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Analysis of Teritip Dam Utilization for Domestic Water Supply in Balikpapan

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Abstract- Teritip Dam has multiple purposes, including flood control and addressing the clean water crisis caused by a lack of raw water sources. The demand for clean water will continue to increase with population growth. This study aims to determine the contribution of the Teritip Dam in meeting the community's clean water needs through the Regional Drinking Water Company (PDAM) of Balikpapan. The study also seeks to provide input for potential contributions and conservation efforts. The analysis of domestic clean water demand involves evaluating the condition of clean water, identifying the supply and demand of clean water, analyzing population projections, and estimating the volume of clean water needed by the population. The study findings indicate that the Teritip reservoir provides a discharge of 8,891 m^3/day, fulfilling only 14.3% of the clean water demand in Balikpapan. Therefore, implementing water resource conservation measures is crucial to meet the water demand in Balikpapan. These conservation activities include improving the supervision of water withdrawal and usage by considering conservation interests, raising public awareness about water issues, and controlling groundwater use for new drilling activities, particularly in critical groundwater areas.

Keywords— Teritip Dam, Balikpapan, Water, Supply, Demand

I. INTRODUCTION

Water availability is a fundamental necessity for human life. As populations grow, industrial activities expand, and urbanization progresses, the demand for water also increases (Fulazzaky, 2014).

Balikpapan is a city in East Kalimantan, Indonesia, known as a prominent hub for business, industry, and the largest economy on the island of Kalimantan. It is renowned for its petroleum and mining sectors and is situated along the coastal area with a bay. According to reports from the Balikpapan City Government, the projected population of Balikpapan by the end of 2022 is expected to reach 727,665 people. (DKB, 2022)

Alongside the continuous population growth, there is a consequent rapid expansion and development of settlements (Wahyuni & Junianto, 2017).

Balikpapan is currently experiencing significant economic growth, leading to a subsequent increase in population. This population growth, in turn, creates a greater demand for clean water among the residents of Balikpapan (Prijanto & Ismoyo, 2010). The statement is also supported by (Salim, 2019), stating that Bekasi City is one of the cities that has experienced significant population growth in line with the development of the city itself, which also led to an increase in demand for clean water. In (Martila, 2020) the estimation of clean water demand is calculated based on available

secondary data and compared to the availability of clean water sources. It then projects the future growth of the population to determine the future demand for clean water.

Currently, Balikpapan relies heavily on the Manggar Reservoir to fulfill approximately 73% of its total water demand (Sukmara, Pratama, & Ariyaningsih, 2020). To meet the remaining water demand, Balikpapan utilizes a combination of deep wells and other surface water sources, including the Teritip reservoir. These sources are employed in addition to the reliance on the Manggar Reservoir to ensure an adequate water supply for the city.

Teritip Dam serves multiple purposes, including flood control and addressing the clean water crisis caused by a lack of raw water sources. With a storage capacity of 1.834 million m^3 and an inundation area of 79.228 ha, the dam is utilized by PDAM Balikpapan City to overcome the clean water scarcity issue.

The facilities at Teritip Dam that support its functions and infrastructure include a water storage/reservoir, homogeneous soil dam, spillway, and intake.

The purpose of the study mentioned is to assess the extent of Teritip Dam's contribution to fulfilling the water availability for the community, specifically through the Regional Drinking Water Company of Balikpapan City. The research aims to provide insights and considerations regarding the dam's contribution and potential conservation activities.

II. Literature Review

A. Definition of Water

Water is a crucial natural resource for human life. It is a renewable and dynamic resource, meaning that the primary source of water, namely rainwater, consistently follows its own timing and seasonal patterns throughout the year (Kadoatie, 2021). Water undergoes a continuous cycle known as the water cycle, involving various stages such as evaporation, precipitation (rainfall), and the flow of water over land surfaces (runoff). This process includes the formation of springs, rivers, and estuaries, ultimately leading the water back to the sea (Novia, Nadesya, Harliyanti, Ammar, & Arbaningrum, 2019).

Water sources are crucial for providing clean water, as without a reliable water source, a clean water supply system cannot function effectively. These water sources for meeting clean water needs can be classified into 3 main categories:

1. Surface water refers to rainwater or other forms of water that flow or collect on the Earth's surface. It is visible and can be easily observed. However, in general, surface water is not suitable for direct human consumption without proper treatment. Water from surface sources may contain impurities, pollutants, or microorganisms that can pose health risks. (Rachmawati & Riani, 2020).
2. Groundwater is the part of water in nature that is found below the ground surface. The formation of groundwater follows the cycle of water circulation on earth called the hydrological cycle, a natural process that takes place in water nature that undergoes sequential and continuous displacement (Kadoatie, 2021).
3. The spring is a place where groundwater seeps or flows out of the ground naturally. The ground surface naturally. A spring is a place where groundwater emerges in the aquifer layer from below ground level to above ground level naturally. naturally. Furthermore, the water that comes out of the spring will flow on the ground surface as surface water through the surface as surface water through river channels. Springs are often identified as the initial source of water for existing rivers (Hendratta & Tangkudung, 2021).

B. Dam

A dam is a construction built to withstand the flow of water in a river and form a water reservoir commonly called a reservoir. The dam has several functions, among others, as a hydroelectric power plant, to stabilize water flow or irrigation, to prevent flooding, and for the diversion of buildings. This building does not only consist of the dam body but there are several supporting components such as foundations, sluices, spillway buildings, circumvention systems (circumvention dams and circumvention channels), and reservoirs.

In connection with its function as a water barrier or lifting the water level in a reservoir, the dam body is largely a barrier to seepage of water downstream and a buffer for the water reservoir. In terms of the placement and arrangement of materials that make up the dam body to be able to fulfill its function properly, the earth fill dam can be classified into 3 (three) main types:

1. Homogeneous dam
2. Zonal dam
3. Bulkhead dam

Weir construction has certain parts that have different functions. These parts will work so that the weir operation works properly. The parts of the weir construction in general are:

1. The Weir body is the main structure that functions to stem the flow of the river and raise the river water level from the initial elevation.
2. The Sluice gate serves to regulate the opening and closing of water flow in the channel.
3. The intake door serves to regulate the amount of water entering the channel and prevent the entry of solid and rough objects into the channel.
4. Energy-reducing ponds, are created to reduce the strength of water flow so that the potential for local scour can be minimized.
5. The flushing building is one of the main equipment of the weir located near the intake. The flushing building serves to avoid the transportation of bottom sediments and reduce the transportation of elevated sediments into the intake.

C. Water Balance

The hydrological cycle involves a relationship between the total water input and the total water output within a

watershed. This relationship is commonly known as the water balance. The concept of water balance illustrates the equilibrium between the amount of water that enters, exists within, and exits from a specific system. (Zulkipli, et al.,2012)

D. Rain

Rain is one of the natural phenomena contained in the hydrological cycle and is strongly influenced by climate. The existence of rain is very important in life because rain can meet the needs of water that is needed by all creatures. Types of rain based on rainfall according to BMKG are divided into 1) moderate rain, 20-50 mm per day; 2) heavy rain, 50-100 mm per day; and 3) very heavy rain, above 100 mm per day (Park, 2017)

The availability of rainwater depends on the size of the rainfall so that water is not sufficient for the general supply because the amount fluctuates. Rainwater cannot be taken continuously because it depends on the season. In the dry season, the possibility of water will decrease because there is no additional rainwater (Sutrisno, 2016)

E. Demographics

The population is a resource that plays an important role in changing an area so that the population determines the direction of future development of the area. The increase in population affects the need for clean water facilities. Population growth can be caused by immigrants from other areas (migration) and birth. To observe the characteristics and level of population development, past data is needed to estimate the population in the future (Stefan, 2018).

Population growth is actually a dynamic balance between the two forces that increase or decrease the population. The development population will be affected by the number of babies born but simultaneously will be reduced by the number of deaths that can occur in all age groups. In the spatial context of population mobility also influences changes in the population of the number, where immigration will increase the population and emigration will reduce the number of people in an area (Rochaida, 2016)

There are three demographic factors that affect the rate of population growth namely fertility (birth), mortality (death), and migration (Anggraini, 2012). According to (Akhmad, Peirisal, & Komara, 2022) in a study entitled "Policy Determinant Factors for Controlling the Population Growth Rate of Subang Regency 2017-2022" stated that the factors that most influenced the rate of population growth in Subang Regency were in-migration and out-migration. Incoming Migration, the high influence on the Population Growth Rate in Subang Regency is more due to regional developments that lead to industrialization. Meanwhile, for the Out Migration Variable, it is more due to the low competitiveness of the Subang Regency area compared to the regencies/cities in the Greater Bandung Metropolitan Area and Bodebekarpur

F. Domestic Water Needs

The need for clean water is unlimited and sustainable. This increase in demand is caused by an increase in population, an increase in the standard of living of residents and the development of City/Region services or matters related to improving the social and economic conditions of residents (Chaiddir & Eveline, 2016). Demand/demand for water is the need for water needed to be used to support all human activities, including domestic and non-domestic clean water. Domestic water demand is determined by the population and water consumption per capita. The use of water for each component is difficult to define with certainty, so in planning or calculations assumptions or approaches are often used based on city categories and population. (Afriyanda, et al., 2019)

Domestic water needs or household clean water needs are water needed for households that is obtained individually from water sources made by each household such as shallow wells, piping, or public hydrants, or can be obtained from the Drinking Water Supply System (DWSS) service.) PDAM. Household clean water needs, expressed in units of Liters/Person/Day (L/P/D), large needs depending on city category based on population (Astani, et al., 2021).

Domestic water demand is defined as the need for water used for household purposes. One that influences domestic air demand is the age of the population. Age groups that affect a lot of water needs. Because basically, the need for water is increasing along with our improvements (Astuti, et al., 2018).

III. METHODOLOGY

This research was conducted from July to September 2022 at the Teritip Dam, East Balikpapan District, Balikpapan City, East Kalimantan Province. The data collection technique in this study is a survey research method or in short it is usually called the survey method, namely research in which the main data sources and data information are obtained from the field as research samples using observation and documentation techniques. The research procedure and framework are presented in Figure 1.

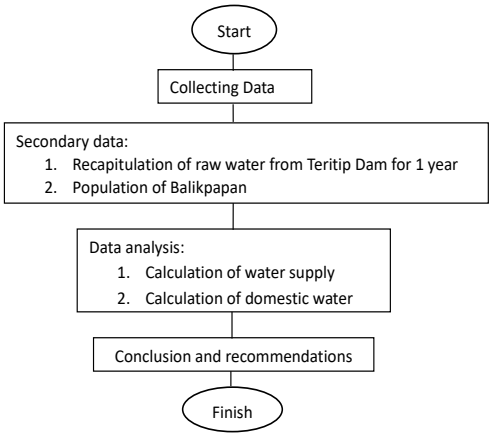

Figure 1. Research procedure and framework

A. Research Variables

The research variables are divided into two formulated research objectives as follows.

1) Analyze the supply and demand for clean water in 2022 to see if the need for clean water in 2022 is sufficient or not. The variables are the availability of clean water sources and the demand for clean water.
2) Analyzing the variable demand for clean water is the need for domestic clean water.

B. Water Supply Calculation

The calculation of water supply is needed in this study to calculate the amount of discharge flowed by the PDAM for one day. Water supplies were calculated from Equations (1) – (3).

$$\text{Production Discharge} = \text{discharge} \times \text{time} \quad (1)$$

The production debit explains how much debit is produced by the PDAM in one day. The resulting production discharge must be reduced by the level of water loss.

$$Qs = 30\% \times \text{Production Discharge} \quad (2)$$

Where (2) Qs is Water Loss (L/day), water loss is the difference between produced water and distributed water

The two calculations above can produce total discharge where calculating the total discharge reduce the production discharge with water loss.

$$\text{Total discharge} = \text{Production discharge} - Qs \quad (3)$$

Total discharge is the amount of discharge flowed by PDAM to residents' homes in one day.

C. Domestic Water Demand Calculation (Water demand for residents)

Domestic water needs are calculated based on the number of residents in the area. To determine the need for domestic use was calculated from Equation (4).

$$Q_{domestic} = Pt \times Un \quad (4)$$

Where (4) $Q_{domestic}$ is the Total population water demand (liter/capita/second), Pt is the Total population in the relevant year (people), and Un Value of per capita water demand per day (liters/person/day).

Domestic water demand is determined by population and per capita water consumption. The use of water for each component is difficult to formulate, so in planning or calculations, assumptions or approaches are often used based on the city category and population (Brahmanja, 2014). Clean water standards are presented in Tables 1 and 2.

Table 1. Clean Water Requirement Standard (SNI 6728. 1: 2015)

Category	Total Population	Water Consumption (liter/day/person)
Metropolitans	>1.000.000	150-200
Big	500.000-1.000.000	20-150
Medium	100.000-500.000	100-125
Small	20.000-100.000	90 – 110
Village	3.000-20.000	60-90

Table 2. Clean Water Needs of Various Sectors (SNI 19-6728. 1-2002)

Types of Usage	Standard	Unit
City with population > 1 million	250	(liter/day/person)
City with population < 1 million	150	(liter/day/person)
rural	100	(liter/day/person)
Public Taps	30	(liter/day/person)

IV. Result and Discussion

Figure 2 presents the Teritip Balikpapan Dam. It was built on February 24, 2014 - December 19, 2019. The background of the construction of Teritip Dam is due to the reduction of raw water for the local drinking water company which only relies on Manggar Reservoir as its main source.

Figure 2. Balikpapan Teritip Dam

The total population of the city of Balikpapan in 2022 is 727,665 people. West Balikpapan District has the highest population in Balikpapan City, namely 183,444 people. Meanwhile, the lowest population in the city of Balikpapan is in the District of Balikpapan City with a population of 85,325 people. The complete population of Balikpapan City in 2022 can be seen in Table 3.

Table 3. Total Population of Balikpapan

Districts	Total (Person)
East Balikpapan	100.003
West Balikpapan	97.215
North Balikpapan	183.444
Central Balikpapan	106.183
South Balikpapan	155.495
Balikpapan City	85.325
Total	727.665

A. Water Supply Analysis

Based on the data shown in Table 4. It is known that the Balikpapan City Regional Water Supply Company distributes water from the Teritip Dam on an average of as much as 147 liters/second. The highest water distribution occurred in January, which was 169 liters/second. The lowest water distribution occurred in September, which was 136 liters/second

Table 4. Recapitulation of Monthly Calculation of Raw Water Flow from Teritip Dam to Balikpapan City Regional Drinking Water Company

Month	Raw Water (Liter/second)
January	169
February	150
March	146
April	147
May	145
June	142
July	147
August	145
September	136
October	153
November	141
December	146
Average	147

B. Water Demand Analysis

Balikpapan City in 2022 has a population of 727.665 people. Based on the SNI standard 19-6728.1-2002 concerning the Arrangement of Spatial Balance of Natural Resources. Whereas Balikpapan City is an area with the category of a big city because it has a population of between 500.000-1000.000 people. Based on this category, Balikpapan City's water consumption must be in the range of 20-150 liters/day/person.

Analysis of water needs is only carried out to calculate the domestic needs of the community. Based on the observed data, it was found that the clean water needs of the people of Balikpapan City are 120 liters/person/day. The use of 120 liters/person/day is in accordance with the standard of SNI 19-6728.1-2002 concerning the Preparation of Natural Resources Spatial Balance.

C. The comparison of supply and demand

Water supply is calculated based on the clean water supply per pipe because the available water flow rate is measurable, making it easier for calculation. The calculation for clean water supply can be calculated using the formula in equation (1) – (3):

Production Discharge = discharge x time
=147 liter/sec x 86.400 sec/day
=12.700.800 l/day

Water Loss = 30% x Production discharge
= 30% x 12.700.800 liter/day
= 3.810.240 liter/day

Total Discharge = Production discharge – Water loss
= 12.700.800 liter/day – 3.810.240 l/day
= 8.890.560 l/day (8.891 m^3/day)

Calculation of the volume of water supplied PDAM Balikpapan from Teritip Dam is 8,891 m^3/day. As for the need for clean water in the existing year 2022 can be calculated using the formula in equation 4.

$Q_{domestic}$ = Pt x Un
= 727.665 Person x 120 liters/person/day
= 87.319.800 l/day (87.319,8 m^3/ day)

Based on the results of the supply and demand analysis, the daily supply of clean water is 8.890.560 L/day while the need for clean water is 87.319.800 l/day. The results of a comparison of supply and demand can be it was concluded that the Teritip dam was not able to provide the water needs of all the people of Balikpapan City. This is because the purpose of the construction of the Teritip Dam is to meet the clean water needs of the people of Balikpapan City which cannot be met by the Manggar Dam. According to the Ministry of PUPR (2018), the Teritip Dam has a capacity of 2,430 liters, which can be used to supply the inadequate clean water needs of the City of Balikpapan. The need for raw water for the city of Balikpapan reaches 1,600 liters/second. Meanwhile, the supply of clean water from the Manggar dam is only 1,000 liters/second.

V. CONCLUSIONS

The conclusion of the research is that the fulfillment of raw water by the Regional Water Company of Balikpapan sourced from Teritip Dam is 14.3% or 8,891 m^3/day. Conservation activities can be conducted as one of the efforts to support water availability in Balikpapan. These conservation activities include increasing supervision of water extraction and usage to consider conservation interests, raising public awareness/concern about water issues, controlling groundwater use for new drilling activities, especially in critical groundwater areas, and promoting efforts to preserve water infiltration areas through the implementation of land use regulations according to their intended purposes and ensuring

integration of spatial planning with water resource potential and development.

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