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Sustainability Assessment of Rural Water Supply System

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Abstract: The commitment to provide clean water and proper sanitation is one of the goals of the Sustainable Development Programs (SDGs). The government of each region needs to strive for clean water for the community. Efforts to fulfill clean water can be realized with the Water Supply System. Water Supply System sustainability indicators need to fulfill three aspects of quality, quantity, and continuity. The aim of this research is to assess the sustainability of the 'Sugio' Water Supply System in Lamongan Regency which serves three villages, namely Sugio, Lebakadi, and Sekarbagus. The aspect of water quality, seen from the results of the analysis of the quality of production water, shows that it meets the quality standards as raw water for drinking water. The aspect of water quantity is calculated to meet water needs for the next 20 years. The calculations results show that the daily average debit requirement is 17 L/s and the daily maximum debit is 19 L/s, while the existing debit is 15 L/s. The aspect of water continuity is calculated from the ability to distribute water during an emergency. The calculation results show that the distribution of clean water when there is no source of electrical energy can only be carried out in a maximum of 1 hour 13 minutes 48 seconds. The conclusion obtained is that the sustainability of the 'Sugio' Water Supply System from the aspect of water quantity and continuity still needs to be improved.

Keywords: water supply system, water quality, water quantity, water continuity.

1. Introduction

Water is a vital necessity and plays a very important role for the life of living things on this earth. Sustainability and sustainability of water resources is important to always be maintained. Efforts to protect water resources by carrying out good water management such as saving, not throwing garbage and waste into water bodies which can pollute water so that it can disrupt existing ecosystems [1].

Commitment to managing water for sanitation purposes continues to be improved. This commitment is supported through the Sustainable Development Programs (SDGs). SDGs are a new development framework replacing the Millennium Development Goals (MDGs) program which ended in 2015. SDGs are a global program agreed by many countries for the 2015-2030 period[2]. The SDGs program has 17 goals, one of which is goal number 6 which is clean water and sanitation. The goal number 6 indicator ensures that water and sanitation resources can be accessed easily in all regions and ensures that water is safe in quality and continuous for use [3].

The availability of clean water is the responsibility of the government to support the welfare of society. The unavailability of clean water can have a negative impact on health and the environment. Clean water that is good in quality and continuous in quantity can improve proper sanitation. Sanitation is an indicator of community welfare. In Indonesia there are still 37.86% of households that do not have access to proper sanitation [4].

The government of each region needs to strive for clean water for the community. Clean water can be obtained from surface water, such as rivers, lakes, reservoirs, swamps, and also from ground water [5]. Efforts to provide clean water can be realized with the Water Supply System. The sustainability indicators of Water Supply System need to fulfill 3 (three) aspects of quality, quantity, continuity [6].

The Water Supply System sustainability is the achievement of aspects of quality, quantity and continuity in the supply of water as a clean water service to the community and provides environmental sanitation health benefits. The Water Supply System is determined to be sustainable when the water supply system is running and can be used [7]. The Water Supply System runs for a long time without having a negative impact on the environment, all operational and maintenance financing is met, there is an institution that manages it, and gets proper support from outsiders [8].

The Regional Drinking Water Company of Lamongan Regency has the 'Sugio' Water Supply System which is located in Sugio District, Lamongan Regency. The 'Sugio' Water Supply System has been operating since 1997. The 'Sugio' Water Supply System's water source comes from the Gondang Reservoir. The main objective of developing and operating the 'Sugio' Water Supply System is to provide clean water services to the community, also build, maintain and operate clean water facilities which include the service are of Sugio Village, Lebak Adi Village and Sekar Bagus Village. The 'Sugio' Water Supply System provides clean water for the majority of community who have not yet been reached clean the water services by The Regional Drinking Water Company of Lamongan Regency. The 'Sugio' Water Supply System sustainability needs to be analyzed based on aspects of water quality, water quantity, and water continuity so that it can become the basis for operational evaluation.

2. Material and Method

The analytical method applied to this research is quantitative analysis. The data obtained through primary and secondary data collection.

2.1 Water quality

Water quality data collection was carried out by sampling the water produced by The 'Sugio' Water Supply System. Water samples were analyzed on a laboratory scale. Water quality is compared with the quality standards in the regulations that apply to sanitation hygiene water.

2.2 Water Quantity

The quantity calculated in this study is water debit. The water debit of The 'Sugio' Water Supply System is currently obtained through secondary data collection owned by The Regional Drinking Water Company of Lamongan Regency. In this study, the calculation of the water debit needs for the 'Sugio' Water Supply System services for the next 20 years is carried out. The need for water debit is influenced by the number of populations and their growth rate [9]. Population projections are calculated using three methods, namely Arithmetic, Geometric, and Least Square. The results of the population projection chosen are the method that gives a correlation value close to 1 [10]. Calculation of water debit uses the following Eq. (1) and Eq. (2) [11]:

$$Q = P \times q \quad (1)$$

$$Q_{md} = Q \times f_{md} \quad (2)$$

Information:
Q = daily average debit
P = number of people served (person)
q = water requirement per person per day (liters/person/day)
Q_{md} = daily maximum debit
f_{md} = daily maximum factor

2.3 Water Continuity

The 'Sugio' Water Supply System continuity is analyzed based on the ability to distribute drinking water when there is no source of electrical energy. The calculation used uses the following Eq.(3):

$$t = \frac{V}{Q} \quad (3)$$

Information:
t = duration of water supply time
V = reservoir volume
Q = daily average debit

3. Results and Discussion

The 'Sugio' Water Supply System is one of the Water Supply System units owned by The Regional Drinking Water Company of Lamongan Regency. The 'Sugio' Water Supply System serves as much as 4.58% of the total services of all Water Supply System units in Lamongan Regency. The scope of the the 'Sugio' Water Supply System services covers three villages, namely Sugio, Lebakadi and Sekarbagus.

3.1. Water Quality

The raw water source for the 'Sugio' Water Supply System comes from the Gondang Reservoir. Raw water is taken through the intake building and is treated in water treatment units, including coagulation, flocculation, sedimentation, filtration and disinfection units. These units' function to reduce water pollutant parameters so that water quality can meet sanitation hygiene water quality standards. The water treatment units in the 'Sugio' Water Supply System can be seen in Figure 1.

Water produced by the 'Sugio' Water Supply System is analyzed and compared with the quality standards in Regulation of the Minister of Health number 492 of 2010 concerning Standards of Drinking Water. The results of the water quality analysis can be seen in Table 1. The quality of water produced by the 'Sugio' Water Supply System meets the quality standards of Drinking water.

(a) (b)

Fig. 1. (a) Coagulation-flocculation-sedimentation unit; (b) Filtration unit

Table 1. Water Quality of the 'Sugio' Water Supply System

Parameter	Analysis	Standard	Unit
Temperature	25	Dev 3	°C
TDS	248	500	mg/L
Turbidity	1.34	5	NTU
Color	15	15	TCU
pH	7.9	6,5 – 8,5	-
Sulfate	76.12	250	mg/L
Chloride	24	250	mg/L
Fluoride	0.28	1,5	mg/L
Cyanide	0.00	0.07	mg/L
Hardness	171.43	500	mg/L
Iron	0.12	0.3	mg/L
Cadmium	0.000	0.003	mg/L
Zinc	0.01	3	mg/L
Lead	0.00	0.01	mg/L
Total chromium	0.00	0.05	mg/L
Detergent	0.00	0.05	mg/L

Source: Data Analysis

3.2. Water Quantity

The maximum volume of the Gondang Reservoir based on official records is 23,500,000 m^3 during the rainy season while the minimum volume is 2,000,000 m^3 during the dry season. The current debit for taking raw water from the Gondang Reservoir is 15 L/s. In this study, a comparison of the existing debit to the debit requirement for the projection of the next 20 years is carried out.

Population projections are calculated for the coverage of the 'Sugio' Water Supply System services, namely the villages of Sugio, Lebakadi and Sekarbagus. The chosen projection method is Least Square Method. The results of the population projection for the next 20 years are 6,664 people in the Sugio Village, 3,813 people in the Lebakadi Village, and 5,988 people in the Sekarbagus Village. The projected population is used to calculate debit requirements.

The 'Sugio' Water Supply System service level is assumed to be 60% of the total population. This is because some households still use well water as a source of clean water. The assumed value is

determined with the consideration that the water supply system has a higher sustainability value than taking groundwater from wells, so that in the future it is expected that groundwater withdrawal from wells will decrease [12]. The clean water consumption per person is 110 L/day [13]. The water loss factor in the clean water distribution channel is considered in the calculation of the daily average debit, the value determined is 20% [14]. The calculation results for the daily average debit needed by the 'Sugio' Water Supply System is 17 L/s. The maximum daily discharge needs to be calculated to find out the water demand during peak hours of activity. The daily maximum factor value ranges from 1.15 – 1.7 [10], and the research used a value of 1.2. The calculation results for the daily maximum debit is 19 L/s.

3.3. Water Continuity

The 'Sugio' Water Supply System has one reservoir unit as a production water reservoir. The volume of the reservoir is 75,000 L. The 'Sugio' Water Supply System does not provide any generators, so if the source of electrical energy goes out, the processing unit stops and the distribution of clean water only relies on water that has been stored in the reservoir. The period of water distribution in the reservoir based on calculation is 1 hour 13 minutes 48 seconds. Based on this period, it can be seen that the 'Sugio' Water Supply System can still distribute water supply during a power outage, up to a maximum of 1 hour 13 minutes 48 seconds. Water continuity shows that water distribution to customers must run continuously for 24 hours without any water jams [15]. If there is a power outage at the 'Sugio' Water Supply System, it is necessary to have another source of electricity to support the operation of the water treatment and distribution unit.

4. Conclusions

The 'Sugio' Water Supply System sustainability can be assessed based on aspects of quality, quantity and continuity. The 'Sugio' Water Supply System water quality can meet quality standards through processing in water treatment units. The water debit requirement for the 'Sugio' Water Supply System services is analyzed for the next 20 years, and it is found that the water production capacity needs to be increased to meet the needs for an average daily debit of 17 L/s and daily maximum debit of 19 L/s. The continuity aspect of the 'Sugio' Water Supply System still needs to be improved for emergency conditions such as when the power outage is only able to distribute water for a maximum of 1 hour 13 minutes 48 seconds, so a replacement energy source is needed to continue to run the 'Sugio' Water Supply System unit operations.

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