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Procurement Clean Water by Using Groundwater (Case Studi in Bukit Asah Bugbug Village Karangasem Bali)

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Abstract. Bukit Asah is a residential complex located in the village of Bugbug Karangasem, position of about 8.498162 LS, 115.602957 BT, the height between 120 - 150 m, the population of about 800 people, the location of the house spread. Bukit Asah has no water source. Taking into account such circumstances, residents in Bukit Asah took the initiative to raise water using pumps with the ability and knowledge of sober. The water discharge can flow about 0.5 m^3/hr. Households can be serviced by about 50 households with a total volume of 6 - 9 m^3 per month. With such a large discharge, there are still many unserved households, pumps work all day, resulting in frequent burning of pumps. The use of dug well water leads to the quality of the water in doubt. The low technology used to raise the water resulted in the expensive water that is Rp. 9,000, - /m^3. An underground water survey has been conducted using Geolistrik Method, the result has been found aquifer. In the place has also been done drilling. Water sources are found at a depth of 18.5 m. After analyzing the quality of water, pursuant to Governor Regulation No. Bali. 8/2007 on Environmental Quality Standards and Raw Environmental Damage and Guidelines for Drinking Water Quality, WHO, Geneva, 1982, water quality is feasible for drinking water sources. The result of the analysis using Quality Water Index Calculator test showed that the well water of drill has 89 quality index with good category. Optimum discharge of well 65 m3 / hour. If this water is transmitted to Bukit Asah, electricity costs Rp. 1.288 /m^3

1. Introduction

Water is a vital good that is needed by humans, animals and plants. Water is very limited. Water in an area can come from rain, wells, and springs. The location of the water source to the neighborhood of residents from a few meters to thousands of meters. The position of the water source may be higher or lower to the home environment of the population. If the position of the water source is higher than the environmental position of the people's house, water can be drained gravity to the people's homes. If the position of the water source is lower than the environmental position of the resident's house, water should be discharged with the help of the machine.

Bukit Asah is a residential complex located in the village of Bugbug Karangasem, position of about 8.498162 LS, 115.602957 BT, the height between 120 - 150 m, the population of about 800 people, the location of the house spread. Bukit Asah has no water source. The water source is below, on the shore of a dug well and a water company drinking water village. Many locals use rain water for washing, bathing and drinking water. The rain water is accommodated by the shelters in the houses. The reservoirs are made with volumes between 10 - 50 m^3. There are also residents who come down to take water for drinking water with a distance of about 1- 2 km. Taking into account such circumstances, residents in Bukit Asah took the initiative to raise water using pumps with the ability and knowledge of sober. The water discharge can flow about 0.5 m^3/hr. Households can be serviced by about 50 households with a total volume of 6 - 9 m3 per month. With such a large discharge, there are still many unserved households, pumps work all day, resulting in frequent burning of pumps. The use of dug well water leads to the quality of the water in doubt. The low technology used to raise the water resulted in the expensive water that is Rp. 9,000, - /m^3

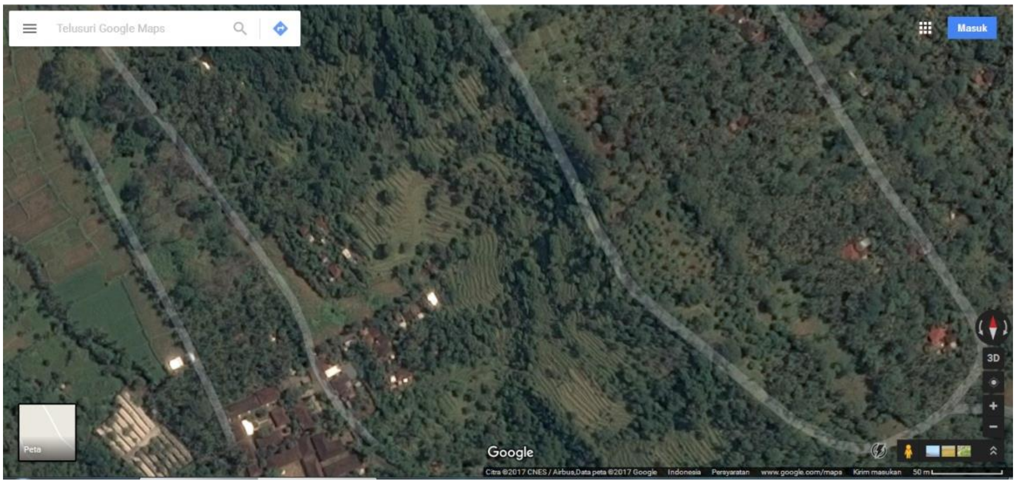
Taking into account the existence of water problems in Bukit Asah, it is necessary to find a quality water procurement solution and meet the quantity. Water resources research (Aquifer) using Geolistrik Method has been done many, some of them at Nyitdah International Hospital Project Tabanan Bali, in Project Villa Puri Persada Denpasar, and at Project Joglo Bedugul (Simpen, 2016 a, 2016 b, 2016 c). Several studies have been conducted in order to estimate the aquifers by Geoelectric Method, namely, Indriatmoko and Herlambang (2005), Purnama and Sulaswono, (2006), Anomohanran (2011), Rolia (2011), Irjan (2012), Karunia et al. (2012) Wulandari (2014), VenkataRao et al., 2014), Alile et al. (2011: Olawuyi and Abolain (2013) and Anomohanram (2013) and the results are very suitable.Seeing the success of the Geoelectric Method in interpreting the aquifer's position, this method is worthy of consideration for suuse.

Physically, the aquifer has the resistivity contrast to its environment (Keller and Frischknecht in Sajeena et al., 2014). Geoelectric Method is one of the geophysical methods to estimate the presence of sub-surface coatings based on their resistivity differences. Geolistrik Method works by injecting electric current (I) into the earth (soil) and then measuring the potential difference generated (V). The strong magnitudes of current (I) and the magnitude of the resulting potential difference (V) reflect the magnitude of the rock resistivity at the point of measurement. Geoelectric Method can map rock resistivity in the vertical and horizontal direction. The presence of water content in rocks results in decreased rock resistivity. There are several factors that determine the magnitude of the resistivity value of rocks, ie material types, water content, rock porosity, and chemical properties of fluid fillers (Sen et al., 1988; Araffa, 2013; Simpen et al., 2016). Thus the Geoelectric Method is expected to help obtain a good aquifer so that it can be explored and if it is raised to serve the population in Bukit Asah how much it will cost.

2. Research Methods

2.1 Time and location of study

The study was conducted in May - June 2015 in around of Bukit Asah Village of Bugbug Karangasem Bali. Geographically located at position 8.5735280 LS and 115.120702 BT, at an altitude of 25 - 150 m (Figure 1).



Source: https://www.google.co.id/maps/@-8.4972515,115.5970595,337m/data=!3m1!1e3

Figure 1 Location of Study

2.2 Research tool

ISBN : 978-602-99806-3-9

Equipment used in this research are: Set resistivimeter gauge, Laptop, Res2Divn Software.(Figure 2).

Figure 2 Research tool

2.3 Method of data retrieval

The data needed in this research are location height data, geoelectric data and cost data of raising water to reach Bukit Asah. Location altitude data is measured by General Position System (GPS) tool. Geoelectric data is measured by a multichannel SkillPro resistivimeter tool set by the Wenner configuration. The cost data of raising water up to Bukit Asah is calculated based on electricity consumption.

2.4 Method of data analysis

Data obtained from geoelectric measurements in the form of strong current injected data (I) and magnitude of the resulting potential difference data (V). Further I data and data data processed by Res2Divn program so that obtained contour cross section sideways resistivity. The analyzes were conducted on the color and shape of the contour cross-sectional resistivity image. From the analysis of the resistivity contour of the cross section can be known aquifer and also obtained the position of drilling point to get ground water with good quality and quantity.

3. Data Analysis Research Results

Geoelectric data is initially a strong quantity of injected current (I) and potential difference quantity (ΔV) due to current injection. However, in the Geolistrik Skill Pro tool set can be directly obtained the apparent resistivity scale at the measurement points. The apparent resistivity value is then analyzed by Res2divn program so that the real resistivity value of each point in the cross section of the trajectory and the cross sectional resistivity contour is obtained. Figure 3 is the result of geoelectric measurement after being processed using Res2divn program.

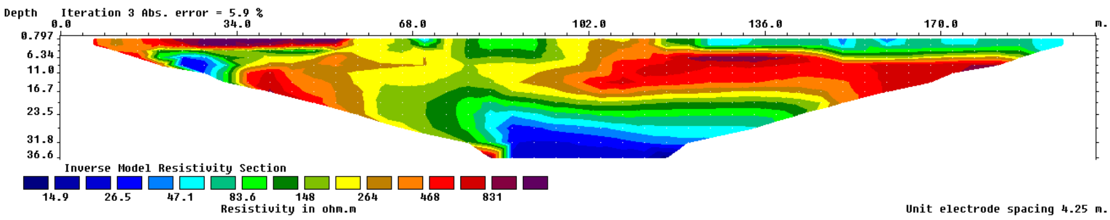


Figure 3. Contour Cross Section of Geoelectric Measurement

From the picture it appears that the contras resistivity of small resistivity from 14.9 - 26.5 ohm.m with the position of around the point 102 and the depth of 18.5 m which indicates the area of the aquifer.

ISBN : 978-602-99806-3-9

The aquifer in the research area is suspected of a distressed aquifer. The aquifer is thought to have come from a trench buried by the eruptive material of Mount Agung. This situation can be seen in positions 24 - 28, that the presence of aquifer at a depth of 6 m. According to locals, around this place before Mount Agung erupted in 1963, there was a trench as a boundary of land. Now revived again the trench, but its position shifted 10 m (in position 34-38). Similarly, the acquired aquifer, suspected of a ditch buried by the eruption of Mount Agung in 1905. The results of this study in accordance with Simpen (2015a) which states that the aquifer can be formed from the accumulation of trenches by volcanic eruption material. Such aquifers are usually shaped grooves according to the previous ditch groove.

Based on the drilling at 87.75 position obtained aquifer at a depth of 18.5 m, then drilling continued to a depth of 27.74 m. After meeting the aquifer, the water level up until 17.22 m. This means the acquired aquifer is a distressed aquifer, its infiltration upstream. Well water obtained need to be tested quantity and quality. The quantity test is done using step drown test method. The results of the pumping test can be seen in Table 1.

Table 1. Pump Well Test Results

Step	Q (m^3/s)	Sw (m)
1	0,00078	0,088
2	0,00125	0,187
3	0,00181	0,320
4	0,00233	0,428
5	0,00278	0,533

Description: Q discharge pumping and Sw decreasing the water level at the well due to pumping

Qualitative analysis of the result of well pumping test with step drown test method based on Table 1 shows that optimum discharge of well 65 m3/hour.

Drilling well water is chemically, physics, and biology analyzed. To get more accurate results, two tests were performed. The test results are presented in Table 2. These results suggest that the values of biological parameters such as ALT, Coliform, E. Coli, Staphilococcus aereus, Salmonella/Shigella and BAL are all zero, so it can be interpreted that a wellbore aquifer has a water infiltration site upstream. From the results of qualitative analysis with reference to the Bali Governor Regulation no. 8/2007 on Environmental Quality Standards and Environmental Damage Standards and Guidelines for Drinking Water Quality, WHO, Geneva, 1982, and analyzed using the Quality Water Index Calculator (http://www.water-research.net/index. Php / water-treatment / water-monitoring / monitoring-the-quality-of-surfacewaters) showed that wellbore water has a good quality index of 89 (Table 3), interpreted that the water obtained from the borehole is suitable for use drinking water.

The economic calculation is done to get water up to Bukit Asah. Existing data include 375 m water transmission data, height 130 m, population 800 people, water requirement 60 l/person/day (Dirjen Cipta Karya, Public Works Department, 2007). Based on the data, the daily water requirement is 48000 l. The installed pump is a pump capable of transmitting water between 2000-2500 l / hr. One of the pump brands that can be used for this purpose is Groundforce pump SQ 3-105 power 2.3 KWh (Groundforce, 2012). Installation of this pump in theory the pump will work 20 - 24 hours / day. Price of electricity per KWh Rp. 1400, then the water price becomes Rp. 1288 /m^3. This price only covers the price of electric power required, not including the depreciation of investment and maintenance. Installation of such pumps above will not cause the well water to recede because the optimum well discharge of 65 m3 / hr, is still well below the optimum well discharge. The well has also been tested for taking water with a discharge of 10 m^3/h (Table 1), for 24 hours, well water does not recede, just down 53 cm.

Table 2. Water Quality Test Result of Drilled Well

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No.	Parameter	Unit	Test 1	Test 2	Threshold
1	pH		7,12	7,42	6-9 [1)]
2	BOD5	mg/l	1,83	1,28	2 [1)]
3	COD	mg/l	4,28	3,20	10 [1)]
4	Nitrite (NO2)	mg/l	0,001	0,004	0,06 [1)]
5	Nitrate (NO3)	mg/l	7,242	6,421	10 [1)]
6	Sulfate (SO4)	mg/l	15,926	14,829	400 [1)]
7	Darkness	mg $CaCO_3$/l	241,297	157,642	500 [2)]
8	Chloride (Cl)	mg/l	21,3	51,79	600 [1)]
9	Amonia (NH3)	mg/l	0,002	Ttd	0,5 [1)]
10	Turbidity	mg/l	18,75	16,5	1000 [1)]
11	Colour	UnitPtCo	0,001	0,001	50 [2)]
12	Odor		odorless	odorless	odorless [2)]
13	Taste		Does not taste	Does not taste	Does not taste [2)]
14	Calcium	mg/l	7,363	7,476	200 [2)]
15	Magnecium	mg/l	1,135	1,244	150 [2)]
16	Sodium	mg/l	-	-	0 [2)]
17	Iron	mg/l	Not detected	Not detected	1,0 [2)]
18	*ALT*	CFU/ml	0	0	0 [2)]
19	*Coliform*	MPN/100ml	0	0	0 [2)]
20	*E.Coli*	MPN/100ml	0	0	0 [2)]
21	*Staphilococcus aureus*	CFU/ml	0	0	0 [2)]
22	*Salmonella/Shigella*	CFU/ml	0	0	0 [2)]
23	*BAL*	CFU/ml	0	0	0 [2)]

[1)]*Bali Governor's Regulation no. 8 of 2007 on Environmental Quality Standards and Raw Environmental Damage*
[2)] *Guidelines for Dringking Water Quality, WHO, Geneva, 1982*

Table 3. Water Quality Index Test Results

Factor	Weight	Meaured	Quality Index
Dissolved Oxygen	0.17	-	100
Fecal Coliform	0.16	-	100
pH	0.16	7.27	92
BOD	0.11	1.55	89
Temperature Change	0.11	1	89
Total Phosphate	0.10	-	100
Nitrates	0.10	6.82	58
Turbidity	0.08	17.625	64
Total Solids	0.07	17.625	84

Factors Entered:	9
Final Index:	89

Water Quality Index Legend

Range	Quality
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very Bad

4. Conclusions

Provision of clean water in high areas such as Bukit Asah with an altitude of 120 - 150 m above sea level can be done by first surveyed water source, drilling then transmitted to the desired location.

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Survey water sources one of them using Geolistrik Method. The water obtained is suitable as a source of drinking water. In theory until the price of water in Bukit Asah Rp. 1288 /m^3.

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