Study on the accessibility of water sources to meet the water needs of rural communities in semi-arid regions of Indonesia

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Abstract. There are a large number of people in the world who live without an adequate supply of clean water, and spend hours to get clean water. For this reason, access to water and water sources is one of the main keys to meeting the needs of the community's clean water, specifically rural communities in the semi-arid regions of Indonesia. This study aims to analyze the extent to which access to clean water sources affects the patterns of water use and fulfillment of rural communities. The method used is a survey completed with a questionnaire and observation. The object of the research was the rural water user community in TTS Regency, East Nusa Tenggara Province with a total of 87 families, and water sources in the study area. Samples were divided into three areas which were categorized as dry, normal and wet. based on the analysis of rainfall data at 14 rain stations. The results showed an average water use level of 49 Lpcd (SD = 25) and the distance to the water source as far as 521 m (SD = 1100). There is a negative correlation between the distance of the water source and the amount of clean water used. Water availability factors affect water usage more than long distances but can be reached. This study also found that the use of clean water by the community is adaptive to the availability of water according to environmental conditions. This study recommends the importance of handling clean water issues according to the characteristics of each different region.

Key words: Accessibility, Indonesia, Rural water, Semi arid, Sustainable.

1. Introduction
Regency of South Central Timor (Timor Tengah Sekatan = TTS Regency ) is one of the districts located in the province of East Nusa Tenggara (NTT), Indonesia, which has a semi-arid climate [1, 2]. As a semi-arid region, the dry season lasts eight to nine months, and the remaining three to four months is the rainy season [2, 3]. The issue of clean water supply in this area is still a complicated problem, around 663 million people in the world have not had access to adequate clean water [4], and in Indonesia, according to the national development planning agency (BAPPENAS) in 2018, around 72 million people do not yet have access to adequate clean water [5]. The Regional Government of
TTS Regency states that the level of clean water services managed by the Regional Drinking Water Company (PDAM) in SoE City is currently around 60.3%, through the piping system. For the sub-district capital (ibu kota kecamatan = IKK), there are seven IKK that already have a drinking water supply system (SPAM) out of a total of 32 sub-district capitals in the TTS Regency [6]. The range of services is still very limited in the surrounding area. A number of weaknesses in rural water supply as follows: low quality of water services; lack of sustainability of built infrastructure; difficulty in serving the poor; and inadequate internal information systems [7]. Next, successful factors that influence community-based rural water management, namely the need for financial, technical and managerial support [8]. Sustainable water use is the use of water that supports the community’s ability to survive, and develop into an unlimited future without damaging the hydrological cycle or system [9]. A number of experts [8, 9, 10], describe the problems that can be faced in meeting the needs of clean water and should receive attention, namely: handling from technical, economic, socio-cultural and environmental aspects. The technical aspects are related to the readiness of the technology to provide clean water from the water source area to the distribution area. This also relates to the quality of human resources who will operate it. The economic aspect is related to the demand to adjust to economic rules in order to guide the allocation of water resources and encourage the implementation of the business sector as a professional corporate, behave efficiently, and produce benefits. This aspect is also related to financing the provision of clean water. In the socio-cultural aspect, it is necessary to consider the social values that must be aspirated in the development and its position as the most basic public sector, and also the culture of the community in terms of water usage or utilization that is unique to each region. On the environmental aspect, the water sector is dealing with environmental issues related to pollution, over-exploitation of water and efforts to conserve water and water resources. To accelerate the fulfillment of the need for clean water for the community, the government has issued Presidential Regulation No. 185 of 2014 concerning the acceleration of drinking water supply and sanitation aimed at increasing the quantity, quality, continuity and affordability of clean water for the community [11]. One interesting factor to study is the accessibility (affordability) of clean water and its impact on meeting the water needs of rural communities. This relationship is examined through the variable usage patterns and the amount of household clean water usage.

2. Method
The method used in this study is a survey using a questionnaire, and in-depth observations in the study area. The study was conducted in the TTS Regency, which was grouped into three regional groups. The area groups are categorized as dry, normal and wet which are determined based on the analysis of rainfall data at 14 rain stations in the study area. The object of research is the water user community with 87 households as samples, and water sources are available in the study area. Descriptive data analysis is done by calculating the average value and percentage to be able to state about water use and other related variables. Correlation test is used to find out the relationship between distance and clean water usage. The data is analysed using Microsoft Excel by Windows.

3. Research Location
Research location in TTS Regency, NTT province, Indonesia. Astronomically, TTS Regency is located between 9°26’ - 10°10’ South Latitude and 124°49’ - 124°04’ East Longitude (Figure 1). The total area of South Central Timor Regency is around 3,955.36 km², the whole of which is in the form of land with the northern part bordering Timor Tengah Utara Regency, the western part bordering with Kupang Regency, the southern part with the Timor Sea and the eastern part with Belu Regency. The southern part of the district is located close to the coast, has a fairly high temperature. Meanwhile, places that are located far from the coast have an average temperature of 24°C. The total population in 2017 is 463,980 people, spread in 32 sub-districts, 278 villages. Around 90% of the population live in rural areas. 29.40 percent of the population in TTS Regency is classified as poor, with an average income of Rp. 293,617 per capita per month [3].
4. Results and discussion

4.1. Rainfall and water sources

The average annual rainfall in the study area is 1639 mm per year. The highest rainfall was recorded at the Netpala Rain Post at 2219 mm per year and the lowest at the Oebelo Rain Post at 1170 mm per year. Dry areas are identified in areas with annual average rainfall ranging from 1170 mm to 1362 mm per year. Normal areas are identified in areas with annual average rainfall ranging from 1479 mm to 1660 mm per year. Meanwhile, wet areas are identified in areas with annual average rainfall ranging from 1972 mm to 2219 mm per year.

The main water sources used by respondents consisted of: 26% piped water that was affordable through the village pipeline network and regional water companies (PDAMs), 20% dug wells, 21% of springs or rivers, bought through tank trucks as much as 8%, and usage water more than one source (combination) 25% (Table 1).

| Areas category | Springs or rivers | Pipe line | Dug wells | Bought through tank truck | More than one water source | Total |
|----------------|------------------|-----------|-----------|---------------------------|-----------------------------|-------|
| Dry            | 5                | 13        | 9         | 5                         | 11                          | 43    |
| Normal         | 11               | 3         | 4         | 1                         | 3                           | 22    |
| Wet            | 2                | 7         | 4         | 1                         | 8                           | 22    |
| Total          | 18               | 23        | 17        | 7                         | 22                          | 87    |
| Percentage     | 21%              | 26%       | 20%       | 8%                        | 25%                         | 100%  |

Source: Results of research analysis (2019)

Clean water obtained by the community from water sources is used for cooking, drinking, washing, bathing and using latrines. In areas that have difficulty obtaining clean water or limited water availability, washing and bathing activities are carried out directly in water sources as an adaptive behavior to the lack of water availability. To get clean water, some people take it directly to the water source or buy it through a water tank car. Access to water sources is done by walking or using vehicles for those who have it.
Water availability is faced with a problem of continuity due to the influence of the seasons. The variability of water discharge at water sources is very high between the dry season and the rainy season. TTS Regional Government Report that the variability of water discharges at water sources used reached 90%, reduced during the dry season [6]. The same conditions that water variability in the Kupang and surrounding areas reached 80% [12].

Subsequently, a study of the adequacy of water availability was conducted based on community perceptions (Table 2). The results of the study stated that 79% of respondents said it was enough while the remaining 21% said it was not enough. In the wet category, more respondents said that it was enough (82%) compared to normal and dry areas (77%). This data is in line with the ownership of water sources that are consumed daily namely for the ownership of dug wells, 84% said that they are their own, while only 16% are public property. Whereas for the ownership of water from the pipeline network, only 32% have the status of house connections or their own and 68% are public property (public hydrants).

| Areas category | Adequacy of Needs | Dug wells ownership | Piped water ownership |
|----------------|-------------------|---------------------|----------------------|
|                | Yes | No | Private | Public | Private | Public |
| Dry            | 77% | 23% | 90%     | 10%    | 6%      | 94%    |
| Normal         | 77% | 23% | 75%     | 25%    | 57%     | 43%    |
| Wet            | 82% | 18% | 88%     | 13%    | 33%     | 67%    |

Average 79% 21% 84% 16% 32% 68%

Source: Results of research analysis (2019)

4.2. Access to water and water sources

Next, the researcher examined the access of water sources (distance) to the amount of clean water used to meet daily needs and obtained data as shown in Table 3.

| Areas category | amount of water usage | The average distance from the house to the water source | Correlation value |
|----------------|-----------------------|--------------------------------------------------------|-------------------|
|                | amount (Lpcd) | Deviation standard (SD) | distance (m) | Deviation standard (SD) |
| Dry            | 45         | 19                      | 653          | 1,424          | -0.0758 |
| Normal         | 45         | 23                      | 609          | 811            | -0.1152 |
| Wet            | 62         | 32                      | 176          | 269            | -0.5564 |
| Average        | 49         | 25                      | 521          | 1,100          | -0.0062 |

Source: Results of research analysis (2019)

The average amount of clean water usage is 49 L/sec (SD = 25). Based on the regional category, in the dry category is 45 Lpcd (SD = 19), in the normal area is 45 Lpcd (SD = 23), and in the wet area is 62 Lpcd (SD = 32). In wet areas with access to relatively close water sources (176 m, SD = 269) and sufficient water availability, the use of clean water is more than normal and dry areas. In normal and dry areas, the relatively small amount of water used is due to the limited availability of clean water. Statistical tests, as shown in Table 3, show a negative correlation between the distance of the house to the water source and the amount of household clean water usage. This means that the distance does not prevent the community from obtaining clean water, as long as the water source can be reached on foot or by motorized vehicle, because it is a basic need. Field observations also support the results of this study.
The impact of this condition is the community must travel a considerable distance (an average of 521 meters), spend a lot of energy, and also spend a long time to get clean water. The next impact is the productivity of the community to do something useful for their lives to be reduced because they have to concentrate to get clean water. This is the same as said by UN Water [4].

5. Conclusion
The results showed the average level of clean water usage in rural communities was 49 Lpcd (SD = 25) and the average distance to 521 m (SD = 1100). There is a negative correlation between the distance of the water source and the amount of clean water used. In the wet region the correlation value is stronger than in the normal and dry regions. The availability factor influences water usage more than the relative distance that can still be reached. The research also found that the use of clean water daily is adaptive to the availability of water, which means that the less water available the smaller the water usage. This study recommends the importance of handling clean water issues according to the characteristics of each region that is different, so that the expected supply of clean water can be sustainable.

6. Acknowledgment
The author thanks the DRPM Ministry of Research in Technology and Higher Education, Republic of Indonesia.

References
[1] UNEMG. (2011). Global Drylands: A UN System Wide Respons, United Nations Environment Management Group. https://www.unep-wcmc.org/resources-and-data/global-drylands--a-un-system-wide-response, download 14 February 2019.
[2] Messakh J. J., Arwin, S., & Hadihardaja, I. K., & Dupe, Z. (2015). Management strategy of water resources base on rainfall characteristics in the semi-arid region in Indonesia. International Journal of Scientific and Engineering Research (IJSER). 8 (6), 331-338.
[3] Statistics of Timor Tengah Selatan Regency (2019): Timor Tengah Selatan Regency in Figures 2018. Statistics of TTS Regency. SoE.
[4] UN-Water. (2019). Water Fact. https://www.unwater.org/water-facts/download 09 May 2019.
[5] Messakh, J. J., & Zakarias, H. (2019). Effect of educational factors on the use of clean water in rural communities in the dry tropical areas, east nusa tenggara, Indonesia. Eco. Env. & Cons. 25 (September Suppl. Issue) : 2019; pp. (S92-S97).
[6] Government of Timor Tengah Selatan Regency (2016): Master Plan for Water Supply System (RISPAM) of Timor Tengah Selatan Regency. DPU TTS. SoE.
[7] Jiménez, A., & Pérez-Foguet, A. (2010). Challenges for water governance in rural water supply: lessons learned from Tanzania. International Journal of Water Resources Development, 26(2), 235–248.
[8] Hutchings, P., Chan, M. Y., Cuadrado, L., Ezbekhe, F., Mesa, B., Tamekawa, C., & Franceys, R. (2015). A systematic review of success factors in the community management of rural water supplies over the past 30 years. Water Policy, 17(5), 963–983.
[9] Devit, D. dan Morris, D. (2010): “Sustainable Water Use in Urban Landscapes in the 21st Century: a Las Vegas Perspective” Acta Horticulturae, 881, 483–486.
[10] Kim, S. H., Choi, S. H., Koo, J. Y., Choi, S. I., & Hyun, I. H. (2007). Trend analysis of domestic water consumption depending upon social, cultural, economic parameters. Water Science and Technology: Water Supply, 7(5–6), 61–68.
[11] Presidential Regulation (PERPRES) No. 185 of 2014 about Accelerated Water Supply and Sanitation.
[12] Messakh, J. J., Arwin, H. I. K., & Chalik, A. A. (2015). A study on fulfillment of drinking water need of people in semi-arid areas in Indonesia. Journal of People and Environment, 22 (3), 271–280.