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Improvement of People's Welfare Through Fulfilling The Needs of Water in Morotai Island As Outermost Island

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***Abstract*—One of the government's targets to increase the service quality of water resources is the compliance of raw water to the entire districts in Indonesia, including the district in border areas and/or outermost islands, which is the front porch of this country. One of the islands in the border which is also the outer island is Morotai Island. Morotai Island consists of five districts, which are Morotai Jaya, South West Morotai, Eastern Morotai, and Northern Morotai. Among those five districts, the Morotai Jaya is the outermost district which is directly adjacent to the water free zone. Morotai Jaya District is the center of the northern region which is focused on the development of infrastructure arrangement. Regarding the regional and infrastructure development, the water supply service is very important and urgent. For that reason, the research about water supply is conducted. This research is oriented to the raw water supply for the next 20 years. The method used in this research is a survey of social studies with direct measurement of water potential and Mock method approach, topographic surveys, planning and provision of services, and the design concept. Based on the result of the research, the water resources potential in the study area are able to fulfill people's needs for the next 20 years. However, it is important to make a plan of an established, decent, and adequate infrastructure design, so the potential of water resources which has already exist can be optimized.**

Keywords—Morotai Island, outermost island, needs of water

I. INTRODUCTION

One of the government's targets to increase the service quality of water resources is the compliance of raw water to the entire districts in Indonesia, including the district in border areas and/or outermost islands, which is the front porch of this country. One of the islands in the border which is also the outer island is Morotai Island. Morotai Island consists of five districts, which are Morotai Jaya, South West Morotai, Eastern Morotai, and Northern Morotai. Among those five districts, the Morotai Jaya is the outermost district which is directly adjacent to the water free zone. Morotai Jaya District is the center of the northern region which is focused on the development of infrastructure arrangement. Regarding the regional and infrastructure development, the water supply service is very important and urgent. For that reason, the research about water supply is conducted. While the aim of this research is to analyze the potential and the supply of raw water for the next 20 years.

II. METHOD

A. Location

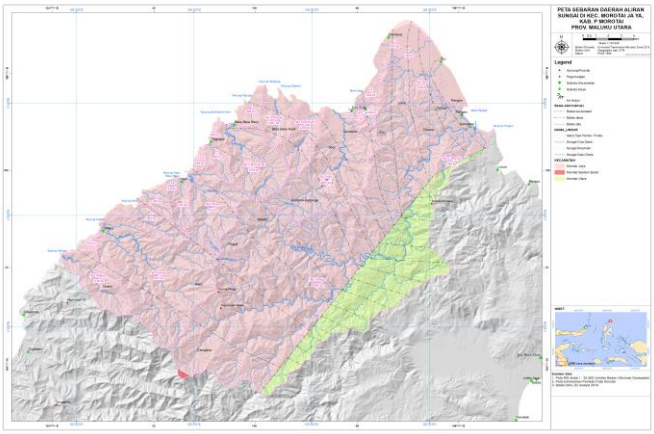

Fig. 1. Map of Morotai Island District

Resource: Data Process Result, 2016

The location of this work is in North Maluku River, North Halmahera, Morotai Island District, and Morotai Jaya District.

(See Fig. 1). Morotai Jaya District consist of 14 villages but this research is focused on Sopi village and Majiko village which are the center of the regional development.

B. Method

The method used in this study is a survey of social studies with direct measurements of water potential and Mock method approach, topographic surveys, planning and provision of services, and the design concept.

- Social survey is conducted to calculate water needs based on population and projection for the next 20 years. Socio-economic survey analyzed the literature study from several resources, including North Maluku in the number of BPS. However, interviews about socio-economic condition with local residents are also conducted, those interviews are focused on Morotai Jaya villagers, specifically Sopi and Majiko village.
- Study of the water potential is performed to calculate the potential availability of water using Mock approaches and direct measurements in the field such as hydrological survey. Hydrological survey is conducted on several rivers including Sopi River and Majiko River. In addition to hydrological survey in the study of potential water, it is also required the calculation of region waterfall. While the precipitation data used are Tabelo Station Year 2008-2014, Galela Station Year 2012-2016, Tutuling Jaya Year 2007-2015. The formula used to determine the region rainfall is Polygon-Thiesen.
- Topographical survey is conducted to become a basis of raw water interlocking network. Topographic survey is conducted at two study locations which are Ake Sopi water resource and Aru village water resource. The steps in topographic survey are the pioneer and installation of stake, BM, and CP, Polygon measurement, and water pass measurement.
- Plan and provision of services is based on the need and water potential. This is an effort to support the government's plan to fulfill all the needs of water in every district in Indonesia.
- Based on the survey and study above, it is prepared a concept design of raw water network. The concept of raw water must be oriented to the people's needs of water and the efforts of sustainable raw water supply.

III. FINDING AND DISCUSSION

A. Description of Study Location

Morotai Island is a district in North Maluku province, which the territory is archipelagic surrounded by the sea and since 2002, Morotai Island administratively belongs to the Government of North Halmahera District with the center located in Tobelo City. It is based on the approval of North Maluku Parliament with an assessment number: 188.4/06/DPRD/MU/2002 dated February 15th, 2002. Morotai Island District is a marine district as most of its area (90%) are coastal villages. Morotai Jaya District consist of 14 villages, including Sopi Village and Majiko Village which become the focus study areas. The population of these villages in 2014, respectively 650 people and 1983 inhabitants area with a population growth rate of 6,82 % per year. The whole villages in Morotai Jaya District are unserved of clean water from taps. The compliance of water needs for the people of Morotai Jaya District are obtained from dug wells, rivers, and springs that are managed independently.

B. Analysis of Potential Water

Water potential in an area can be known through calculation of debit mainstay, one of the ways is by using FJ Mock method. From the result of calculation, it is known that debit mainstay for Sopi Village is 5,79 m3/second at Q80 and 3,78 m3/second at Q90, while for Majiko village is 5,42 m3/second at Q80 and 3,55 m3/second at Q90. Based on the calculation of water potential in the study area, it can be known that the number of potential is quite large, but the people in Morotai District specifically Sopi and Majiko villages are still difficult to get raw water source for household drinking water with decent quality and adequate quantity.

C. Analysis of Water Supply

Based on the data amount and population projection for the next 20 years using the standard water requirement of 60 liters/day/person, it is known that the projected amount of water needs in the Sopi and Majiko village in 2036 respectively are 166,33 m3/day and 507,54 m3/day. The graph of water needs projection is presented in Fig. 2.

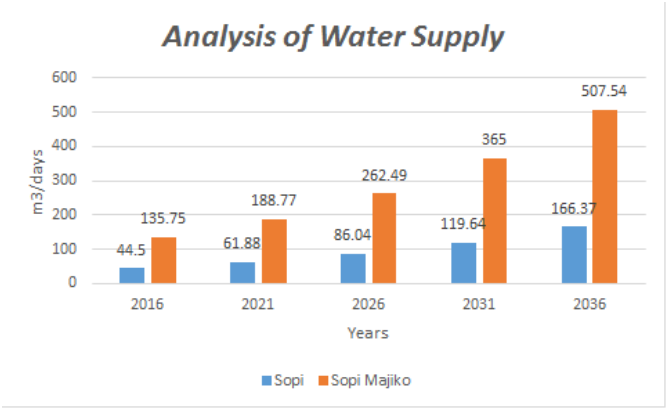

Fig. 2. Water Needs Projection

Resource: Data Process Result, 2016

D. Analysis of Water Balance

Nasution dan Syaifullah (2005, p 235) generally states that "water balance explains the relationship between the flow of water entering (input) with a stream of water coming out (output) in an area within a certain time".

Based on the calculation of people's water needs in Sopi and Majiko Village, as well as the calculation of the potential of water availability, the water balance is obtained for both villages. Analysis of water balance portrayed that both villages have a high water potential and it can be expected to fulfill people's water needs for the next 20 years. Water balance graph is presented in Fig. 4.

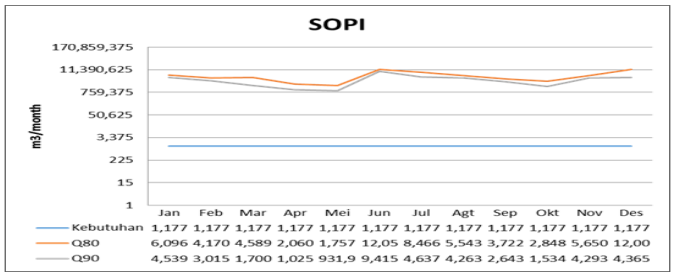

Fig. 3. Water Balance of Sopi Village

Resource: Data Process Result 2016

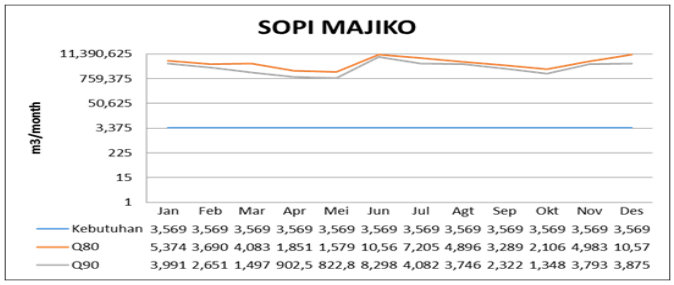

Fig. 4. Water Balance of Majiko Village

Resource: Data Process Result 2016

E. Hydraulic Analysis

Hydraulic analysis is conducted in order to find the raw water debit which will be distributed to the service region appropriate with the scheme of raw water network. Hydraulic analysis is also conducted in deciding kinds of pipe which will be used in the raw water network that will be known exactly through several hydraulic calculation.

- Scheme of Raw Water Network

Before determining the raw water network scheme, firstly the alignment of raw water must be specified. The raw water channel comes from Ake Sopi River with the length of channel that flows to the north toward the main reservoir located in the Sopi Majiko village, then it is channeled to the reservoir 1 which is Majiko Reservoir, and reservoir 2 which is Sopi Reservoir. The height difference between the intake and the reservoir is 45,83 m, the height difference between the main reservoir and Majiko Reservoir is 1,45 m, while the height difference between the main reservoir and the Sopi is 1,7. The intake length until the reservoir is 8 km, the length of the main reservoir until Majiko Reservoir is 750 m, and the length of the main reservoir until Sopi Reservoir is 1200 m. The trace has been presented in Fig. 5 and 6.

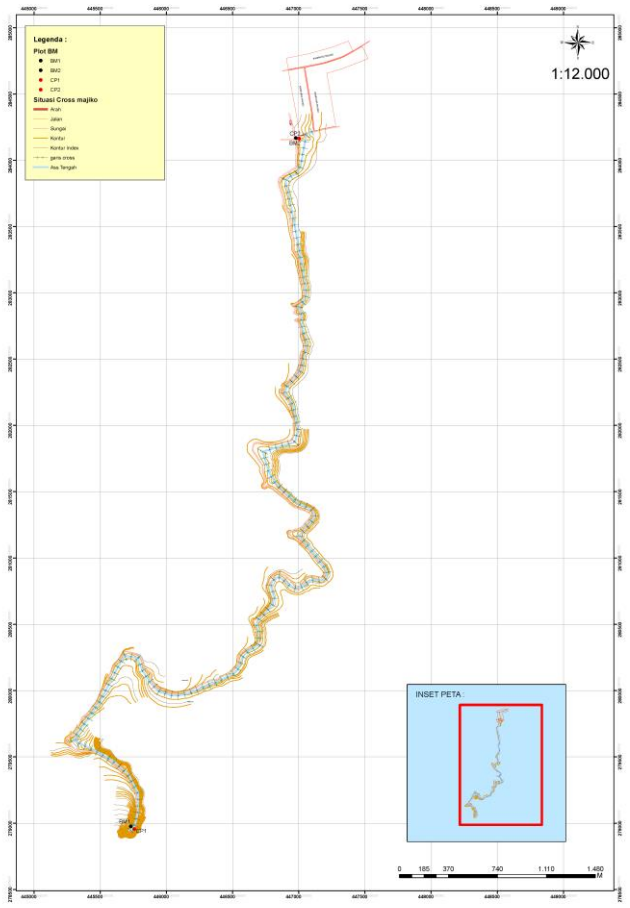

Fig. 5. Intake Plan Map

Resouce: Data Process Result 2016

Fig. 6. Intake Plan Map of Citra Satelit

Resouce: Data Process Result 2016

Raw water scheme is a process of raw water to be used by people for domestic needs. The process of raw water into clean water, starting from the water source that can be either surface or groundwater, but in Morotai District this water source is a surface water that is a river. Then the surface of the water is taken by buildings, namely water intake. The Raw Water Intake Building is a building to extract raw water that is sourced from surface water, river, lake, reservoirs or canal. The intake construction is adapted to the construction of water (Pt-T- 55-2000- C Facility Maintenance Procedures of Raw Water Intake). After the water is taken using the tools of raw water intake, then the water is collected in the main reservoir with QRU of 2,64 L/second and be drained toward reservoir 1 and reservoir 2 to be distributed to the people's houses for everyday purposes. The reservoir serves to solve the problem of the rise and fall of water needs and it is a part of the process of water distribution in community.

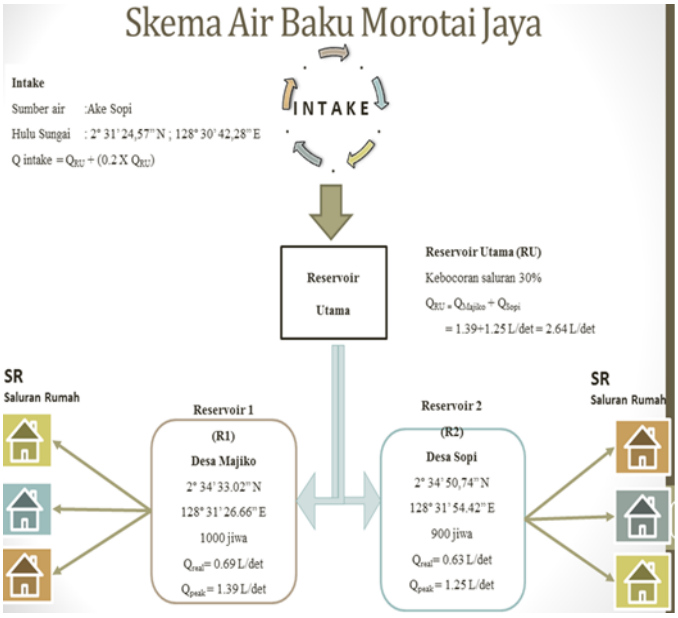

Fig. 7. Scheme of Morotai Jaya Raw Water

Resouce: Data Process Result 2016

F. Determination of Pipe Dimension

The determination of raw water network pipe dimensions is carried out to determine the pipeline which will be used in the raw water network that will be built. The determination of pipe dimensions using the methods of Hazzen-Willians by taking several parameters such as types of pipe material, height difference, coefficient and friction, and discharge with the following formula (Haestad, 2001 : 278).

D = (Q*10^6/(0,2785*C*((dH/L)*100)^0,54)))^0,38

Information:

D = Pipe Diameter (m)
Q = Debit (liter/sec)
dh/L = Height difference (m)
C = Pipe's Coefficient

Based on the hydraulic analysis it is known that different types of pipe have different coefficient so the dimension that is used is also different. PVC pipe has a larger dimension than PE pipe, because PVC has a larger coefficient than PE pipe. The hydraulic calculation results have been presented in Table 1.

TABLE I. HYDRAULIC CALCULATION RESULTS

Service	Necessity	Height Difference	Length (m)	C	Debit (m^3/sec)	D (mm)	D (")	≈ D (")	Types of Pipe
Main Reservoir		45.83	8000	140	QRU = 2.639	D I,RU = 76.78	2.91	3	PE
Sopi Majiko Village (R1)	2263	1.45	730		Q R1 = 1.389	D RU,R1 = 74.76	2.83	3	
Sopi Village (R2)	742	1.7	1200		Q R2 = 1.250	D RU,R2 = 76.99	2.92	3	
Main Reservoir		45.83	8000	120	QRU = 2.639	D I,RU = 81.41	3.08	4	PVC

Service	Necessity	Height Difference	Length (m)	C	Debit (m^3/sec)	D (mm)	D (")	≈ D (")	Types of Pipe	Service	Necessity
Sopi Majiko Village (R1)	2263	1.45	730		Q R1 =	1.389	D RU,R1 =	79.27	3.00	4	
Sopi Village (R2)	742	1.7	1200		Q R2 =	1.250	D RU,R2 =	81.63	3.09	4	
Main Reservoir		45.83	8000	130	QRU =	2.639	D I,RU =	78.97	2.99	3	Steel with Protective Coating (cement)
Sopi Majiko Village (R1)	2263	1.45	730		Q R1 =	1.389	D RU,R1 =	76.90	2.91	3	
Sopi Village (R2)	742	1.7	1200		Q R2 =	1.250	D RU,R2 =	79.19	3.00	3	

In table 1 it can be seen that the pipe dimension calculation results by using Hazzen-Willians method. Pipe dimensions are categorized by type of pipe which are PE, PVC, dan Steel with Protective Coating (cement). The calculation shows that pipe dimension which is efficiently used for the main reservoir at the rate of 2,639 m^3/sec is 3" for PE type, 4" for PVC type, and 3" for steel type, then to the pipe dimension of Majiko reservoir which is efficiently used is 3" for PE type, 4" for PVC type, and 3" for steel type, while the pipe dimension which is efficiently used for Sopi reservoir with the debit of 1,250 m^3/sec is 3" for PE type, 4" for PVC type, and 3" for steel type.

G. The Efforts for Sustainable Raw Water Supply

The supply of raw water must be sustainable. Therefore, the raw water facilities and infrastructure which are built must be noticed. The operation and maintenance should involve the local community through community empowerment. Deepa Narayan (1995) states that the sustainability of the water supply system can be influenced by the following criteria:

- Clear water component can be functioned: the quality and debit rate of water resource; operation and maintenance; cost recovery
- Developing the capacity and ability of people and institutions: the management ability, retrieval and decision making: knowledge and expertise; public confidence;
- The position of local agencies: autonomy; leadership support; system for learning and problem solving.
- Conservation of the environment: protection of water resources; building maintenance/clean water facilities.
- Cooperation between institutions: planning; activity.

IV. CONCLUSIONS AND SUGGESTIONS

The total water needs of people in Morotai Jaya District specifically Sopi village and Majiko village in 2036 respectively is 166,33 m^3/day and 507,54 m^3/day. While the potential of water resources from the calculation is known that the debit mainstay for Sopi village is 5,79 m^3/sec at Q80 and 3,78 m^3/sec at Q90, while for Sopi Majiko village is 5,42 m^3/sec at Q80 and 3,55 m^3/sec at Q90. So it can be concluded that Morotai Jaya District is able to fulfil people's water needs for the next 20 years. However, there should be a sustainable effort in maintaining the raw water supply with an optimal operation and people's role through community empowerment.

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