Song Bajul Spring Potency for Resident’s Clean Water Supply in Pucanglaban Village, Tulungagung in 2017-2032

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Abstract. The spring’s water were needed for humans. Lack of utilization of water sources resulted in a water crisis. These water crisis occurred in the Pucanglaban village Tulungagung. The springs that irrigates the village was Umbul Bendo has a debit of 0.5 litters/sec which was only able to meet 500 people, while it has a 22,197 inhabitants. Increased population continues to occur in 8 years-time (2002-2008) of 0.67%. Projection of population water requirement in 2032 amounted to 658.346,60. The large water demand resulted in the population very difficult to get water supply. Based on these problems Song Bajul springs became an effective solution in overcoming the water crisis of Pucanglaban Village. Song Bajul spring water source has great water discharge and good water quality. Currently the villagers of Pucanglaban Village do not know that the source of Song Bajul springs was able to fulfil all the needs of the Song Bajul population in the next 15 years. It was necessary to evaluate the potential of Song Bajul spring water source to the people of Pucanglaban Village in 2017-2032 to overcome the water crisis of Pucanglaban villagers.

1. Introduction
Water as a natural resource exist in this earth is abundant about 70% of the total surface area of the earth. The amount of water contained in the earth about 1.3 to 1.4 billion cubic kilometer, with details of the 97.5% of sea water, 1.74% of ice, and 0.73% on the mainland as river, lake, water soil, and snow [1].

Water has an important role for life on earth. The need for clean water services from time to time is increase. This increase in water demand due to population and in the degree of citizens’ lives as well as the development of the city or regional services or matters relating to the improvement of socio-economic conditions of citizens coupled with an increase in the amount of per capita water demand. Providing clean water is not balanced can cause drought or lack of water supply.

Drought is a problem that resulted in disaster for the lives that could disturb the balance of the ecosystem, especially humans. This disaster can be felt both directly and indirectly. Drought itself is a situation where most people feel a lack of water to meet their needs. Limitation dry state is difficult to determine because it depends on many factors, among others, the opinion of those who feel the consequences. People will soon be able to understand it dry if the water that comes from precipitation deficiency.

Currently the level of water services in rural areas of Tulungagung prone clean water reaches 44% of the population. Based on the decision of the Minister of settlements and Regional Infrastructure No. 534/KPTS /M/2001 on Minimum Service Standards for Housing and Settlement states that water service coverage of at least between 55% -75%. With the percentage of such services, the coverage of rural
water services in water prone areas of Tulungagung still does not meet minimum service. Likewise Pucanglaban Village is the region that most severely affected by drought and water shortages. Residents in the village of Pucanglaban in meeting the needs of clean water, which is for cooking, drinking, showers/sanitation, washing, etc. mostly they get water supply from springs Umbul Bendo contained in Pucanglaban village, where the water spring is managed by HIPPAM. However, the supply of water obtained from springs that does not meet the needs of the entire population in the village Pucanglaban, this is because the springs of Umbul Bendo have very small discharge, which is 0.5 liters / sec. In fact, the springs that have debit 1 liter / sec is only able to meet the water needs 1000 population, so the springs Umbul Bendo only able to meet the water needs of 500 people and resulted in not only the smooth supply of water every day, that water will flow every 3 -4 days or there is a time limit.

Based on the above problems, it just needs to be a solution to overcome, namely by using springs that have a large discharge and has good quality. Among all the springs that exist in the District of Pucanglaban, there is a spring that has a sufficiently large discharge. This spring is located in the village called Panggungkalak Song Bajul. Currently Pucanglaban villagers do not know whether Song Bajul springs can meet the needs of clean water the entire population and whether the springs Song Bajul can meet the needs of clean water for the entire population within 15 years to come. So there should be an evaluation of potential water spring Song Bajul for clean water supply in the village population Pucanglaban Tulungagung subdistrict Year 2017-2032 in order to achieve the balance of the ecosystem.

The purpose of this study was to evaluate the potential for quantity and the need for clean water springs Song Umbul years 2015 to 2030 in the village of Panggungkalak, District Pucanglaban, Tulungagung.

2. Methods

This study was designed using a survey method. The data collected in the form of primary and secondary data. This research was conducted in the field to determine the flow of water from springs Song Umbul and the amount of clean water needs of the villagers of Pucanglaban Tulungagung.

General study to evaluate the potential of springs Song Umbul to meet water needs in 2017-2032 the village population Pucanglaban Tulungagung subdistrict. The sample in this research that the respondent sample taken Proportional Stratified Random Sampling. The data analysis was conducted by comparing a large discharge of water with clean water needs of the population.

3. Results and discussion

3.1. Quality of Song Bajul Spring

Springs occur wherever groundwater flows out from the earth’s surface. Springs typically occur along Hillsides, low-lying areas, or at the base of slopes. A spring is formed when natural pressure forces Groundwater above the land surface [2]. Song Umbul spring is located in the Panggungkalak village belonging to the karst area. Todd (1980) in Acehpedia [3] states that the aquifer can be found in some landform, one of which is limestone. Ground water is trapped in the cracks of the limestone layer. This limestone porosity is secondary. However, according to Haryono [4] although the limestone porosity is secondary because it large of dissolution cavities, karst aquifers remain capable of leaving the water in the dry season to supply the underground rivers, so most of the underground river is perennial (flowing throughout the year). This can occur due to secondary porosity largely filled by sediment stuffing. In addition to these, the water stored in the sediment contents cannot drain quickly into an underground river system because of limestone that has not been dissolved under epikarst zone is watertight. Drained water can only pass through the crevices of the rock (muscular or cesarean). Thus dissolution cavities and deposition fields in the zone near the surface serves as a water reservoir [5]. From these explanations,
the springs Song Umbul has a large discharge. With the development of the management of Song Umbul springs, there are problems in the village Pucanglaban can be resolved. Results obtained from the quantity of data collection springs, as well as the need for clean water and the population at this time next 15 years (2017-2032).

Based on the results of measurements of the quantity of water in the field using a floating Area Method, it is known that a large quantity of springs Song Umbul in the rainy season, which in February amounted to 201.67 liters/sec or 17,424,616.32 liters/day. Based on the magnitude of the discharge, the water source Song Umbul including springs in Class III or moderate (average discharge 0.1–1 m³/sec or 100–1000 liters/sec) [6]. Song Umbul springs are perennial springs, the spring that flows throughout the year. This is due to the relatively large water reserves in the rainy season and removed little by little throughout the year.

Springs discharge measurements made during rainfall the region of 236 mm. In the spring discharge measurements performed by Song Umbul [7], obtained a minimum flow of 45 liters/sec. The measurement is carried out during the dry season that is in July with an estimated rainfall of 49 mm region. The study area included within the groundwater basin is an area of 85.79 km² of the total area of the District Pucanglaban.

Data annual rainfall in the study area (10 years) ranged between 1033-2015 mm/year, or an annual average of 1,318 mm/year, with a monthly average of 109.83 mm/month. When the precipitation is falling on the area Basin Groundwater in the research area with an area of approximately 85.79 km² or 85.79 million meters², it will obtain the discharge rainfall is about 9422.32 million m³/year or 814,088,448 m³/sec.

### 3.2. Clean Water Needs Population Per Capita Per Day Per Type of Work in Pucanglaban village

Clean water from springs located in the village of Pucanglaban largely utilized to meet the everyday needs such as drinking, cooking, bathing, washing clothes, washing vehicles, watering plants, as well as cattle drink [8]. The most utilization of clean water per capita per day in the village population Pucanglaban known from interviews to the 156 respondents in the village Pucanglaban on each type of occupation. The number of respondents of households in the village Pucanglaban are as follows: 132 Farmers, 13 Peasants, 7 Traders, and 4 civil servant. Each family has a family member who has a 2-8 clean water needs are not the same magnitude. To determine the water needs of each respondent on the various types of work can be seen in the following table.

| No | Occupation | Requirements Respondents water (liter/day) | Total Number of Members family Respondents (soul) | Water Needs per capita per day |
|----|------------|------------------------------------------|---------------------------------------------------|-------------------------------|
| 1  | Farmers    | 73.257                                   | 652                                               | 112.36                        |
| 2  | Peasants   | 4.496                                    | 57                                                | 78.88                         |
| 3  | Traders    | 2.785                                    | 25                                                | 111.40                        |
| 4  | PNS        | 2.190                                    | 15                                                | 146.00                        |

Source: Personal Documents

The above table shows that the need for water per capita per day for each different type of work, the need for water per capita per day highs on the type of work of civil servants is 146 liters/capita/day, farmers 112.36 liters/capita/day, Dealer 111.4 liters/capita/day, and the water demand per capita per day lows on the type of job the Peasants is only 78.88 liters/capita/day. As for determining the need for clean water the entire population per capita per day for each type of work must be known population composition of each job, because the data are obtained only by the head of the family. The
composition of the villagers Pucanglaban based on the percentage of the work presented in the following diagram:

![Figure 1. Villagers Pucanglaban percentage based on the type of work](image)

The diagram above shows that the type of work that has the highest percentage in the village Pucanglaban that type of work Farmers 85%, 8% Peasants, Merchants 5%, and the lowest on the type of job that only 3% of civil servants. This percentage is calculated based on the ratio between the number of families of each type of work with the overall number of heads of household who then multiplied by 100%. For the composition of the village population Pucanglaban by type of work presented in the following diagram:

![Figure 2. Villagers conditions Pucanglaban By Type of work](image)

The diagram above shows that the composition of the villagers of the highest Pucanglaban on the type of work Farmers are 4319 people, 412 Peasant Workers soul, soul Dealer 257, and the lowest on the type of work of civil servants is only 154 inhabitants. The composition is calculated by multiplying the percentage of the population based on the type of job Pucanglaban village with a total population of the village Pucanglaban currently amounting to 5,142 inhabitants.

Based on the figure 2, it can be seen and the average total amount of clean water needs of the entire population of the village of Pucanglaban are presented in the following table 2.

| Work   | Water needs work (liter/capita/day) (x) | Population (soul) (f) | Water Needs (liters/day) (f.x) |
|--------|----------------------------------------|------------------------|--------------------------------|
| 1 Farmers | 112,36                           | 4,319                   | 485,282.84                      |
| 2 Peasants | 78,88                           | 412                     | 32,498.56                       |
| 3 Traders | 111,40                           | 257                     | 28,629.80                       |
| 4 PMS | 146,00                             | 154                     | 22,484.00                       |
| The total amount | 5,142                         |                        | 568,995,20                      |

Based on the figure 2, it can be seen and the average total amount of clean water needs of the entire population of the village of Pucanglaban are presented in the following table 2.
The average value of clean water needs of the population per type of work in the village Pucanglaban is
\[
\bar{x} = \frac{\sum (f \times x)}{\sum f}
\]
The above table shows that the total amount of water needs of the villagers Pucanglaban of 568,895.2 liters / day and water demand per capita per day amounted to 110.64 liters. Average water consumption per capita per day in the village of Pucanglaban in accordance with the size of Indonesia, which is between 90 liters to 140 liters [9], where the consumption of clean water for consumption of primary and secondary consumption. The details of the use of clean water in the village Pucanglaban among others detailed in the following table.

|   | Water Usage       | Farmers | Peasants | Traders | PNS       |
|---|-------------------|---------|----------|---------|-----------|
| 1 | Primer:           |         |          |         |           |
|   | a. Cook           | 2.15    | 1.49     | 4.20    | 4.33      |
|   | b. Drink          | 1.97    | 1.84     | 2.20    | 2.33      |
|   | c. Bath (2x)      | 86.41   | 68.42    | 80.00   | 106.67    |
|   | d. Wash           | 8.50    | 6.84     | 9.40    | 16.00     |
|   | **Total**         | **99.03** | **78.59** | **95.80** | **129.33** |
| 2 | Sekunder :        |         |          |         |           |
|   | a. Washing vehicles | 12.30 | 0.00 | 15.60 | 14.00 |
|   | b. Livestock drink | 0.48   | 0.00    | 0.00   | 2.33     |
|   | c. Watering the plants | 0.55 | 0.28 | 0.00 | 0.33 |
|   | **Total**         | **13.33** | **0.28** | **15.60** | **16.66** |
|   | **Total**         | **112.36** | **78.87** | **111.40** | **146.00** |

Based on the above table it is known that the level of water consumption for the primary needs in the village Pucanglaban greater than for secondary needs. The average water consumption per capita is different. The highest consumption of residents who work as civil servants amounted to 146 liters / capita / day. While the lowest consumption in the working population as a laborer, ie 78.87 liters / capita / day.

The primary use of water in the village on the type of job the highest Pucanglaban PNS (129.33 liters / capita / day), Farmers (99.03 liters / capita / day), Merchant (95.80 liters / capita / day), and the lowest type of Peasants (78.59 liters / capita / day). While the secondary use of the highest fresh water on the type of work PNS (16.66 liters / capita / day), Merchant (15.60 liters / capita / day), Farmers (13.33 liters / capita / day), and the lowest on the type of job Peasants (0.28 liters / capita / day).

From the above table, it can be seen that the people who worked as civil servants have the need for clean water is higher. This is because the pattern of water consumption is relatively more diverse civil servants. PNS tend to wash clothes every day because they have a different uniform every day. Then, most of the civil servants also have a vehicle, so they also need water for washing vehicles, as well as water for watering plants in the yard. For the purposes of civil showers tend not to think too much about how much they spend water, while to the Peasants largely considered, as adjusted their ability to pay for water each month, so that the people who worked as the Peasants tend to be saving water.
3.3. Evaluation of Potential Spring Song Bajul To Meet Needs Clean Water Village Pucanglaban Year 2015-2030

In the analysis and discussion will be described regarding the evaluation of water quantity Song Umbul to the need for clean water in the village population Pucanglaban, District Pucanglaban, Tulungagung.

a. Estimated Population in Rural Pucanglaban Year 2015-2030

Based on the calculation of the 2002-2010 population showed that the number of people in the village Pucanglaban constantly increasing. From these calculations, obtained an average rate of population growth Pucanglaban village for 8 years (2002-2010) is 0.006735, or by 0.67%.

Table 4. Estimated total population and the need for clean water the villagers Pucanglaban

| Year | Total population (inhabitants) | Total water demand (liters / day) |
|------|--------------------------------|----------------------------------|
| 2010 | 5142                           | 568,895.20                       |
| 2015 | 5315                           | 588,051.60                       |
| 2020 | 5495                           | 607,966.80                       |
| 2025 | 5680                           | 628,435.20                       |
| 2030 | 5871                           | 649,567.44                       |
| 2032 | 5950                           | 658,346.60                       |

b. Estimated Total Needs Water Village Pucanglaban Year 2017-2032

Based on the results of the calculation of population projections by using mathematical methods by means of an arithmetic growth of the obtained results that the number of residents in the village of diving Pucanglaban 8 years (2002-2010) continues to increase. The average rate of growth of population in the village of Pucanglaban of 0.006735 or by 0.67%. Quantity Evaluation Spring Song Umbul to Meet Water Needs Villagers Pucanglaban, District Pucanglaban, Tulungagung 2017-2032

To determine the quantity of springs in the Song Umbul meet the need of clean water in the village population Pucanglaban, can be done by way of comparison. The amount of the entire population needs clean water obtained from multiplication between the average water needs of each population to population. From these calculations showed that the amount of water needs throughout the villagers Pucanglaban in 2010 amounted to 568,895.20 liters / day. For more details can be seen on the following calculation:

\[ Q_{source} = 17,424,616.32 \text{ liters / day} \]
\[ Q_{population} = 568,895.20 \text{ liters / day} \]

\[ Q_{source} > Q_{population} \]

Then, it is also necessary comparison between the quantity of springs Song Umbul during the dry season with the amount of clean water needs of the entire population in the village Pucanglaban. It is known that a minimum flow of springs Song Umbul in the dry season is 45 liters / sec, or 3.888 million liters / day [5] The comparison is as follows:

\[ Q_{source} = 3,888,000.00 \text{ liters / day} \]
\[ Q_{population} = 568,895.20 \text{ liters / day} \]

\[ Q_{source} > Q_{population} \]

The comparison can be concluded that the discharge of springs Song Umbul is sufficient clean water needs of the population in the village Pucanglaban to record steady rainfall throughout the year and there is no human activity which can damage the area around the springs Song Umbul. Song Umbul eye discharge water discharge based on their characteristics have a relatively stable, ie up to 2-3 months after
the rainy season [6]. Thus, the springs Song Umbul capable of supplying clean water needs population not only during the rainy season but also during the dry season.

To determine whether the discharge of springs Song Umbul can meet the need of clean water in the village Pucanglaban population during the next 15 years (2017-2032), it can be done by way of comparison as above. The amount of water needs Pucanglaban Village 2030 is 649,567.44 liters / day. For more details can be seen on the following calculation:

\[
\begin{align*}
Q_{\text{source}} & = 17,424,616.32 \text{ liters / day} \\
Q_{\text{population}} & = 649,567.44 \text{ liters / day} \\
\end{align*}
\]

\[Q_{\text{source}} > Q_{\text{population}}\]

The comparison can be concluded that the discharge of the water source is sufficient clean water needs of the population in the village Pucanglaban in the period 2017-2032. It also carried out a comparison to determine whether the discharge of springs Song Umbul able to meet the needs of clean water in the village Pucanglaban population during the dry season during the next 15 years ie 2017-2032 year. From the calculation, unknown amount of clean water needs Pucanglaban village of 649,567.44 liters / day. For more details can be seen on the following calculation:

\[
\begin{align*}
Q_{\text{source}} & = 3.888 \text{ million liters / day} \\
Q_{\text{population}} & = 649,567.44 \text{ liters / day} \\
\end{align*}
\]

\[Q_{\text{source}} > Q_{\text{population}}\]

The comparison above it can be deduced that the discharge of springs Song Umbul is sufficient need for clean water in the village Pucanglaban population during the dry season in 2017-2032. Quantity springs Song Umbul can supply the water needs of the villagers Pucanglaban with no record of pipeline leaks during the distribution process. In addition, factors of land use in the area Basin Groundwater also affect the quantity of springs [10]. the use of land in the village of Pucanglaban largely a rice field, plantation, and thickets. Then the village land use Panggungkalak which is where the presence of springs Song Umbul mostly fields, plantations, and scrub where the condition of the region is still very natural, away from activities that could undermine the sustainability of the population springs Song Umbul.

4. Conclusion

Based on the results of research it can be concluded that Song Umbul springs have discharge 17,424,616.32 liters / day or 201.67 liters / sec. The amount of discharge is not changed from time to time because the springs Song Bajul is a karst spring which has a stable discharge along the years. The need for clean water of Pucanglaban village population in 2010 amounted to 568,895.20 and in 2015 predicted water needs amounted to 588,051.60 liters / day. The highest water consumption in the work of civil servants, which is 146 liters / capita / day. While the lowest consumption on the job Peasants is 78.87 liters / capita / day. The total water needs of the villagers Pucanglaban 2030 is 649,567.44 liters / day. Quantity springs Bajul Song may supply clean water to the entire population of the village Pucanglaban 2030, both in the rainy season and dry season.

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