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Analysis of Clean Water Demand of the Residents from Springs in Boyolali Sub-District

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ABSTRACT

The availability of clean water is very important to support the clean water demand of the residents. Spring water is one of the water sources that can be used to fulfil the clean water demand of the residents. This research aims to determine the distribution of springs and analyse the fulfilment of clean water demand of the population around the springs. This research was conducted in Boyolali sub-district with a population consisting of the number of springs and the number of residents. Spring samples were taken from springs that have been used by residents to fulfil their clean water demand. Residents samples were taken on the condition that residents reside in the vicinity of the spring and have used the water, sampling residents with purposive sampling. The methods used were observation and interviews. Springs in Boyolali sub-district have water flow throughout the year, springs are able to meet the clean water demand of the surrounding residents. The average clean water demand of each resident around the spring is 62 litres/day. The fulfilment of the clean water demand of the residents from the spring is done by two ways of obtaining water, using the force of gravity and using a water pump.

Keywords: *water demand, clean water, springs*

INTRODUCTION

Population growth is consistent with regional development, and has an influence on the demand of clean water which continues to increase in quantity (Noperissa & Widodo, 2018). The growth of an area has become the main reason for changes in the consumption patterns of clean water for the increasing residents (Kospa & Rahmadi, 2019). The increase in water demand both quantitatively and qualitatively is determined by the increase in population and walfare levels (Hardati, 2015). The fulfilment of clean water is a basic need for every resident, clean water is used as support in various activities (Paramita et al, 2024).

Water consumption tends to increase while the availability of clean water tends to slow down, estimated to decrease by 15-35% of what is needed per year (Mutiara et al, 2023). The clean water needs of the residents are increasing while clean water is limited in availability, due to the narrowing of infiltration areas and the exploitation of raw water sources that do not pay attention on their sustainability (Suheri et al., 2019). The availability of clean water is very complex in use related to the fulfilment of resident needs that have differences in each region and level of life (Manune et al., 2019). Water availability affects various sectors of human life including fisheries,

agriculture, tourism, industry, transportation, trade, etc (Martuti, 2021).
Deficiency in the ability to fulfil the water needs of the residents can create various problems for the fulfilment of community clean water demand, regional development and food production (Amadi et al, 2020). Lack of clean water can create problems in the areas of sanitation, health, social and welfare. The reason for the failure to fulfil the residents water demand is the management system of the water supply (Gusdini et al., 2016).
The fulfilment of clean water demand of the residents should be considered both in quantity and quality. Clean water demand based on calculations from World Health Organization (WHO) for developed countries each person needs 60-120 litres/day, while in developing countries each residents needs 30-60 litres/day. Indonesian National Standards (SNI) clarify that the water needs of urban residents require 120 litres/day, while rural residents require 60 litres/day.
Springs are one of the water supplies that have the potential to be used to meet the clean water demand of the residents (Amalia et al, 2023). Springs with good water quality are not only used for the fulfilment of clean water, but also for drinking water (Nurdin dkk, 2022). Springs with relatively low discharge flow are usually used by local residents, while springs with high discharge flow are used for the benefit of the government and companies as a provider of drinking water needs (Aryastana dkk, 2018). Boyolali regency is known to have a large groundwater potential, the existence of the Karanganyar – Boyolali groundwater basin with an area of 3,877 km2 causes this area have abundant groundwater (Putranto, 2019). The use of spring needs to be done carefully and wisely so that its existence is maintained, given the increase in water demand along with the rapid development and increase in residents (Palguna, 2024).
Boyolali sub-district is one of the areas in Boyolali district that has several springs that never dry up. This research focuses on five springs that have been utilised by the local residents to fulfil their clean water demand. The purpose of this research was to determine the distribution of springs used to fulfil clean water needs in Boyolali sub-district, and to analyse the fulfilment of clean water demand of the residents around the springs.

MATERIALS & METHODS

This research on the use of springs to fulfil the clean water needs of the residents is located in Boyolali subdistrict, Boyolali district, Indonesia. Boyolali sub-district is astronomically located at 7°48’68” - 7°54’92” south latitude and 110°63’40” - 110°54’92” east longitude. Boyolali subdistrict has an area of 2.625,1 hectares, consisting of 6 villages and 3 urban villages including: Kebonbimo village, Mudal village, Kiringan village, Karanggeneng village, Penggung village, Winong village, Banaran urban village, Siswodipuran urban village, and Pulisen urban village. This research focuses on residents in villages that have springs and have utilised springs to fulfil their clean water demand. The research location is presented in figure 1 below.

The population in this research consists of two types, which are the population of the number of springs and the population of the residents around the springs. The springs that are sampled in this research are springs that have been used to fulfil the clean water needs of the residents, totalling 5 springs located in 4 villages. Resident samples were calculated using purposive sampling techniques on residents who reside around springs and have used water. The data used in this research are primary data and secondary data. Primary data include the location of springs and data on water use by residents, while secondary data are data on the physical condition of water obtained from the Boyolali district environmental office. Data collection techniques in this research used observation and interview methods. Field observations were used to

obtain information on the distribution of springs that have been used by residents to fulfil clean water demand in the Boyolali sub-district. Interviews were used to obtain information related to the clean water demand of residents which included the source of daily clean water fulfilment along with the amount, and the costs incurred by residents to fulfil clean water demand. The data analysis method used in this research is quantitative descriptive analysis, presenting tables and figures. The data analysis method in this research uses spatial analysis to describe the spatial distribution of the water springs using Geographic Information Systems, which is realised in the shape of a thematic map in the distribution of springs that have been used to fulfil clean water demand in Boyolali sub-district.

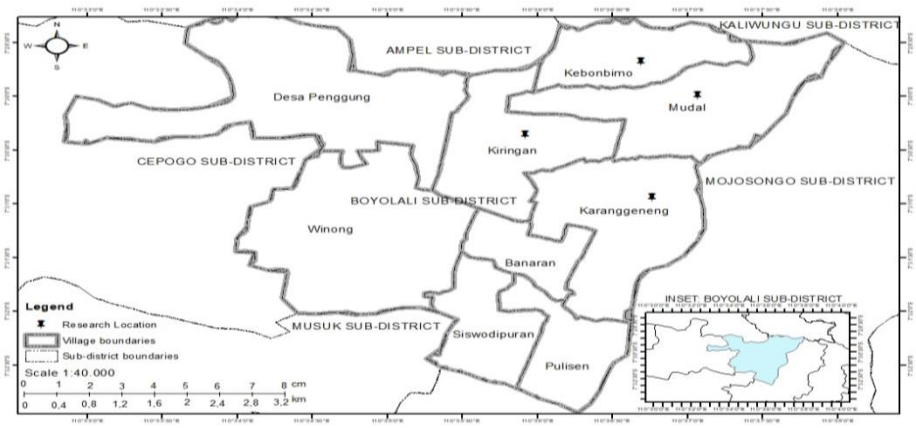


Figure 1. Research Location Map
Source: observation, 2024

RESULT

Distribution of Sprigs in Boyolali Sub-district

Boyolali sub-district has ten springs that have been identified and utilised to support various activities. Springs in Boyolali sub-district are utilised for agriculture, fisheries, tourism, as well as to fulfil clean water demand the residents. However, only five springs have been utilised by the residents to fulfil their clean water demand. Five springs spread across four villages that are used to fulfil the clean water demand of the residents. The distribution of springs that have been used to fulfil the clean water demand of the resident is as follows.

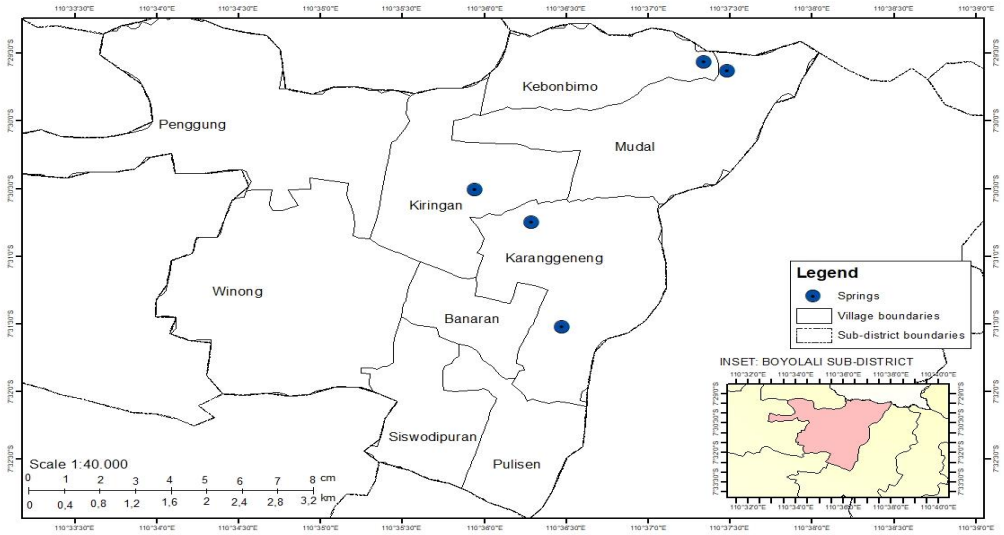


Figure 2. Map of Spring Distribution in Boyolali Sub-district
Source: Observation, 2024

The utilisation of spring water to fulfil clean water demand has been carried out by residents who have a living space around the springs. Water collection is done in three ways, firstly utilising the force of gravity by channeling water through pipes to people's homes. Secondly by using a water pump to drain water in the pipes to people's homes, and the third is collecting water manually using buckets or gallons.

The springs in Boyolali sub-district have varying water discharge. Springs in Boyolali sub-district are not dried up, but in the dry season experience a decrease in discharge. The water discharge at the springs as follows.

Tabel 1. Phycal condition of springs in Boyolali sub-district

Spring	Area (Ha)	Discharge (Lt/s)	Storage (m^3)
Sedalem	2	50	42
Rejo	10	200	100
Karangboyo	25	5	16
Dukoh	2	2	4
Bakalan	3	1	1

Source: Boyolali district environment office, 2024

The highest water discharge is in Rejo spring, while the lowest water discharge is in Bakalan spring. Springs in Boyolali sub-district are a type of spring that has continuous water flow throughout the year, so it has the potential to fulfil the clean water demand of the residents around the spring. Observations of the physical condition of water from springs should be made to determine the feasibility of water to be used as a source of clean water supply. Physical observations of water in Boyolali sub-district springs include water colour, water odour, water taste, foam, and turbidity. Regulation of the minister of health or PERMENKES No. 32 of 2017 indicates that the physical quality of spring water in the proper category includes water that is colourless, tasteless, odourless, and effervescent.

In addition to observing the physical condition of water in the spring, the spring catchment building condition also needs to be considered. Spring catchment building serves to capture water and protect spring from contamination.

The results of physical water observations are as follows.

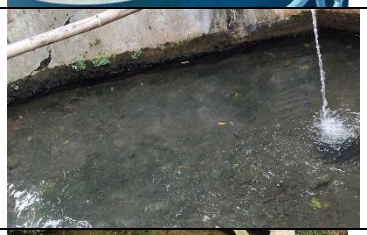
Springs	Physical water
Sedalem	
Rejo	
Karangboyo	
Dukoh	
Bakalan	

Figure 3. Physical water spring
Source: Observation, 2024

Observations physical condition of the water in springs showed that all springs were in good condition. Water at the five springs in Boyolali sub-district is colourless, tasteless, odourless, foamy and turbid. Turbidity in spring water can occur due to a

mixture of organic and inorganic materials such as mud, sand, and others.

Observations of spring catchment buildings also need to be made determine their condition. Spring catchment buildings have the function of capturing the flow of seepage water from the source. The construction of spring catchers needs to be considered in order to protect the spring from contamination.

Based on observations of five springs in Boyolali sub-district, only Rejo spring has a spring catchment building with a well-managed spring cover. Meanwhile, the spring catchment buildings for Sedalem spring, Karangboyo spring, Dukoh Spring, and Bakalan spring are only buildings with partitions on each side without any cover. The springs in Boyolali sub-district lack spring enclosures, making the water quality vulnerable to contamination.

Clean water demand of residents around springs

Clean water demand is the volume of water needed by residents in fulfilling their daily requirements. The clean water demand of each resident is different, this is influenced by different resident activities. Clean water demand of the residents must be met in quality and quantity, lack of clean water can create various problems.

The clean water demand of the resident are presented in the following table.

Table 2. Clean water needs of residents

Hamlet	Total residents	Clean water source	Average daily clean water volume/resident	Average monthly expenditure clean water/resident
Sedalem	79	Rejo spring	60 lt/day/resident	Rp. 10.000
Bakalan	112	Bakalan spring, PDAM	53 lt/day/resident	Rp. 40.000
Karangboyo	146	Karangboyo spring, well	62 lt/day/resident	Free
Ngringin	189	Dukoh spring, PDAM	71 lt/day/resident	Rp. 75.000
Tlatar	104	Rejo spring, well	65 lt/day/resident	Free

Source: research data, 2024

According to the Indonesia National Standard, the urban residents need 120 litres/day, while the rural resident need 60 litres/day. The average clean water requirement for residents in Boyolali sub-district is 62 litres/day. The clean water demand of the residents includes bathing, washing clothes and house equipment, cooking and drinking, residents utilise springs to fulfil their clean water demand, and some residents use it for drinking water. Residents use spring water to fulfil their drinking water needs by boiling the water first. The fulfilment of the clean water demand of the residents using water from springs in Boyolali sub-district is known by analysing the total residents demand with daily water discharge to determine whether the spring is able to fulfil the clean water needs of the residents of not. The following is the calculation of the daily water demand of the residents and the daily water discharge.

Table 3. fulfilment of clean water demand

Helmet	Clean water needs of the residents	Water discharge/day
Sedalem	4.760 litres/day	4.320.000 lt
Tlatar	6.760 litres/day	17.280.000 lt
Karangboyo	9.052 litres/day	432.000 lt
Ngringin	13.419 litres/day	172.800 lt
Bakalan	5.936 litres/day	86.400 lt

Source: research data, 2024

Calculations between the clean water demand of the residents in Boyolali sub-district can be covered by water from springs. Five springs have a higher water discharge when compared to the daily needs of the residents. The entire population of

Sedalem hamlet utilises water from Rejo spring, located in Kebonbimo village, to fulfil their needs for clean and drinking water. Utilisation for drinking water is done by boiling water from the spring first before consumption. Bakalan hamlet and Ngringin hamlet, only small proportion of the residents uses water from the spring and the rest from the regional drinkink water company or PDAM. Residents of Karangboyo hamlet and Tlatar hamlet fulfil their clean water demand with water from a source such as well. The use of water from springs is only done during the dry season or when the water source forms the well is shrinking.

DISCUSSION

Fulfilment of Clean Water Needs of the Residents from Springs

Springs in Boyolali sub-district have a continuous flow of water throughout the year. The springs never dry up during the dry season and only experience a decrease in water discharge, but the water discharge will increase again during the rainy season (Amalia, 2023). Spring discharge during the rainy season is higher than during the dry season, due to the greater water supply in the catchment area that is used to recharge groundwater (Setyowati, 2014). Five springs in Boyolali sub-district have water discharges that have the potential to supply the entire clean water demand of the residents around the springs.

The utilisation of water from springs requires attention to the physical quality of the water. The physical quality of water in Boyolali sub-district is measured by the parameters of colour, odour, taste, foam, and turbidity, springs in Boyolali sub-district have good water quality. The conditions around the springs also need to be considered because they can affect the water quality. Exposed springs have the possibility of contamination with organic and inorganic materials that can affect water quality. Water contamination in springs can also come from various resident activities such as bathing and washing near springs which can increase the mineral content of the water (Manume et al, 2019). The colour of water in springs can change to murky instantly if there is contamination with objects or substances that enter the water such as leaves, animal faeces, washing water, or water containing residual material such as sand.

The construction of spring catchers needs to be accompanied by a cover to avoid contamination of water with organic and inorganic materials. Maintaining water quality in springs in necessary to avoid pollution. Polluted water has a negative impact on health, as it can cause various diseases. Residents around springs need to understand and practice the concept of spring conservation in order to maintain the water quality of springs. Spring conservation needs to be carried out so that its existence, sustainability and function are maintained both in quality and quantity (Budihardjo et al, 2022). Poorly managed springs can reduce the quality of the spring water, and may lead to the loss of the spring water.

Water from springs in Boyolali sub-district is used by the local resident to fulfil their clean water demand, although water utilisation has not been carried out thoroughly. Water demand of the residents is influenced by several factors including income, city size, and climatic conditions (Putra et al, 2020). The climatic conditions are the factor that most influences the use of springs to meet their clean water demand only utilise springs during certain conditions, namely during the dry season. In addition, income factors also influence the use of spring water to fulfil clean water demand in the Boyolali sub-district. Residents with stable economic conditions choose to use PDAM as the main water source fulfilment and springs as a side water source fulfilment. While residents with poor economic conditions choose springs as the main water source in fulfilment of clean water demand.

The majority residents in Karanggeneng village use PDAM to fulfil their need for

clean water in daily lives, while the spring is only utilised by residents who live not far from the spring. Residents around the spring obtain water by using buckets or used gallons to collect water from the spring. Most residents in Ngringin hamlet and Bakalan hamlet choose to use PDAM to fulfil their main clean water demand due to poor accessibility. The distance between the spring and people's houses is far. In addition to accessibility factors, topographical factors also influence residents use of the spring.

The settlements are located at a higher elevation than the springs, so residents prefer to use PDAM to fulfil their clean water demand. The utilisation of spring water for the entire residents is considered inefficient, requiring the construction of pipes to channel water from the spring to all residents in the two hamlets in Karanggeneng village. The use of pipes to deliver water to people's homes is considered more expensive to install and maintain.

Residents around Karangboyo spring in Kiringan village utilise water from the spring for the needs of washing clothes, washing vehicles, and washing other household items. In addition, the use of spring water is carried out under certain conditions, namely during the dry season or when water sources from wells have decreased. Residents around the spring use water sources from wells with depths ranging from 7-11 metres. Water sources from wells are used for clean water demand such as drinking water, bathing, cooking and others. The spring is used to fulfil the needs during the dry season and to fulfil various activities of the population such as agriculture and fisheries.

Fulfilment clean water demand the residents of Tlatar hamlet in Kebonbimo village comes from two water sources, which are from wells and springs. Clean water in Desa Kebonbimo is available in abundance, there are three springs in this area, Rejo spring that is used to fulfil the clean water demand of residents from Tlatar hamlet and other neighbouring hamlets. Water is distributed from the spring to people's homes using pipes that come from a water storage building near the spring, and water is channelled using a water pump. Residents in Tlatar hamlet use water from wells to fulfil their drinking water needs and some activities such as bathing and cooking. Meanwhile water from spring used for washing clother, washing vehicles, washing mats and other household items.

Residents in Sedalem hamlet fulfil their daily clean water demand from a spring in Kebonbimo village. Water from Rejo spring is channelled using pipes with the assistance of gravity, the water storage building at Rejo spring is located higher than the settlement in Sedalem hamlet. Sedalem hamlet has a spring with a large discharge, but Sedalem hamlet has a lower elevation than the settlements. The difference in topography means that people in Sedalem hamlet prefer to use spring water from Rejo spring. Sedalem spring is used by residents to fulfil their clean water demand when the water pipes from Rejo spring are demaged or need maintenance. Sedalem spring is also used as a water supply for PDAM and PAMSIMAS.

Clean water drainage system by gravity due to the difference in height between water sources and settlements, the network system used in the distribution of clean water from springs pipes (Kia, 2021). Taking water by utilising the force of gravity and distributing it using pipes is cheaper to make and maintain when compared to using a water pump. The construction and maintaining of water pipes is more expensive and difficult for springs that are located lower than settlement because they require water pumps climb to the settlement.

CONCLUSION

Springs in Boyolali sub-district have year-round flow with a decrease in discharge during the dry season. There are five springs in Boyolali sub-district that have been used by the local residents to fulfil their clean water needs. The springs are also used by

some residents to fulfil their drinking water needs by boiling them first. The utilisation of water from springs has been used as a source of clean water both primary and secondary. Water is collected from the springs using pipes that are channelled to people's homes with the help of water pumps or utilising the force of gravity, as well as collecting water manually using buckets. The springs in Boyolali sub-district have the potential to fulfil the clean water needs of the residents around the springs well, with the amount of daily discharge being able to fulfil the daily clean water needs of the residents.

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