengonagung catchment area

Month	Eto (mm/day)	Ep (mm/month)
January	**4,47**	**134,14**
February	4,84	135,51
March	4,74	146,97
April	5,24	157,34
May	5,31	164,58
June	5,18	155,35
July	6,04	187,34
August	7,47	231,48

September	10,18	305,26
October	**10,60**	**328,54**
November	7,52	225,64
December	4,59	142,19

Table 6 is showing amount of monthly evapotranspiration value in Sengoagung Catchment area where the biggest number found in dry season specifically in the month of September (10.60 mm/day or 328.54 mm/month) and the lowest number in the month of January (4.47 mm/month or 134.14 mm/month).

From data result that listed on table 6, the water availability can be determined by calculating the dependable flow at the current water source condition. The next table will show result calculation of the dependable flow of clean water availability for the next 10 years.

4.1.4. The Calculation of Dependable Flow

The calculation of Dependable flow is used as a benchmark for the availability of incoming water discharge. To obtain the number of dependable flow, 90% chance of the inflow discharge (of the water source taken from certain period discharge recording) is calculated.

Data result from Dependable flow Calculation at Jempinang Watershed Area is listed in the following table (Table 7).

Table 7. Result of dependable flow calculation

No	Year	Month											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
1	2009	1,13	1,08	0,69	0,29	0,49	0,21	-0,19	-0,29	-0,38	-0,52	-0,06	0,57
2	2010	1,42	1,29	1,12	0,99	0,69	0,43	0,36	-0,02	0,21	0,16	0,47	1,05
3	2011	1,16	0,70	1,23	1,12	0,56	0,10	-0,17	-0,29	-0,43	-0,38	0,66	0,95
4	2012	0,94	1,37	0,62	0,52	0,29	-0,06	-0,19	-0,29	-0,47	-0,44	-0,04	0,85
5	2013	0,91	0,90	1,11	0,60	0,34	1,11	0,22	-0,29	-0,47	-0,41	0,66	1,47
6	2014	1,13	0,92	0,52	0,64	0,24	0,05	-0,16	-0,29	-0,47	-0,52	-0,19	1,51
7	2015	1,12	1,48	0,78	0,68	0,40	-0,11	-0,19	-0,29	-0,47	-0,52	-0,12	0,71
8	2016	0,83	1,82	0,48	0,64	0,52	0,75	-0,03	0,01	-0,37	0,33	0,56	1,21
9	2017	2,08	1,41	1,18	1,02	0,20	0,17	-0,19	-0,29	-0,44	-0,37	1,49	1,15
10	2018	1,31	1,42	0,90	0,25	0,03	0,15	-0,19	-0,29	-0,47	-0,52	0,29	0,60
11	2019	1,32	1,44	0,91	0,24	0,02	0,14	-0,19	-0,29	-0,47	-0,52	0,28	0,62

From the dependable flow result tabulation by applying Fj Mock method, data result then arranged into rank order from the lowest score to the highest score, and before establishing ranking order, the researchers calculating the percentage of dependable flow which determined by using the assumption of raw water requirements with a 99 % water discharge availability as presented in Equation 13 below:

$$M = 0{,}01 \text{ X } 11 = 0{,}1 = 1 \quad \text{.....} \quad (4)$$

From equation 13, the expected number of dependable flow to be established as the first order of data can be found. While the entire rank as the full result of dependable flow tabulation by employing Fj. Mock method is listed in the following table (Table 8).

Table 8. Result of dependable flow rank tabulation

No	Month											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
1	0,83	0,70	0,48	0,24	0,02	-0,11	-0,19	-0,29	-0,47	-0,52	-0,19	0,57
2	0,91	0,90	0,52	0,25	0,03	-0,06	-0,19	-0,29	-0,47	-0,52	-0,12	0,60
3	0,94	0,92	0,62	0,29	0,20	0,05	-0,19	-0,29	-0,47	-0,52	-0,06	0,62

4	1,12	1,08	0,69	0,52	0,24	0,10	-0,19	-0,29	-0,47	-0,52	-0,04	0,71
5	1,13	1,29	0,78	0,60	0,29	0,14	-0,19	-0,29	-0,47	-0,52	0,28	0,85
6	1,13	1,37	0,90	0,64	0,34	0,15	-0,19	-0,29	-0,47	-0,44	0,29	0,95
7	1,16	1,41	0,91	0,64	0,40	0,17	-0,17	-0,29	-0,44	-0,41	0,47	1,05
8	1,31	1,42	1,11	0,68	0,49	0,21	-0,16	-0,29	-0,43	-0,38	0,56	1,15
9	1,32	1,44	1,12	0,99	0,52	0,43	-0,03	-0,29	-0,38	-0,37	0,66	1,21
10	1,42	1,48	1,18	1,02	0,56	0,75	0,22	-0,02	-0,37	0,16	0,66	1,47
11	2,08	1,82	1,23	1,12	0,69	1,11	0,36	0,01	0,21	0,33	1,49	1,51

Table 9 is showing result tabulation of dependable flow rank which can be plotted into the original/real dependable flow data.

Table 9. Result of dependable flow discharge tabulation

No	Year	Month											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Okt**	**Nov**	**Des**
1	2009	1,13	1,08	0,69	0,29	0,49	0,21	-0,19	-0,29	-0,38	-0,52	-0,06	0,57
2	2010	1,42	1,29	1,12	0,99	0,69	0,43	0,36	-0,02	0,21	0,16	0,47	1,05
3	2011	1,16	0,70	1,23	1,12	0,56	0,10	-0,17	-0,29	-0,43	-0,38	0,66	0,95
4	2012	0,94	1,37	0,62	0,52	0,29	-0,06	-0,19	-0,29	-0,47	-0,44	-0,04	0,85
5	2013	0,91	0,90	1,11	0,60	0,34	1,11	0,22	-0,29	-0,47	-0,41	0,66	1,47
6	2014	1,13	0,92	0,52	0,64	0,24	0,05	-0,16	-0,29	-0,47	-0,52	-0,19	1,51
7	2015	1,12	1,48	0,78	0,68	0,40	-0,11	-0,19	-0,29	-0,47	-0,52	-0,12	0,71
8	2016	0,83	1,82	0,48	0,64	0,52	0,75	-0,03	0,01	-0,37	0,33	0,56	1,21
9	2017	2,08	1,41	1,18	1,02	0,20	0,17	-0,19	-0,29	-0,44	-0,37	1,49	1,15
10	2018	1,31	1,42	0,90	0,25	0,03	0,15	-0,19	-0,29	-0,47	-0,52	0,29	0,60
11	2019	1,32	1,44	0,91	0,24	0,02	0,14	-0,19	-0,29	-0,47	-0,52	0,28	0,62

4.2. Analysis of Clean Water Necessity

4.2.1. Clean Water Necessity for Education and Office Facilities

In accordance with standards from Directorate General of Human Settlements of Public Works Department issued in 2000, water requirement for educational facilities is calculated based on the necessity of the school level. Whereas data of occupants/students number from each institution was taken by direct surveys at the study field. Data of students in every Darut Taqwa Islamic Schools displayed in the following table (Table 10).

Table 10. Number of occupants/students in Ngalah Islamic School per dormitory in 2009 - 2019

No	Dorm	Year										
		2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1	RA	49	47	48	53	40	42	40	45	55	60	50
2	MI	151	152	163	165	175	174	179	199	189	207	212
3	MTS	853	879	809	670	694	751	824	852	816	868	907
4	SMP		105	245	385	455	490	560	595	770	865	1172
5	SMA	485	468	449	436	424	411	451	490	540	619	749
6	MA	433	457	477	476	508	530	588	640	548	653	637
7	SMK	153	176	208	180	210	222	229	265	260	254	327
8	UYP	1212	1379	1648	1843	2567	2672	1985	2238	2729	3473	3353
9	DT Foun dation	8	12	12	13	15	15	17	16	18	18	20

From data in table 10, the projected number of residents (students) of Darut Taqwa Islamic Schools as calculated by arithmetic method can be found, and the following table (Table 11) is showing the projected number of residents (students) of Darut Taqwa Islamic Schools for the next 10 years.

Table 11. Number of occupants/students of Darut Taqwa foundation in 2020 – 2030.

No	Dorm	Year										
		2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
1	RA	50	50	50	50	50	51	51	51	51	51	51
2	MI	212	221	229	238	246	255	263	272	281	289	298
3	MTS	907	913	918	924	930	936	941	947	953	959	964
4	SMP	1.172	2.363	3.554	4.745	5.936	7.127	8.318	9.509	10.700	11.891	13.082
5	SMA	749	790	831	871	912	953	994	1.034	1.075	1.116	1.157
6	MA	637	667	697	727	757	787	817	847	877	907	937
7	SMK	327	364	401	439	476	513	550	587	625	662	699
8	UYP	3.353	3.945	4.538	5.130	5.722	6.315	6.907	7.499	8.091	8.684	9.276
9	DT Foun dation	20	21	23	24	25	27	28	29	31	32	33

4.2.2. Analysis of Total Water Necessity

In conforming the standards of Directorate General of Human Settlements from Public Works Department in 2000, calculation of water necessity for educational facilities are:

- Water Loss
  Assumption of water loss is predicted to 20 % of total necessity of domestic and non-domestic water, as calculated with equation below:
  Qa = (Qdn+QfasilitasPend +Qfper) x 20%

- Total Water Necesssity
  To calculate total water necessity, the researchers use the following equation:
  Qt = Qdn+QfasilitasPend +Qfper

- Maximum Daily Water Necessity
  To calculate maximum daily water necessity, the number can be found from the following equation:
  Qm = 1,25 Qt

- Peak Hour Water Necessity
  To calculate the peak hour water necessity, the researchers use the following equation:
  Qp = 1,75 Qt

After research data has been analyzed, result of data tabulation by these equations are listed in the following table (Table 12).

Table 12. Calculation of total water necessity

NO	Year	Non-Domestic Necessity	Water Loss (20% assumption)	Total Water Necessity	Maximum Water Necessity	Peak Hour Water Necessity
		Qdn = number of users x q(lt/indv/day)	qHL = (Qn) x 20% q(lt/indv/hr)	Qt = Qnd+Qoffice and education facilities	Qm = 1,25 Qt	Qp = 1,75 Qt
1	2020	1.000.570	200.114	1.000.570	1.250.713	1.750.998

2	2021	1.162.471	232.494	1.162.471	1.453.089	2.034.325
3	2022	1.231.823	246.365	1.231.823	1.539.778	2.155.690
4	2023	1.434.044	286.809	1.434.044	1.792.555	2.509.577
5	2024	1.523.246	304.649	1.523.246	1.904.057	2.665.680
6	2025	1.705.677	341.135	1.705.677	2.132.096	2.984.935
7	2026	1.841.328	368.266	1.841.328	2.301.660	3.222.324
8	2027	1.377.070	275.414	1.377.070	1.721.337	2.409.872
9	2028	2.112.911	422.582	2.112.911	2.641.139	3.697.594
10	2029	2.176.132	435.226	2.176.132	2.720.166	3.808.232
11	2030	2.336.365	467.273	2.336.365	2.920.457	4.088.639

4.2.3. Water Balance Tabulation

Based on calculation of water availability projection at Sengonagung Catchment area also water necessity for the population of Pandean sub-Village, total amount of water availability and water necessity is shown in the following table (Table 13).

Table 13 is showing result of Water Balance Tabulation at Sengonagung Catchment area in current time, in two years ahead, five years ahead and the next ten years.

Table 13. Water balance tabulation

Month	Water Availability (m3/sec)	Water Necessity (m3/sec)				Water Balance (m3/sec)			
		present (2020)	2 yr (2022)	5 yr (2025)	10 yr (2030)	present (2020)	2 yr (2022)	5 yr (2025)	10 yr (2030)
Jan	**0,83**	0,012	0,014	0,020	0,027	0,815	0,807	0,807	0,800
Feb	**0,70**	0,012	0,014	0,020	0,027	0,693	0,685	0,685	0,678
Mar	**0,48**	0,012	0,014	0,020	0,027	0,471	0,463	0,463	0,456
Apr	**0,24**	0,012	0,014	0,020	0,027	0,231	0,223	0,223	0,216
May	**0,02**	0,012	0,014	0,020	0,027	0,012	0,004	0,004	-0,003
Jun	**-0,11**	0,012	0,014	0,020	0,027	-0,125	-0,133	-0,133	-0,140
Jul	**-0,19**	0,012	0,014	0,020	0,027	-0,201	-0,209	-0,209	-0,216
Aug	**-0,29**	0,012	0,014	0,020	0,027	-0,305	-0,3	-0,313	-0,321
Sep	**-0,47**	0,012	0,014	0,020	0,027	-0,481	-0,489	-0,489	-0,496
Oct	**-0,52**	0,012	0,014	0,020	0,027	-0,535	-0,543	-0,543	-0,550
Nov	**-0,19**	0,012	0,014	0,020	0,027	-0,199	-0,207	-0,207	-0,215
Dec	**0,57**	0,012	0,014	0,020	0,027	0,562	0,554	0,554	0,547

From data listing in table 13, it is clear that amount of water availability for the next 10 years is able to be maintained and can be used for fulfilling the water necessity for all dormitories and other facilities at Darut Taqwa Islamic School complex for the next 10 years, by diverting excess water during the month of rainy season

to be utilized for months of dry season where the area tends to experience discharge water scarcity. The amount of excess water that can be utilized for the months of dry season is displayed in the following table (Table 14).

Table 14. Amount of Q diversion

No	∑ Q	present (2020)	2 yr (2022)	5 yr (2025)	10 yr (2030)
1	∑ Q Remains (Jan-May & Dec)	2,786	2,770	2,737	2,696
2	∑ Q (Jun - Nov & May 2030)	-1,845	-1,861	-1,894	-1,941
3	(1) - (2)	0,940	0,908	0,842	0,755

V. CONCLUTION

The result of research and analysis of the water necessity and water availability at Darut Taqwa Foundation withdrawn into the following conclusions:

1. Demand for clean water necessity in Darut Taqwa Foundation based on the increase of projected population for the next 10 years is ± 2.336.365 l/year, by the year 2030.
2. The amount of water discharge availability at each water source to fulfill the clean water necessity of Darut Taqwa Foundation in the subvillages of Njoso and Canggih is:
   Source 1: 1, 736 l/sec.
   Source 2: 1, 385 l/sec.
   Source 3: 1, 553 l/sec.
   Source 4: 4,386 l/sec.
3. From calculation results of clean water necessity and clean water availability at Darut Taqwa Foundation, it can be predicted that water availability will able to fulfill the clean water necessity for the next 10 years with amount of $\pm$ 1.08 m^3/sec/year, by assumption that excess of clean water from the months of January to May and December is diverted to months where the water availability is less such as in the months of June to November and May.

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