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Clean Water Needs in Duweibey Village, Warmare District, Manokwari Regency, West Papua

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Abstract

Water was one of the natural resources that plays an important role in human life and the environment. The demand for water increases along with population growth and development. The purpose of this study was to describe the domestic water needs in Duweibey Village. The water demand of Duweibey Village, with a population of 159 people, wai 9,540 liters/day or 9.5 m^3/day, with a 5-year requirement of 13,203 liters/day or 13.2 m^3/day, and a 20-year requirement of 14,256 liters/day or 14.2 m^3/day. This condition illustrated that there were alternatives for future clean water needs through springs and rivers in the surrounding area.

Keywords: Water; Demand; Utilization; Population; Duweibey

1. Introduction

Water was an environmental service that played a vital role in human life and the environment. Its importance was such that water resources must be protected to ensure their continued using. Water utilization for various purposes must be carried out wisely, taking into account the interests of both present and future generations. Water conservation and conservation must be instilled in water users [1].

The fulfillment of water for human needs and other uses was largely determined by the quality of the water used. Water was naturally abundant in nature, but the availability of water for human consumption was relatively limited. According to Jeffries and Mils (1996) in [1], more than 97% of the Earth's water was seawater, which could not be consumed directly by humans. Of the remaining 3%, 2% was stored as icebergs (glaciers) [2]. Only 0.62% of the water remaining for human use, including lakes, rivers, and groundwater, was truly available for human consumption. In terms of water quality, only 0.03% of all available water was adequate for human consumption [3].

Duweibey Village, Warmare District, Manokwari Regency, was an area with potential water resources to support life. This potential was evident in the presence of springs that flow through the region's rivers. The village's water needs were met through a gravity-fed piping system, utilizing nearby springs after being collected in reservoirs. However, scientific information regarding the area's clean water needs was still unknown.

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2. Research Method

2.1. Research Time and Place

This research lasted for 6 months (May-August 2025), covering the preparation and implementation stages of the research and was located in Duweibey Village, Warmare District, Manokwari Regency, West Papua Province, Indonesia..

2.2. Tools and Materials

The equipment used in this study was a camera, writing instruments, a computer as equipment for data collection and analysis. The materials used were in population data (Central Bureau of Statistics of Warmare District)

2.3. Research Procedure

The data collected consists of primary (main) data in the form of population and clean water source capacity and secondary (supporting) data in the form of general conditions of the research location.

2.4. Data Analysis

The analysis of Duweibey Village's water needs began with a carrying capacity analysis using secondary data and was continued with an analysis of the population's water needs per liter per person. Considering that the Manokwari Regency area was categorized as small (206,419 people in 2025 in the small city category with a population of 100,000 - 500,000 people. Furthermore, Duweibey Village in Warmare District was categorized as rural (population <10,000 people) with a water need of 60 liters/day/person.

3. Results and Discussion

3.1. Domestic Water Needs

First, it's important to understand several factors determining water needs. First, before analyzing the water needs of Duweibey Village in relation to potential water availability, the population was defined as all individuals residing in the territorial area for 6 (six) months or more, and/or those residing for less than 6 (six) months but intending to settle. Furthermore, the population growth rate was a figure indicating the percentage increase in population over a specific period. Population distribution was the pattern of population distribution within a region, both based on geographic boundaries and administrative boundaries. Population density was the ratio between the number of people and the area they occupy. Population density was measured in units of people per square kilometer. The sex ratio was the ratio of the male to female population in a given area and at a specific time. It was usually expressed as the number of males per 100 females. Based on [4], the population of Warmare District in 2024 reached 9,709, with 4,920 males (51%) and 4,789 females (49%). Nimbay Village had the largest population, with 815 (8.4%), while Aiwow Village had the smallest population, with 83 (0.9%).

Duweibey Village, the study base, with an area of 106.94 km2 (19.18%), had a population of 159 (1.7%) of the Warmare District population. This number included 85 males (53.5%) and 74 females (46.5%), representing a sex ratio of 114.86% and a population density of 1.49 km2, indicating a relatively small population compared to the area.

The presence of the Duweibey Village population was a factor in shaping the water needs of Warmare District and was directly related to the availability of water from surrounding water sources through storage facilities and gravity-fed distribution to residents' homes. Furthermore, this availability was influenced by water availability, demand, and service quality, in terms of the reach of residents' water needs.

Based on [5], it was known that residential water needs were 160 liters per occupant per day, consisting of:

- Simple houses: 60-80 liters per person per day
- Middle-class houses: 80-100 liters per person per day
- Luxury houses: 100-150 liters per person per day
- Villages/rural areas: 60 liters per person per day
- Dorms: 120 liters per person per day
- Elementary schools: 40 liters per student per day.

Furthermore, the Public Works and Public Housing (PUPR) standard, as stipulated in NSPM Kimpraswil No. Regulation T-02-2006-C concerning Drinking Water Supply System Planning provides the following categories:

- Rural areas: 60 liters/person/day
- Small towns: 80-100 liters/person/day
- Medium cities: 100-120 liters/person/day
- Large cities/Metropolitan areas: 120-150 liters/person/day
- Additional factors: Water loss: 20% of total demand
- Non-domestic demand: 15% of domestic demand for public facilities

Based on these references, the clean water needs of Duweibey Village were as follows:
Water needs = Population x Village Water Needs = 159 people x 60 liters = 9,540 liters/day= 9.54 m^3/day or approximately 286 m^3/month.

These needs could be broken down according to water usage requirements, including daily usage, as follows:

Table 1 Water Categories and Needs of Duweibey Village Residents

Categories	Needs	Information
Drinking and cooking water	159 x 7 liter = 1.113 liter	
Bathing, Washing, Toilet	159 x 45 liter = 7.155 liter	
Other needs + reserves (10%)	1.272 liter	
Total	9.540 liter/day	

This value was only limited to domestic household water needs and did not include agricultural needs, sub-health centers, schools and other facilities or activities.

3.2. Domestic Water Demand Projection

The basic planning assumptions for the needs of 159 residents and a growth rate of 0.5%/year (Manokwari's population growth rate was 1.9%), for a standard rural/village water requirement of 60 liters/person/day plus determining factors. These determining factors included water loss and non-domestic needs, with the population using the equation 159 x 1.005^5 years = 163 people, thus obtaining water requirements for 5 years (2030) and 20 years (2045).

Table 2 Estimated Water Requirements for Duweibey Village (Growth 0.5%)

Water Needs	Total	Information
Resident	159 x 1,005)^5 tahun = 163 person	5 years
Domestic Needs	163 x 60 = 9.780 liter/day	
Water Loss 20%	1.956 liter	
Non-domestic 15%	1.467 liter	
Total	13.203 liter/day≈ 13,2 m^3/day	
Resident	159 x (1,005)^20 = 176 person	20 years
Domestic Needs	176 x 60 = 10.560 liter/day	
Water Loss 20%	2.112 liter	
Non-domestic 15%	1.584 liter	
Total	14.256 liter/day ≈ 14,26 m^3/day	

Based on the analysis, it was found that the 20-year increase was only 1.38 m^3/day from the current 12.88 m^3/day. If the SPAM design used was 15 m^3/day, it would be sufficient for the next 20 years. The minimum water flowed rate for 15 m^3/day was 0.17 liters/second if operated 24 hours a day, or 0.52 liters/second if operated for 8 hours.

To meet water needs through the storage unit, a target of 15 m^3/day = 15,000 liters/day could be used. The capacity of the water tank or basin according to PUPR requirements was at least 30% of the daily requirement for fluctuations in usage + reserves: 30% x 15,000 liters = 4,500 liters. This indicated that using a 5,000-liter tank or two x 3,000-liter tanks was sufficient. For simple firefighting, an additional 1,000-2,000 liters would be added, totaling 6,000-7,000 liters.

Meeting pump needs without a gravity system was highly dependent on operating hours. Pump Operating Hours: 15,000 hours ÷ 86,400 = 0.17 liters/second. Small pump, running continuously for 12 hours: 15,000 hours ÷ 43,200 = 0.35 liters/second. Commonly used in villages: 8 hours: 15,000 hours ÷ 28,800 = 0.52 liters/second. Cheap electricity at night, with 6 hours, equals 0.69 liters/second. The recommended pump capacity was 0.5-1.0 liters/second to maximize performance (without overworking).

The next assumption was that if the population's water needs reached 100 liters/person/day, then the area's water needs were calculated as the product of the population (159 people x Village Water Needs) = 159 people x 100 liters = 159,000 liters/day.

Table 3 Estimated Water Needs for Duweibey Village (1% Growth)

Water Needs	**Total**	**Information**
Residents	159 x 1,005)^5 year = 163 person	5 years
Domestic Needs	163 x 100 = 16.300 liter/day	
Water Loss 20%	3.260 liter	
Non-domestic 15%	2.445 liter	
Total	22.005 liter/day ≈ 22,0 m^3/day	
Residents	159 x (1,005)^20 = 176 person	20 years
Domestic Needs	176 x 100 = 17.600 liter/day	
Water Loss 20%	3.520 liter	
Non-domestic 15%	2.640 liter	
Total	23.760 liter/day ≈ 23,8 m^3/day	

If the domestic water requirement standard was increased to 100 liters/person/day (considering village progress), then the input system load of Duweibey village immediately increased significantly. The value increased to 8.6 m^3/day compared to the standard of 60 liters. 5-Year Projection Population of 163 people. Domestic needs of 163 x 100 = 16,300 liters/day and water loss of 20% = 3,260 liters and Non-domestic 15% = 2,445 liters with a total of = 22,005 liters/day ≈ 22.0 m^3/day. 20-Year Projection Population of 176 people. Domestic water demand was 176 x 100 = 17,600 liters/day. Water loss was 20% = 3,520 liters, and non-domestic water loss was 15% = 2,640 liters, totaling 23,760 liters/day (23.8 m^3/day). The analysis results showed that the ratio of 60 vs. 100 liters/person/day.

Table 4 Estimated Water Needs for Duweibey Village

Period	60 liter/person/day	100 liter/person/day	Difference
Nowdays	12,88 m^3/day	21 m^3/day	8,6 m^3/day
5 years	13,2 m^3/day	22,0 m^3/day	8,8 m^3/day
20 years	14,26 m^3/day	23,8 m^3/day	9,5 m^3/day

Based on the analysis results, it showed that for 24 m^3/day it was 0.28 liters/second and if it was 24 hours, or 0.83 liters/second for 8 hours. The discharge in the main pipe which included a peak discharge of 2.5 L/second had increased to 2.5 inch PVC so as to ensure pipe safety. The minimum supply capacity was 0.3 liters/second continuously. Increasing to 100 liters/person/day meant that the system capacity must be almost 2x the village standard of 60 liters. This could be used with consideration if the Duweibey village already had a communal toilet, school, health center, or the target was to be upgraded to a developed village [6].

4. Conclusion

The water needs of Duweibey village with a population of 159 people were 9,540 liters/day or 9.5 m^3/day with a need for the next 5 years of 13,203 liters/day or 13.2 m^3/day and a need for 20 years of which indicated the existence of alternative sources of clean water.

Compliance with ethical standards

Acknowledgment

Permission to conduct research within the management authority of Duweibey Village for their time and knowledge assistance, which greatly supported the research activities.

Disclosure of conflict of interest

The authors declared no conflict of interest regarding the publication of this paper.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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