ARTIFICIAL AQUIFER OF RAIN WATER DEPOSIT (ABSAH) TO PROVIDE A CLEAN WATER FOR DRY SEASON IN KARANGMONCOL DISTRICT, PURBALINGGA REGENCY

DARMADI Ir

Faculty of Planning and Civil Engineering, Jayabaya University
Jln. Raya Bogor 28 - East Jakarta 12530

email: darmadi1860@gmail.com

Generally, Central Java Province is quite prone to drought. Based on the balance sheet need's water in 2020, Java will have a fairly large deficit in water demand. This study aims to overcome its conditions appropriate technology-based countermeasures. The method that used in this research is a literature review, secondary data collection, field observations and round table discussion. The result of this study is an analysis of construction that solving deficit water conditions in districts of Karangmoncol, Purbalingga regency. The concept of construction proposed is implementation efforts are made especially for treatment with the technology of production ponds, ABSAH (Artificial Aquifer of rain water Deposit, Akuifer Buatan Simpanan Air Hujan) model. Karangmoncol District have problems in the availability of raw water, because well is very deep in the dry season. As an alternative can be taken the second highest value of ABSAH. In Indonesian, the schemes attributed to the so called ABSAH (Akuifer Buatan dan Simpanan Air Hujan), which stands for Artificial Aquifer and Rainfall Storage (AARS). AARS is a result of modification of the well known rainfall harvesting storage tank (PAH) schemes. A guideline for designing this AARS has been accepted for solving water shortage problems elsewhere in Indonesia. This paper discusses the concepts and philosophy of design and modification view points behind these new schemes. Based on population data 2350 person in 535 household we taken 5 person every household. Everyday water demand calculated is 125 liter/man/day, so we should provide 625 liter/day every household. We have taken rainfall data in Karangmoncong district and it required 70 m² roof area of the house for providing everyday needed by every household. By the calculation of the dimensions as needed every day obtained the valid dimension is 12m in length, 5m in width and 2.5m in depth.

Keyword : Karangmoncol, Rainfall, population data, roof area, absah, harvesting rainfall storage

1. INTRODUCTION

1.1. Background

The availability of water is important in the uncertain climatic conditions. In the long time dry season, many activities of daily life are disrupted due to lack of water supply. Therefore, efforts are needed to maximize the potential of water resources to be sufficient, especially the daily needs during the difficult season of water.

Indonesia is rich in water. Unfortunately, the water is a salty water that utilization has not been able to meet the daily needs due to high salinity (salinity). While fresh water sources in Indonesia such as river water, lake water, and ground water comes from a single parent that is rain water.

However, the rain does not go down all year long even though the amount of water that drops

remains relatively corresponding to the potential for rainfall in each region. One of the causes of many areas that are often the difficulty of raw water in the dry season because the use of water is too centered in the rainy season and no effort to save rain water. In fact, for water to remain available in the dry season is very dependent on water conservation.

Indonesia actually does not need to experience hard water because with the lowest amount of rainfall even if it can be stored, will be able to produce enough water volume when drought. One method that can be used is ABSAH method to be able to accommodate rain water. ABSAH Method is an abbreviation of the Akuifer Buatan Simpanan Air Hujan (Artificial Aquifer of Rain Water Savings). Aquifers are layers of rock in the soil that can hold

and store water. For some dry areas of Indonesia, this aquifer layer is located at a considerable depth to reach even by artesian wells as it can reach over 100 meters. The main principle of working ABSAH is to accumulate rainwater so it can continue to be used for long periods of time even.

1.2. The Pupose

The purpose of this research is to make ABSAH building in its utilization as the fulfillment of clean water requirement of Karangmoncol Sub-District of Purbalingga Regency for daily needs such as drinking water, bathing and washing, which can be used continuously and apart from common water supply system as PDAM (Regional Company of Drinking Water)

1.3. The Study Location

Karangmoncol District is located in the Northern part of Purbalingga Regency of Central Java Province, between the coordinates 34041'38 "North Latitude and 135030'8" East Longitude. This district is in the highlands. Karangmoncol has an area of 523 square kilometers and a population of about 2390 people per January,01, 2013. With a population density of 4.54 people per square kilometer, Karangmoncol is a community activity center in the Northern part of Purbalingga regency. Karangmoncol is included in a hazard-prone zone of clean water in Purbalingga Regency with its hilly terrain.

Figure 1. Kabupaten Purbalingga

Figure 2. Kecamatan Karangmoncol

Figure 4. The Study Location

2. LITERATURE REVIEW

2.1. Aquifers

An aquifer is an underground layer of permeable rock, sediment, or soil that yields water. Aquifers can range in size from a few square kilometers to several thousand square kilometers.

In the Grand River watershed, aquifers provide water for both municipal and private water systems. Some aquifers are in bedrock. Others are in the overburden a layer of materials such as sand, gravel and other unconsolidated sediment that is overtop bedrock.

2.2. Confined Aquifers

Confined aquifers are permeable rock units that are usually deeper under the ground than unconfined aquifers. They are overlain by relatively impermeable rock or clay that limits groundwater movement into, or out of, the confined aquifer.

Groundwater in a **confined aquifer** is under pressure and will rise up inside a borehole drilled into the aquifer. The level to which the water rises is called the potentiometric surface. An artesian flow is where water flows out of the borehole under natural pressure.

Confined aquifers may be replenished, or recharged by rain or streamwater infiltrating the rock at some considerable distance away from the confined aquifer. Groundwater in these aquifers can sometimes be thousands of years old.

2.3. Unconfined Aquifers

Where groundwater is in direct contact with the atmosphere through the open pore spaces of the overlying soil or rock, then the aquifer is said to be unconfined. The upper groundwater surface in an unconfined aquifer is called the water table. The depth to the water table varies according to factors such as the topography, geology, season and tidal effects, and the quantities of water being pumped from the aquifer.

Unconfined aquifers are usually recharged by rain or streamwater infiltrating directly through the overlying soil. Typical examples of unconfined aquifers include many areas of coastal sands and alluvial deposits in river valleys.

2.4. Water for daily life

Water requirements for daily life are generally taken from the aquifers. The more water in the aquifer becomes greatly reduced as a result of the change in watersheds/landuse which result in diminishing water into the soil, increasing population and less rainfall throughout the year.

There are many methods can be used to overcome this water shortage, for example the processing done by drinking water supply company, making rain water tank storage (Penampung Air Hujan), ABSAH and others

2.5. ABSAH building

ABSAH building can overcome the natural flow of water in the form of natural groundwater flow, groundwater flow around dug wells or boreholes, streams, hydrological processes in watersheds (roofs of buildings are rain catching areas), filtration process physical in nature, and the process of adding minerals in nature, physical processes, chemistry and biology.

ABSAH building can be referred to as an independent raw water supply building, which can be made regardless of the general public water supply system as owned by the PDAM (regional water utility company). According to the way it works, ABSAH building is divided into 4 parts, namely: as a rainwater infiltration basin, as an artificial aquifer complete with filter process, as a reservoir of water in order to maintain the volume of water smber for everyday purposes while the dry season, and most it is important to use water as water

which has undergone screening and storage process can then be utilized for daily needs such as consumption and washing.

General requirements in the implementation of ABSAH that is with the supporting factors that serve as a rainwater catcher such as roof or sloping concrete covered land. Dimension size of container pool, beside input from multiplication result between area of rainwater catcher media with big annual rainfall, output factor is water taking by residents for daily needs for 1 year.

Part of the ABSAH building is a water filter basin that serves as a neutralizing rainwater properties consisting of 7 stages. Each stage is filled with different materials that have their respective roles and functions, among others: gravel, sand, red brick crushed, limestone, sand pads, palm fiber, and charcoal. Rainwater has a turbidity level that is not too high so that the screening process can be used natural materials. In addition to reducing snoring, the filter material can remove chemical elements such as iron, manganese, ammonia, and organic pollutants because the screening process runs physically and biochemically. Charcoal has a function as deodorizing and as a disinfectant (bacteria killer). As well as contained in bottled drinking water which has high PH and mineral content, the ABSAH filter basin is equipped with limestone that can be used as a boiler water pH improvement. So with the filter basin, the quality of the physical and the content inside, the water that is accommodated feasible to be used for daily needs such as consumption and washing.

3. RESEARCH METHODOLOGY

3.1. Flowchart of Research Methodology

The flowchart of research steps in the utilization of ABSAH building are as describe bellow:

Figure 4. Flowchart Methodology

1. Determine the study location

The location data of the research is very influential on the utilization of ABSAH building. Geological factors in the form of water escape areas such as karst limestone areas. It includes for dry areas due to climatic factors such as in western Indonesia. Groups of residence located in hilltop areas, settlements where the water supply system does not exist or often based on the experience difficulties. Also for areas with water that can not be used for drinking water, such as water containing too high Fe^{++} or Mn^{+} concentrations, such as in Bangka, Belitung, and mine-producing Fe^{++} or Mn^{+} islands. Coastal areas adjacent to the sea that have water and brackish water from seepage into the ground, including swamps and peatlands.

2. Population Data and Area of the study

Population data is used as a reference for making the volume of water should be reserved in building ABSAH where the assumption of the volume of clean water use in the daily needs are 100 liters up to 150 liters per person per day. Optimum volume is obtained by taking into account the water evaporation factor and consumption daily so that the ABSAH building dimension is not too big.

3. Monthly Rainfall Data

Rainfall data is required in calculating the volume of water entering into ABSAH building as water reserves to be used in the dry season. The size of the rainwater trap depends on the amount of rainfall that occurs. If the area has a low rainfall then it takes a large area of rainfall trap in order to get the desired volume of water. Rainfall obtained from the statistical data of the rainfall testing station needs to be corrected by the evaporation factor due to solar heating by 10%. The Rainfall data whose long time period will give better results especially more than 10 years.

4. Calculate water demand and are of harvesting rainfall water

The calculation of the volume of freshwater needs is done after rainfall data and population data are obtained. That is by comparing the volume of water requirement required for the community of a research area, with the volume of incoming water depending on the extent of the rainwater trap (roof area is needed) and the amount of annual rainfall occurring in the research area. Water taking factors for the daily needs of the community concerned need to be included in the calculation of the volume of clean water needs in order to obtain the optimal volume affecting the ABSAH building dimension.

5. Calculation of ABSAH building dimension.

The magnitude of the ABSAH building dimension depends on the volume of clean water needs. ABSAH building height is usually made 2.5 meters, which is 1.5 meters embedded in the ground and 1 meter above the ground. ABSAH building width is usually made 5 meters with a width ratio of 1.25 meters for the width of the water filter while the remaining width of 3.75 meters is used for the water bath. The length of ABSAH building depends on the optimal volume of needs obtained. So it is concluded that the total ABSID building volume consists of optimal volume of clean water requirement plus the volume of water filter. ABSA building is an impermeable

building that can not be affected by the surrounding environment.

3.2. Step of Calculation

Figure 5. Flow Chart Volume Optimal Calculation ABSAH structure

1. Input Data

The input data needed to calculate the ABSAH building dimension requirement is the annual rainfall data, and the population. Rainfall data obtained from the calculation of statistics conducted in several rainfall testing stations. The annual rainfall data obtained will result in the amount of ABSAH building capacity that will be created. While the number of local residents used as input data in analyzing the needs of the total volume of water used by local communities to meet daily needs. In calculations, the amount of rainfall needs to be corrected by evaporation factors that occur due to warming of sunlight. The amount of evaporation correction factor is Rain water volume

In addition to statistical data of annual rainfall, which affects the volume of rainwater is the area of rainwater trap. Rainwater trap can be a roof of a house or building that has a large area. Rain water that falls to the roof of the building

will flow into the ABSAH building through rain water distribution pipes. If a region experiences relatively small rainfall, then to obtain a large volume of rainwater can be overcome by enlarging the area of rainwater trap.

2. Daily water supply

Daily water supply volume is calculated to determine the volume of water obtained per day in relation to the daily volume of harvest by the community to meet daily needs. Daily supply volume calculation is performed to determine the optimal volume, ie the volume of water entering from the rain water has been reduced by the large volume of water discharged by the community use, so the ABSAH building dimension is not too large.

3. Cumulative volume & optimal volume

The cumulative volume is calculated to obtain the average volume of the optimal volume. The optimal volume is the difference from the volume of rain to the supply volume. In daily life, the volume of rainwater that is accommodated will experience a reduction in volume due to the use by the masses to fulfill daily needs such as consumption and washing. The water contained in the container basin can not be used only during the water crisis, but in daily life it can be used to reduce the volume factor per reckoned in designing ABSAH building so that the final result of ABSAH building dimension is not too big. The calculation of the optimal volume in designing the ABS ABS building is in the form of a water reservoir. As for the overall dimension it should be taken into account the utilization basin, filter basin, and the utilized count bath has its own count anymore, and is not included into the optimal volume.

4. Design of ABSAH building dimension

The ABSAH building dimension consists of a dip revenues dipmark, filter basin, container basin, and bak utilization. The size of the container dimension is based on the optimal volume count obtained earlier. As for the filter filter is evenly divided which will be used as a place for the water

filter that consists of 7 stages, namely: gravel, sand, red brick, broken limestone, sand pads, palm fiber, and charcoal. Generally the length of each filter basin is 1.25 meters with a width of 2.5 meters. The filter basin is placed adjacent to one another. Likewise, the infiltration bath adjacent to a stage 1 filter bath containing gravel has the same dimensions as a filter basin. Dimension basin utilization/storage can be tailored to the needs. Another case in saving the construction process, storage utilization combined with the water reservoir. For the height of building ABSAH made as depth as 2.5 meters with a section that is embedded as deep as 1.5 meters and the rest of 1 meter above ground level.

ABSAH building is made **impermeable** to avoid the influence of the surrounding environment so that the water is not polluted so that it still has a good quality although it has been accommodated for a long time. The intended absorption is with the absence of sun which can cause the growth of moss, and impermeable to seepage of groundwater that can contaminate the container water inside the ABSAH building container.

4. Analysis and Design of ABSAH

4.1. Data Availability

The required data are:

- The population of Karangmoncol sub-district is 2,365 people and 473 household, so we have 5 person per household.
- Factors of correction due to evaporation by 10%.
- Annual rainfall in the district of Karangmoncol, Purbalingga Region

Tabel 1. Annual rainfall Karangmoncol

Month	Number of Days	Rainfall (mm)	Rainfall-Evaporation (mm)
January	31	668	601,2
February	28,25	806	725,4
March	31	298	268,2
April	30	535	481,5
May	31	373	335,7
June	30	84	75,6
July	31	8	7,2

Agustus	31	0	0
September	30	0	0
Oktober	31	22	19,8
November	30	622	559,8
December	31	758	682,2
Jumlah	365.25	1606	1445,4

Figure 6. Annual Daily Rainfall Karangmoncol

4.2. Calculation of Water Demand

Dengan total jumlah penduduk di Kecamatan Karangmoncol sebanyak 5 orang per keluarga, dan jumlah pemakaian air per orang per hari sebesar 125 liter, maka dapat dihitung besar total volume kebutuhan air per harinya sebesar $5 \times 125 = 625$ liter/hari = 0.625 m³/hari, maka diperlukan luasan atap minimal = 61 m², maka digunakan luasan atap 70m² (Rumah type-70).

4.3. Availability of Water Rainfall

Tabel 2. Perhitungan Volume Pasok Air

Month	Rainfall (m3)	available (m3)	defisit (m3)	Cumulative (m3)
	(a)	(b)	(a) - (b)	
Januari	60,12	23,22	18,860	118,86
Februari	72,54	25,48	25,293	144,15
Maret	26,82	23,22	(4,450)	139,70
April	48,15	24,00	9,707	149,41
Mei	33,57	23,22	0,275	149,68
Juni	7,56	24,00	(18,706)	130,98
July	0,72	23,22	(22,720)	108,26
Agustus	-	23,22	(23,224)	85,03
September	-	24,00	(23,998)	61,03
Oktober	1,98	23,22	(21,838)	39,20
November	55,98	24,00	15,188	54,38
Desember	68,22	23,22	24,530	78,91
Jumlah	375.66	Minimum	13.138	
		Maksimum	170.97	

Optimal Volume

$$\begin{aligned}
 &= [\text{maximum cumulative volume}] - \\
 &\quad [\text{minimum cumulative volume}] \\
 &= [149.68 \text{ m}^3] - [39.20 \text{ m}^3] \\
 &= 110,48 \text{ m}^3
 \end{aligned}$$

Persentase Optimum

$$\frac{\text{volume optimal}}{\text{volume hujan}} \times 100\% = \frac{110.48}{262.92} \times 100\% = 42,02 \%$$

4.4. Calculate ABSAH dimension

It is determined that the building height of ABSAH is 2.5 meters, 1.5 meter below ground level and 1 meter above ground level. Similarly, the ABSAH building width of 5.0 meters, which is 1.25 meters wide for the filter tub and the rest 3.75 meters as a water reservoir. While the length = $110.487 / (3.75 \times 2.50) = 11.785$ (rounded = 12 meters) according to the needs of the total length of the 7 tub tub, each along 1.25 meters, plus the rainwater entrance gate. Thus the overall length of ABSAH building is 8×1.50 meters = 12 meters.

Figure 6. Composition of ABSAH construction

Figure 7. Water flow in filter

4.5. Construction and dimension of ABSAH

Overall ABSAH building consists of several parts, namely: **water tank, water filter, water storage, and water utilization basin**. For floors and walls in direct contact with the soil should be used a strong material and waterproof so it protected from the outside environment.

The material used as the outer wall and inner wall insulation can be used masonry. Water filtering by the filter made alternating tube in installation. To distinguish the impermeable outer wall with the inner wall as a chamber, for the impermeable outer wall can be added with plastered coating and added Ø6-500 reinforced wire with plastering by cement impermeable. The top of the ABSAH building is usually temporarily closed with a concrete block plate.

Figure 8. Construction of ABSAH

Figure 8. Isometrik of ABSAH Construction

5. CONCLUSION

This research was made to overcome the deficit of clean water by utilizing the building of Artificial Aquifers And Deposits of Rain Water (ABSAH) which happened in District of Karangmoncol which is a difficult area of clean water during dry season. Based on Karangmoncol District statistics, the total population is 2350 people with population 5 person every household, so it can be calculated the volume of daily clean water requirement of 0.625 cubic meters every household by assuming 125 liters/day/person. With rainfall occurring and an area of 70 rainfall traps meter persegi in the form of an housing roof, then it takes ABSAH building by 12 meters length, 2.50 meters depth and 5 meters width. Each water filter basin 1.25 meters x 2.50 meters. With the ABSAH building, Karangmoncol District will have a clean water reservoir that can be used every time by using rain water.

REFERENCES

- Ayu Wahyuningtyas, Septiana Hariyani, dan Fauzul Rizal Sutikno. "Strategi Penerapan Sumur Resapan Sebagai Teknologi Ekodrainase Di Kota Malang (Studi Kasus: Sub Das Metro)" *College & Research Libraries* 66 (2005): 231-247.
- Bambang Soenarto, KONSEP, FILOSOFI DAN PERHITUNGAN UKURAN BANGUNAN AKUIFER BUATAN DAN SIMPANAN AIR HUJAN (ABSAH), Litbang Kimbangwil Sumber Daya Air, 2003
- Badan Pusat Statistik Purbalingga. "Kecamatan Karangmoncong dalam angka." , 2015
- Kliping Cyber Media. "ABSAH Lumbung Air Ketika Kemarau." 25 November 2009
- Wikipedia. "peta Kecamatan Karangmoncol." <http://id.wikipedia.org/wiki/Karangmoncol> (accessed 17 May 2018)
- Google Map. "Kecamatan Karangmoncong." <http://www.google.com/maps/place/Karangmoncol/@-7.2484277,109.0687881,9816a,35y,270h,38.13t/data=!3m1!1e3!4m2!3m1!1a0x2e6f8584ae5245ed:0x4027a76e352f9d0> (accessed 17 May 2018)