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WATER RESOURCE MANAGEMENT PLANNING BASED ON TECHNOLOGICAL ASPECTS FOR SMALL AND OUTER ISLANDS IN INDONESIA (A CASE STUDY: SELARU ISLAND)

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ABSTRACT

Selaru Island is one of the small and outermost islands in Tanimbar Islands Regency, Maluku Province, Indonesia. Domestic and mining activities cause its population to grow rapidly and the migration to the center of activities in the regency/city leads to higher demand of clean water, particularly water derived from groundwater, which affects the water table. The purpose of this study is to conduct water resource management in Selaru Island using technological approaches. This study is expected to complement other studies related to water resource management in small and outer islands. A form of water resource management that can be carried out is using technological approaches such as retention basin, rainwater harvesting, and groundwater. The results of implementing technological approaches show that Selaru Island will have an increase of population to 59,676 people in 2038 and it will require 164,841 water tanks with the capacity of 5m^3/unit. Water resource management in small outer islands such as Selaru Island necessitates the integration of stakeholders as decision makers, community participation, and academicians to achieve sustainability of the program and its implementation.

KEY WORDS : Retention basin, Selaru Island, water resource, rainwater harvesting system, technology.

INTRODUCTION

Groundwater availability as a source of water is highly vital for terrestrial ecosystem, domestic activities, and agriculture (Falkland, 1999; White *et al.,* 2007a). In this case, groundwater comes from precipitation, while significant absorption of groundwater through evapotranspiration can occur in lowlands and/or areas covered with vegetation (Falkland and Custodio, 1991; Vacher and Wallis, 1992; White, 1996; White *et al.*, 2007b). The existence and position of water table is strongly influenced by human activities, both industrial and domestic. These activities include excessive groundwater extraction and those that pollute surface water sources due to waste and waste spill (White and Perez, 2010). Other threats cover sand and gravel mining for building materials in areas where groundwater sources are located and other activities along the shoreline that cause erosion. The pressure intensifies as populations grow rapidly and people migrate to the center of activities in regencies/cities, which result in higher demands of clean water, especially water that is derived from groundwater, hence affecting the water table.

Selaru Island is one of the small and outermost islands in Tanimbar Islands Regency, Maluku Province, Indonesia. Considering the aforementioned factors that affect water table, there needs to be a water management system that involves every party, namely users, benefactors, and managers. Time is required to realize integrity of planning, togetherness in implementation, and awareness. It is unavoidable, so there has to be a joint effort to apply the approach of one river basin, one plan, and one integrated management. The existence of Masela Block Liquid Natural Gas (LNG) activities will impact clean water demand. Therefore, there is a concern on water demand imbalance and water resource availability in that island. As a result, a proportional and balanced effort to develop, preserve, and use water resources is needed. The purpose of this study is to conduct water resource management in Selaru Island using technological approaches. This study is expected to complement other studies related to water resource management in small and outer islands. Some examples of management efforts using technological approaches are harvesting rainwater by constructing water reservoirs in the form of tanks and building retention basins that can overcome water scarcity problem in Selaru Island (Rumihin, 2017; Rumihin, 2018).

RESEARCH METHODS

The following is the methodology of research analysis, which was begun by collecting primary and secondary data. The primary data required for this study were obtained from a field survey in order to discover the field condition. On the other hand, the secondary data were acquired from the data of total population.

Those data were then projected to find out the total population in the next 20 years, covering both natural residents and additional residents due to mining activities. Based on the resident projection results, the analysis of clean water demand was conducted to formulate probable solutions that can be applied in the area. The clean water demand in Selaru Island can be overcome using several solutions, including using water tanks, retention basins, and water springs.

RESULTS AND DISCUSSION

The projection calculation of natural residents and additional residents caused by mining activities can be seen in Figure 1. The calculation was based on each city calculated in 2023, 2028, 2033, and 2038 using the method of linear regression model test with the deviation of 20. Due to mining activities, the increase of population in 2023 was predicted to be as many as 40,000 people (Rumihin, 2018).According to Rumihin (2018), Adaut Village would have the highest number of natural residents with 5,957 people, whereas Eliasa Village would have the lowest number with 2,365 people. It shows that the mining activities that were forecasted to attract 40,000 new settlers in 2023 can make the population growth rate rise drastically. Besides, the existence of new settlers will also affect the number of populations in Selaru Island. The comparison between the projections of the number of natural residents and the number of additional residents until 2038 (Figure 1).

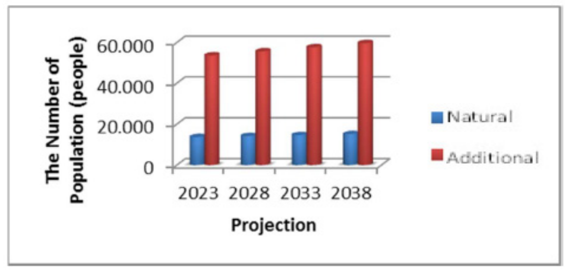

Fig. 1. Comparison between the projections of the number of natural residents and the number of additional residents in Tanimbar Islands Regency

This study used the assumption of clean water demand based on the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia No. 27/PRT/M/2016 on the Implementation of Drinking Water Supply System, which describes the clean water demand for domestic and non-domestic, there are villages require 60 liters/per capita/day, small cities require 90 liters/per capita/day, medium-sized cities require 110 liters/per capita/day, big cities require 130 liters/per capita/day, metropolitan citiesrequire 150 liters/per capita/day

Based on those categories, the district town in Selaru Island belongs to the category of small city with the need of 90 liters/per capita/per day, while the villages require 60 liters. Table 1 and Figure 2 present the projection calculation of water demand and natural population growth in 2023(Rumihin, 2018).

From Table 1 and Figure 2, it can be seen that the result of projection calculation of clean water demand of the natural population in 2039 is 199,039 m^3/0.5 year in the 6-month period dry season. Therefore, based on the clean water demand, the water tanks required will be 39,808 with the capacity of 5m^3/unit. Table 2 and Figure 3 show the projection of clean water demand in 2038 with the

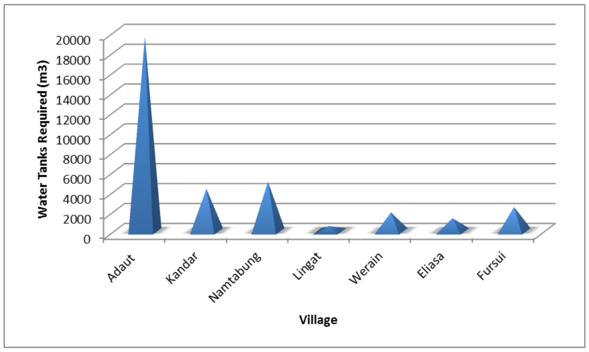

Fig. 2. Water tank required in every village in Tanimbar Islands Regency based on the results of natural population projection

total population that has been added with 40,000 people in 2033 (Rumihin, 2018).

It can be seen in Table 2 and Figure 3 that with the addition of 40,000 people in the population, the projection of clean water demand in 2038 will be 824,203 m^3/0.5 year. If water is harvested with water tanks to fulfill clean water demand, there will be 164,841 water tanks required with the capacity of 5 m^3/unit.

Based on the calculation analysis, it can be concluded that the additional population due to mining activities can raise the demand of water by 76% in 2038. The rise will also increase the need of water tanks in 2038 from initially 39,800 tanks with the capacity of 5m^3/unit to 164, 841.

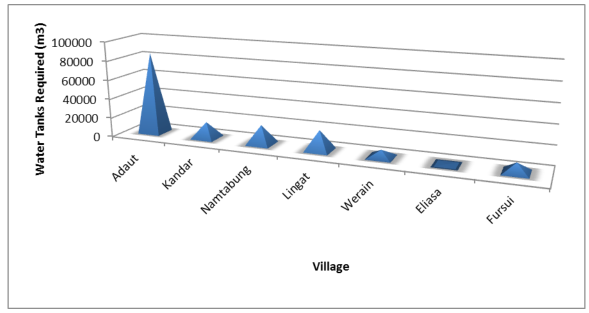

Fig. 3. Water tanks required in every village in Tanimbar Islands Regency based on the result of additional population projection

Besides water tank, water can also be contained using retention basins. Building retention basins is an easy and efficient solution to conserve water and restrain erosion rate. This rainwater harvesting technique is suitable for rainfed ecosystems with the intensity and distribution of rain that are certain.

Table 1. Projection of Clean Water Demand and Natural Population Growth in 2038

No.	Village	Projection of Total Population (people)	Projection of Water Demand (L/sec)	Annual Water Demand (L/year)	Water Tanks Required (5 m^3/unit)
1.	Adaut	5,957	536,131	195,687,996.2	19,569
2.	Kandar	1,952	117,105	42,743,162.55	4,274
3.	Namtabung	2,282	136,918	49,975,025.71	4,998
4.	Lingat	2,411	144,659	52,800,377.27	5,280
5.	Werain	875	52,480	19,155,365.15	1,916
6.	Eliasa	602	36,147	13,193,614.15	1,319
7.	Fursui	1,120	67,181	24,520,941.04	2,452
	Total	15,199	1,090,621	398,076,482	39,808

Table 2. Projection of Clean Water Demand and the Increased Number of Population in 2038

No.	Village	Projection of Total Population (people)	Projection of Water Demand (L/sec)	Demand in M^3 (m^3/0.5 year)	Water Tanks Required (5 m^3/unit)
1.	Adaut	23,390	2,339,002	426.868	85,374
2.	Kandar	7,663	459,807	83.915	16,783
3.	Namtabung	8,960	537,603	98.113	19,623
4.	Lingat	9,467	567,997	103.659	20,732
5.	Werain	3,434	206,063	37.606	7,521
6.	Eliasa	2,365	141,929	25.902	5,180
7.	Fursui	4,396	263,782	48.140	9,628
	Total	59,676	4,516,183	824.203	164,841

Retention basins function to contain rainwater, water spring, or river in rainy season. Usually, retention basin is located near irrigation channel areas so that the water contained in the retention basin can be deflected easily and the retention basin is quickly filled (Rumihin, 2017).

Several technologies that are planned to be implemented to maintain the availability of groundwater in Selaru Island are expected to reduce the burden on water demand from groundwater, both in terms of quantity and quality. In the matter of quantity, the behavior and demand of community will be highly influential. Therefore, the participation of community is indispensable since it is related to land ownership, involving the government, community, and private institutions. Unmonitored groundwater extraction in community areas or private areas will affect the water table. This social approach is required to avoid social conflicts. In this case, it can be in the form of social services, one of which is corporate social responsibility (CSR) (White *et al*., 1999a; White *et al.,* 1999b).

CONCLUSION

A form of water resource management that can be conducted is using technological approaches such as retention basin, rainwater harvesting, and groundwater usage. Based on the projection of population in 2038, 164,841 water tanks with the capacity of 5m^3/unit will be required. Water resource management in small and outermost islands such as Selaru Island needs an integration of stakeholders as decision makers, community participation, and academicians in order to achieve sustainability of the program and its implementation. Therefore, a more detailed study on the prediction of human activities and their relation to the availability and condition of groundwater in Selaru Island using SWAT (Soil Water Assessment Tool) model is required.

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