

STUDY ON CLEAN WATER PROVISION FOR INHABITANS IN BUNAKEN ISLAND

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Abstract

The Bunaken Island, has acquired its municipal water from shallow groundwater or dug water well in which the water condition is below standard. As the result, the local inhabitants are frequently obtaining clean water from the Sulawesi Island mainland. Through this research with title "the study on clean water provision for inhabitants in Bunaken Island", it is expected in producing a recommendation as a solution for the clean water problem in the Bunaken Island, so to fulfil the clean water demand of inhabitants continuously. Recommendation for the Kelurahan Alungbanua and village of Tanjung Parigi that beside operating the water installation provided by the Public Work is also to utilize the Tawara well water. As for the Kelurahan Bunaken it is sufficient by operating the water installation provided by the Public Work. The drawing of water by inhabitants must be regulated, while still utilizing the existing drinking water processor.

Keywords : Bunaken, water, demand.

BACKGROUND

Water is one of the essential resources for living things. The Bunaken Island, which is located in the North Sulawesi Province, has acquired its municipal water from shallow groundwater or dug water well in which the water condition is below standard. In some areas there is even no well available. If there is, the water quality is very bad because of the salty taste. As the result, the local inhabitants frequently obtain clean water from the Sulawesi Island mainland. This research entitled " **The Study on Clean Water provision for Inhabitants in Bunaken Island**" is conducted in an effort to supply the clean water in the Bunaken Island with the intention to obtain a clean water supply which is readily applicable.

The expected result from this research is a recommendation which can solve the clean water problem in the Bunaken Island so as to fulfil the demand of community everlastingly.

METHODOLOGY

The initial stage of research is to collect the secondary data from the corresponding institutions about the general description of the condition in location of the research which include the data of geography, topography, geology, hydrology, hydrogeology, climatology, and land use. The next stage is to survey in location of the research for identifying the existing condition, the water sources, and clean water problems. The following process is to analyse the data and the

discussion which will produce a recommendation of a management system for fulfilling the clean water demand of inhabitants in the Bunaken Island.

RESULTS AND DISCUSSION

Description for Location of the Research

Location

The Bunaken Island, very well known for its coral reef tourism which is located between $1^{\circ}36'$ – $1^{\circ}38'$ North Latitude and $124^{\circ}44'$ – $124^{\circ}47'$ East Longitude, not far from the Sulawesi Island mainland, it still belong to the administrative area of Manado City, and can be reached by using outboard motor boats (40 HP) in less than 50 minutes from the port of Manado.

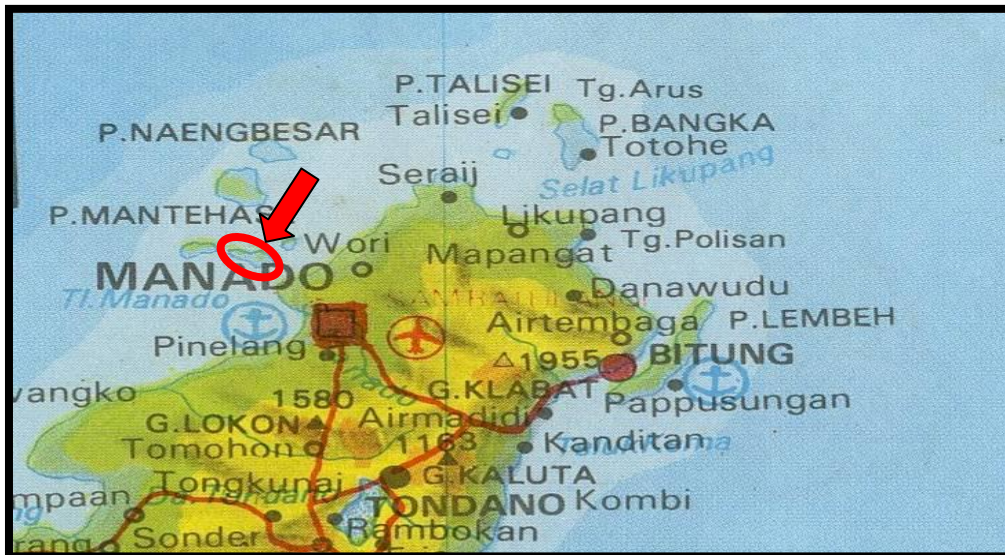


Figure1. Map of Location of the Research : Bunaken Island

Topography

The Bunaken Island with the area of about 7.82 km² has varied slopes, but most of it has gentle enough slopes especially in the eastern part of the island, with the slopes ranging from 0 to 5 %. In the western part of the island there is a hilly region with the highest elevation of about 70 m above sea level. The dwelling areas are located in the flat part (the eastern part) and some are also located in the slope up to ridge of the hill (the western part).

Hidrogeology

The Bunaken Island with low to moderate porosity has local productive aquifer and the center part of the island only has aquifer with low production. There is not any river or water spring in this island, and the wells only exist in some areas not far from the coast.

The Existing Condition of Clean Water Supply

Kelurahan Alungbanua is located in the western part of the Bunaken Island, in the slope of hill up to ± 60 m above the sea level. This administrative village which consists of 2 (two) lingkungan connected to location of the Bunaken Coral Reef and Kelurahan Bunaken by unpaved footpaths passable for human and also for oxcart. Because of the highly situated dwelling area of Alungbanua, it is very

difficult for the residents to obtain clean water. The utilized clean water for the residents comes from the 3 (three) public wells. These wells have diameter of 2.50 m and the depth of about 20 – 25 m. To utilize this water, the residents must walk down and up along the village road with the distance to the nearest dwelling is \pm 200 meter, while the distance to the farthest dwelling is \pm 2 km from the location of wells.



Figure 2. Two public wells at the foot of hill.

The water condition in these wells is very poor. In the dry season, it is almost depleted.



Figure 3. Pumping house and well at the side of village road.

In the year of 2008, the Public Work of North Sulawesi Province built a 4x4 m well with depth of 15 m at the side of the village road. For exploiting the well water, a pumping house has been erected which is equipped with a pump and electricity. In the wet season, the volume of water in these wells is quite large so as to be able to fulfil the demand of inhabitants, but the constraints of water supply and distribution to the high level dwelling area still exist. Besides these three wells, the residents have tried to dig new wells, but the well water conditions are not as good as those of the three previous wells. Water is pumped to the hill in the midst of dwelling where a storage reservoir has already been built. The water from reservoir is conveyed by gravity to public hydrants in the dwelling area. But recently the system has not been utilized to avoid conflicts among the residents because actually only some of them can take benefit of this facility as the location of reservoir which is not in the highest place has restricted its area of service. In the

region of Tawara which is located in the border of kelurahan Alungbanua and kelurahan Bunaken, there are two wells which in the past had been utilized to fulfil the clean water demand in the Bunaken Coral Reef tourism area. But now it has already been unused and in ruined condition. The clean water supply facilities in kelurahan Bunaken are :

1. Clean water well in the area of Pangalisan about 2 km from the center of the village, ± 200 m from the coast. The well water has been exploited by using the pipeline instalation completed with pump, electrical genset, water tank, and water faucets in the dwelling area. Because of the inadequate water pressure (difference in elevation between the tank and the location of faucets in the dwelling area is not sufficient), therefore not all of the faucets can run water.
2. Two fresh water processing machines for drinkable water, which is available to the community for Rp. 2000/gallon. The operation of this apparatus is handled by the Village Government.
3. The drilling of well in the village Tanjung Parigi completed with pump and electrical genset, but until now it has not been tested and passed to the Village Government yet. Particularly, the residents of Kelurahan Bunaken who live in Siladen island, besides getting the water from the village Pangalisan, also obtaining it from the island of Sulawesi mainland. This scheme is bolstered by the proximity of the Siladen island to the island of Sulawesi mainland.

Analysis of Clean Water Provision

From the results of survey and interview on the head of the village and some of the residents, the raw water demand of the village resident in the Bunaken Island is solely for the clean water. Therefore the calculation of the raw water demand in this island is only for obtaining the amount of domestic clean water demand of the village residents.

Projection of Population

The planning period of the village clean water system is based on the standardized criterion which is to be 10 years.

Table 1. Projection of Population in the year of 2020 in Bunaken Island

No.	Kelurahan (Village)	Population in the year of 2020
1	Kelurahan Alungbanua (Lingkungan I and II)	863
2	Kelurahan Bunaken	
	- Lingkungan I s/d IV (Kpg. Induk)	4680
	- Lingkungan VI (P.Siladen)	514
	- Lingkungan V (Tanjung Parigi)	634

Raw Water Requirement

With the assumption that the entire pupolation of the Bunaken Island (including those in the Siladen Island) will use the raw water supply system to fulfil their domestic clean water provision with the capacity of 30 ltr/person/day, hence the raw water demand until the year of 2020 is as follows :

Table 2. The Raw Water Provision in the year of 2002 in Bunaken Island

No.	Kelurahan (Village)	Raw Water Demand (ltr/sec)
1	Kelurahan Alungbanua (District I dan II)	0,300
2	Kelurahan Bunaken	
	- Lingkungan I s/d IV (Kpg. Induk)	1,625
	- Lingkungan VI (P.Siladen)	0,178
	- Lingkungan V (Tanjung Parigi)	0,220

Analysis of Quantity and Quality of the Raw Water Availability

The water sources in Kelurahan Alungbanua are the public wells which are far enough from the coast, private wells which are closer to the coast, and the well in Tawara. The water of the Tawara well can be used to supply the clean water for the residents in Kelurahan Alungbanua and some of the residents in Kelurahan Bunaken (especially the ones who live in Tanjung Parigi). These two wells have concrete lining and is located inside a housing structure with a dimension of 4x8 m². The size of wells are 2,20 m x 2,20 m with the depth of 5,20 m. The depth of water in the dry season is up to 0,70 m. In the wet season, the water in these two wells can be 4,0 - 4,5 m deep. Presently the condition of the housing structure including the wells inside is in disrepair and needs a reparation.

The results of tests on water quality which have been conducted at the Environmental Health Engineering Bureau (BTKL) of Manado show that the hardness level (CaCO₃) is above the limit for the proper drinking water. The clean water demand of the residents in Kelurahan Alungbanua and Tanjung Parigi village (Kelurahan Bunaken) is 0.52 ltr/sec. This means a water need of 44.9 m³ every day. This demand is hard to be fulfilled by the water sources in Tawara during the dry season where its well with the size of 2.1x2.2 and the depth of 0.70 m can be pumped 4 times a day (information: the recharge 4 hours at most), therefore the volume of water available for supply from those two wells is only 27.1 m³. If assumed that the well provided by the Public Work of North Sulawesi Province which has size of 4x4m with the depth of 0.70 m can be pumped 3 times a day, then the volume of water available from this well is 33.6 m³. This means that the basic demand of 30 ltr/sec can be fulfilled by the well of Tawara and the well provided by the Public Work of North Sulawesi Province, while the water need for bathing, washing, and others can be obtained from the other public wells.

The clean water demand of the community in the Kelurahan Bunaken (including those who live in Siladen Island, but not those in Tanjung Parigi) is 1.80 ltr/sec which require water storage of the size 155.8 m³. The main source of water in Kelurahan Bunaken come from Pangalisan. The results of tests on water quality which have been conducted at the Environmental Health Engineering Bureau (BTKL) of Manado show that the amount of solid matter dissolved and the hardness level is above the limit for the proper drinking water, which is the same as the well water quality in Kelurahan Alungbanua.

Analysis of the Clean Water Management System

The plan of a clean water supply system for the residents in Bunaken Island is proposed as follows :

The two wells in Tawara are recommended to be repaired, furnished, thus can be utilized for the interest of residents in Tanjung Parigi and Kelurahan Alungbanua. Water availability in the wet season is not in doubt, but it still cannot fulfil the community demand in the dry season. This problem of clean water shortage can be solved if these wells are operated together with the well already provided by the Public Work of North Sulawesi Province in the year of 2007. There is no more conflict in the community because of the inadequate clean water distribution. There is a need for a comprehensive planning for utilization of Tawara well. The water of Tawara well is pumped to the highly placed distribution reservoir. Using gravity, from reservoir the water is conveyed toward two destinations, Kelurahan Alungbanua and Tanjung Parigi respectively. The providing of pump and electrical genset become a priority, and the housing structure of the well and the electrical genset also need reparation.

The results of analysis have produced the amount of minimal clean water demand (service through the public hydrants) and the clean water supplying capacity as presented in the following table.

Table 3. Clean water demand and the supplying capacity

Raw Water Demand			Capacity of Raw Water Source		
Village/ Kelurahan	Demand (ltr/sec)	Demand (m ³ /day)	Proposed Source	Well capacity in the dry season (m x m x m)	Description
Alungbanua	0,300	25,89	Tawara well	2.2 x 2.2 x 0.7 (2 units, 4 times pumping) = 27.1 m ³	Two well inside the housing structure.
Bunaken : - Tanjung Parigi	0,220	19,02	DPU well	4 x 4 x 0.7 (1 unit, 3 times pumping) = 33.6 m ³	Well provided by DPU Prov.Sulut Year 2007.
Bunaken : - The Main Village	1,625	140,40	Well in Pangalisan	3 x 15 x 1,5 (1 unit, 2 times pumping) = 135 m ³	Well provided by DPU Prov.Sulut Year 2007.
Bunaken : - Siladen Island	0,178	15,42	Drinking Water Processing machine	2 units granted by The Social Ministry, with operation as needed	Already functioned well.

The well with its pipeline instalation in Pangalisan which has already been provided by the Public Work of North Sulawesi Province can be operated by firstly repairing the impaired electrical genset. The public hydrant facility is adequate, but the withdrawal of water must be regulated by turns. The apparatus of drinking water processing machine can be activated as needed to supplement the shortage of water supply from the well in Pangalisan.

The design calculations generally involve the hydraulic calculations such as the calculations for the capacity and number of public hydrants, the capacity of reservoir, the size of pipes, and the capacity of pump and electrical genset.

The following is the summary of the design results :

- The well water is pumped into reservoir with size of 50 m³ (2x25 m³)
- The pump being used has capacity ≥ 5 l/d, with suction head ≥ 15 m, and discharge head ≥ 110 m
- Electrical genset has capacity of 20 KVA
- The flow by gravity from the reservoir to the four public hydrants with size of 2 m³ in Alungbanua and the three public hydrants with size of 2 m³ in Tanjung Parigi.
- Sucking pipe with the type of PVC S-12.5
- Transmission/distribution pipe with the type of PVC S-8

CONCLUSION and RECOMMENDATION

Conclusion

1. For Kelurahan Alungbanua and village Tanjung Parigi, besides operating the water installation provided by the Public Work of North Sulawesi Province, it is proposed to utilize the well water of Tawara. The well water of Tawara is pumped to the reservoir on the hill, then conveyed by gravity to the public hydrants which are spread over the dwelling area of Tanjung Parigi village and Kelurahan Alungbanua.
2. For Kelurahan Bunaken (excluding Tanjung Parigi) it is enough by operating the water installation of Pangalisan which is provided by the Public Work of North Sulawesi Province. The withdrawal of water by residents must be regulated, while still utilizing the drinking water processing machine which was granted by the Social Ministry.

Recommendation

1. The status of ownership of land in the location of Tawara water sources is still not clear. Before the start of construction, the things connected with the right for usage of the well and the possibility of land acquisition must be dealt with.
2. In connection with the operation and maintenance of the clean water supply system, it needs for the establishment of a management council at the village level, which has the full managerial power of authority.

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