Analysis of Community-based Rural Water Management (PAMDES) in the Rural Clean Water Supply System of Jembrana Regency

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Abstract: The low coverage of clean water services causes many people who consume water that does not meet proper health standards. The projected availability of clean water in Jembrana Regency which is managed by the village (pamdes) until 2040 is 41.05 l/sec, while it is managed by PDAM until 2040 is 247 l/sec. The projected water demand in Jembrana Regency until 2040 is 678.99 l/sec, there is a water deficit in 2040 in Jembrana Regency of 390.93 l/sec. The Jembrana Regency Rural Clean Water Supply System is only able to serve the Jembrana community in 2025 around 9.25%, and in 2040 at 6.045%, of the total clean water needs in Jembrana Regency. Efforts to overcome the clean water deficit in Jembrana district by developing the Benel Reservoir 60 l/s, Titab Reservoir 50 l/s, Biluk Poh Longstorage 100 l/s, Yeh Sumbul Longstorage 100 l/s, Balian Longstorage 50 l/s, Springs Pulo Sae 50 l/sec. The development of a clean water supply system in Jembrana Regency is believed to be able to meet the needs of clean water until 2040, resulting in a clean water surplus of 19.06 l/sec.

1 INTRODUCTION

The supply of clean water in Jembrana Regency, especially on a large scale, is still concentrated in urban areas, and is managed by the Regional Drinking Water Company (PDAM). For areas that have not received clean water services from PDAM, they generally use ground water (wells), river water, rain water, source water (springs) and this condition is around 84%. To overcome this problem, one alternative is to build an installation to treat groundwater or well water so that drinking water of quality that meets health requirements is obtained. In terms of the quantity of community-based managed drinking water services (PAM Desa) in Jembrana Regency, it is still very limited and unable to keep pace with the rate of demand due to the increasing population. Jembrana Regency in 2017 only 14% of Village PAMs were able to serve the community in Jembrana Regency.

1.1 Clean Water Supply System

Water supply system capable of providing sufficient potable water is essential for a large modern city. The clean water supply system includes:

Raw Water Unit, it is a building for taking raw water from a water source and flowing it to the production unit through a transmission pipe. The building to tap raw water as far as possible is carried out by gravity, equipped with a coarse filter that functions to filter out waste carried by the flow. There are several ways of taking water systems, including: - Free intake - Broncapturing - Weir – Pump and Production Unit, it is an attempt to change the properties of a substance. This is important for drinking water because with this treatment it will be obtained a drinking water that meets the drinking water standards that have been determined. Distribution Unit about the clean water distribution system consists of a distribution reservoir and a distribution pipe network. - Distribution Reservoir Distribution reservoir is a temporary water reservoir that holds water when the use is less than the supply and is used to cover shortages when the usage is greater than the supply. Distribution reservoirs are usually in the form of reservoir towers/tanks or ground reservoirs. Distribution reservoirs are generally box-shaped and round or conical shapes are usually made to add artistic value so that they are pleasing to the eye. - Pipe Networks The use of pipelines in the field of civil engineering is found in the drinking water distribution network system.

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This network system is the most expensive part of a water company. Therefore, careful planning must be made to obtain an efficient distribution system. The amount or discharge of water provided depends on the number of residents and the type of industry served (Bambang, 2017).

1.2 Drinking Water Quality

Water is a term that describes the suitability or suitability of water for certain uses, such as drinking water, fisheries, industry, recreation and so on. The parameters of the quality of clean water or drinking water stipulated in the Decree of the Minister of Health Number: 492/Permenkes/IV/2010 consist of physical parameters, chemical parameters, radioactive parameters, and microbiological parameters. The mandatory parameters consist of parameters that are directly related to health and parameters that are not directly related to health. Parameters that are directly related to health consist of microbiological parameters and inorganic chemistry while parameters that are not directly related to health consist of physical parameters and chemical parameters. To meet microbiological parameters, drinking water must not contain Coliform bacteria (type of coli) either fecal (eg Escheresia coli) or non-fecal (eg Enterobacter aerogenes). The inorganic chemical parameters include Arsenic, Fluoride, Total Chromium, Cadmium, Nitrite as NO2, Nitrate as NO3, Cyanide and Selenium. Physical parameters include odorless, colorless drinking water, a maximum total dissolved substance (TDS) of 500 TCU, a maximum turbidity of 5 newton total units, tasteless and a temperature of +30C from the current temperature. While the chemical parameters include aluminum, iron, hardness, chloride, manganese, pH,. Zinc, Sulfate, Copper, Ammonia (Badan Perencanaan Pembangunan Nasional, 2003).

1.3 Clean Water Needs

Planning for water needs is seen from the factors that require water, the factors in question are: water Needs for Agriculture (Irrigation Water Needs), the calculation of the water requirement is based on the cropping pattern that will be used in the area in question. By knowing the maximum water demand in lt/sec/Ha, the total demand can be determined based on the area to be irrigated. Water Needs For Domestic Use the larger the size of the city, the more the population, the more industrial and trade activities and the more complex waste network and possibly greater water wastage. The above variables cause the larger the size of the city, the greater the need for water. The Directorate General of Human Settlements (2000), has set a standard water use for metropolitan cities of 190 liters/person/day, this is greater than the standard water requirement for large cities of 170 liters/person/day, medium cities of 150 liters/person/day , and a small town of 130 liters of people/day. In detail, the allocation of water use for several city categories can be seen in Table 1.

Table 1: Criteria for domestic water use in Indonesia.

No.	Description	Metropolitan	Big city	Town	Small Town	Village
1	Domestic demand	190	170	150	130	30
2	Non domestic demand					
	Loose water	20-30	20-30	20-30	20-30	20-30
3	Operation	20-30	20-30	20-30	20-30	20-30
4		24	24	24	24	24

Source: Directorate General of Human Settlements, DPU, 2000

Domestic water demand standards according to the Department of Settlement and Regional Infrastructure in 2003 and SNI in 2002 are shown in the following table 2.

Table 2: Water demand standard.

Amount of People	Calssification	Water Demand (litre/man/day)
>2.000.000	Metropolitan	>210
1.000.000 – 2.000.000	Metropolitan	150 - 210
500.000 – 1.000.000	Big City	120 - 150
100.000 – 500.000	Big	100 - 150
20.000 – 100.000	Sedang	90 - 100
3.000 – 20.000	Smal	60 - 100

1.4 Clean Water Usage Pattern

The use of clean water in an area will never be exactly the same as in other areas due to the characteristics possessed by the area concerned. The pattern of clean water usage is largely determined by climate, population characteristics, environmental issues, industry and trade, water fees, city size and water conservation needs.

1.5 Population Projection

Calculation of population using arithmetic, geometric and least square formulas. To determine the method used in each sub-district, the smallest standard deviation value of the three approaches will be determined.

a. Geometric Method

$$Pn = Po+(1- r)n$$

Source : Construction and Building Guidelines, Dep. Public Works in the Directorate of Irrigation and Bappenas, 2006

Pn = total population in year
n Po = population base year
r = population growth rate
n = number of year intervals

1.6 Village Clean Water Management System

Clean water (sanitation water) is water that can be used for various purposes in the household sector such as for bathing, washing and latrines. Clean water requirements include clear, colorless, tasteless, odorless, non-toxic, neutral pH and free of microorganisms. (Andito, 2020)

PDAM is a regional-owned company engaged in the processing and distribution of clean water. Raw water from PDAM comes from sources located in springs, rivers, lakes or mountains. This raw water cannot be directly used to meet the needs of clean water in daily life. In general, clean water treatment consists of 3 ways, namely physical, chemical and biological treatment. Physical treatment is carried out by utilizing the mechanical properties of water, for example by doing precipitation, filtration (filtering), adsorption (absorption) without the addition of chemicals. (Satmoko, 2005). Meanwhile, chemical processing is done by adding chemical substances such as alum and chlorine. This substance is commonly used to remove heavy metals contained in water. As well as in biological processing, certain microorganisms are used as processing media that can help purify water. PAM Desa has the characteristic that the highest power in making decisions on all aspects related to drinking water is in the hands of community members, starting from the initial stage of identifying drinking water service needs, planning the desired service level, technical planning, implementation of development, to operational management. At certain times during the development process they may obtain facilitation from outside parties, for example information on various alternative technologies and technical assistance (eg contractors, entrepreneurs, or professionals), but the final decision remains with the community itself.

1.7 Clean Water Development System

The elements in a clean water distribution network system are the components that exist in a series of clean water distribution network systems. These elements consist of pipes and their connections, valves, pumps, reservoirs and reservoirs where all of them must work properly.

a. Water Sources: Natural springs, deep groundwater, surface water, lake surface water

b. Pipe
In a clean/raw water distribution network system, pipes are the main component. This pipe serves as a means to drain water from water sources to reservoirs, as well as from reservoirs to consumers. The pipe has a circular cross section with various diameters. In the service of providing clean water, pressure pipes are used more because they are less likely to be polluted and the cost is cheaper than using open channels or gutters. A pressure pipe is a pipe full of water flowing through it.

c. Pump
The pump is a system component that is able to provide additional pressure in a clean water distribution network system. With a pump, the reduced pressure level can be increased again so that the system can flow water to higher and farther service points.

d. Reservoir
Reservoir is a component of a clean water distribution network system that has a function to accommodate and store water from deep ground springs, surface water of lakes or reservoirs, rivers. Things to consider in planning a reservoir are:

2 RESEARCH DESIGN

The research was conducted in Jembrana Regency, with quantitative descriptive research methods. The quantitative descriptive method aims to make a systematic, factual and accurate description or description of a phenomenon or the relationship between the phenomena being investigated.

2.1 Research Time and Location

The research time for Community-Based Rural Water Management (Pamdes) Analysis in the Rural Water Supply System of Jembarana Regency is six calendar months (180 days).

2.2 Data Analysis

Data analysis conducted in this study are as follows: Analysis of rural clean water availability, analysis of clean water availability in lt/sec, and m^3, Analysis of instantaneous water discharge, using the method of measuring flow velocity with a current meter tool. The discharge calculated based on direct velocity measurements is carried out using the VAM (Velocity Mean Method) method, where the cross-section of the river is divided vertically in the form of streams and the average velocity represents the flow velocity in the stream. In this method, each such cross-section does not exceed 10% of the total cross-sectional area. Population Analysis, the calculation of the population is based on Ministerial Regulation No.18/PRT/M/2007, concerning the Implementation of Drinking Water Supply System Development using arithmetic, geometric and least square formulas. To determine the method used in each sub-district, the smallest standard deviation value of the three approaches will be determined. Analysis of existing Rural Clean Water Needs.

The Directorate General of Human Settlements has set a standard water use for metropolitan cities of 190 liters/person/day, this is greater than the standard for large cities of 170 liters/person/day, medium cities of 150 liters/person/day and small cities, 130 liters of people/ day. Analysis of Clean Water Supply System (PAMDES), it is carried out by means of a literature study with the development of the concept of sustainable water source management, based on the current system conditions that have been running, then the sustainability of clean water supply in the future is calculated. To inventory clean water sources that currently exist and village clean water sources that are in the process of development, and which will be planned to be developed.

3 RESULTS AND DISCUSSION

3.1 Potential

Jembrana Regency has 17 rivers that have the potential to be utilized. The river with the lowest Groundwater potential in Jembrana Regency is part of the State Groundwater Basin with a flow capacity of 73 million m3/year. The northern and northeastern areas, which include Pekutatan, part of Mendoyo, and part of Kecamatan Negara, are areas that are not groundwater basins or groundwater basins with no potential. It is part of the Quaternary Jembrana Volcanic Rock Formation which is composed of lava, volcanic breccia, and tuff produced by Mount Kelatakan, Mount Merbuk, and Mount Patas. The western and southern parts which include the Melaya District and part of the Negara District have local aquifers with moderate productivity caused by the capacity is the Bajra River or DAS with a capacity of 17.04 liters/second. The river that has the largest capacity is the Yeh Sumbul River or DAS with a capacity of 2,716.69 liters/second.

Water samples were taken from several rivers flowing in Jembrana Regency. From the sample test results, it was found that all water samples from rivers in Jembrana Regency exceeded their BOD quality where the Minister of Health Regulation Number 32/Menkes/Per/VI/2017 Environmental Health Quality Standards and Water Requirements for Sanitation stated the threshold value was 12 milligrams per liter . In processing river water into raw water, there is still a very high tolerance and it is still very feasible to be processed into raw water.

Palasari Formation which is composed of sandstone, limestone and reefs.

3.2 System for Meeting Rural Drinking Water Needs in Jembrana Regency

In addition to the provision of drinking water through PDAM by the district government, there is also a rural drinking water supply system (Pamdes) in 5 (five) sub-districts, including Melaya District, Mendoyo District, Jembrana District and Pekutatan District. The current conditions for each Pamdes in each sub-district are described as follows:

1) Melaya District

There are 2 (two) groups of water users in the Melaya sub-district, all of which use water from bore wells. The number of Pamdes services in Belimbingsari Village is 2,575 people, while the number of Pamdes services in Candikusuma Village reaches 1,835 people. The total number of Pamdes services in Melaya District is 4,410 people or 8.25% of the total population of Jembrana Regency, which is 53,460 people.

2) Mendoyo District

Mendoyo Subdistrict there are 5 (five) Pamdes groups that use water from bore wells and river water. Total Pamdes services in Mendoyo District are able to serve 3,600 people or 6.16% of the total population of Mendoyo District, which is 58,480 people.

3) State District

There are 2 (two) Pamdes groups in Negara that use water from bore wells and river water. The number of people served by Pamdes Giri Amerta is 177 people, while Pamdes Telepas Ning serves 4,680 people. The total Pamdes services in the Negara sub-district are 4,857 people or 5.78% of the total population of the Negara sub-district, which is 84,000 people.

4) Pekutatan District

Pekutatan subdistrict has 21 (twenty one) Pamdes groups that use water from rivers and springs. The total number of residents that can be served from Pamdes in Pekutatan District is 11,385 people or 44.31 % of the total population of Pekutatan District, which is 26,710 people.

3.3 Population

The standard deviation is used to determine the method to be used in projecting the population, seen from the smallest standard deviation value. The backward calculation of the population projections of the five sub-districts above shows that the standard deviation of the arithmetic method has the smallest standard deviation value. So, population projections for the five sub-districts in 2020, 2025, 2030, 2035, and 2040 in Jembrana Regency using the arithmetic method produce the population as shown in the following table 3.

Table 3: Projected population of jembrana regency 2020, 2025, 2030, 2035, and 2040.

Regency	Projected population (Soul)				
	2020	2025	2030	2035	2040
Melaya	53.72	55.281	56.842	58.403	59.964
Negara	847	87.966	91.189	94.433	97.678
Jembrana	55.65	57.556	59.491	61.397	63.302
Mendoyo	58.68	59.824	60.969	62.113	63.258
Pekutatan	26.82	27.409	27.998	28.587	29.176
Jembrana Regency	279.6	288.044	296.489	304.933	313.378

Table 4: Clean Water Balance of Jembrana Regency in 2021.

Description	Unit	Year				
		2020	2025	2030	2035	2040
Population	Jiwa	279.6	288.044	296.489	304.933	313.378
Water Need	l/dt	278,89	443,48	617,21	660,69	678,99
PDAM	l/dt	247,00	247,00	247,00	247,00	247,00
Non PDAM	l/dt	41,05	41,05	41,05	41,05	41,05
Total Supply	l/dt	288,05	288,05	288,05	288,05	288,05
Neraca Air	l/dt	9,17	155,42	-329,16	-372,63	-390,93

3.4 Current Clean Water Balance

The provision of raw water in the study area is planned to meet the needs of raw water including clean water for the population (domestic) and public facilities, thus it is calculated by considering factors that can support or cause an increase in the need for clean water.

3.5 Jembrana Regency Clean Water Development

Program Jembrana Regency is projected to require 678.99 liters of water/second in 2040, while water

4 CONCLUSIONS

The conclusion of the research is Analysis of Community-Based Rural Water Management (Pamdes) in the Rural Water Supply System of Jembrana Regency. can be presented as follows:

1. The current availability of clean water in Jembrana district which is managed by the village (pamdes) until 2040 is 41.05 litre/second, while managed by PDAM until 2040 is 247 litre/second. Water demand in Jembrana Regency up to 2040 is 678.99 litre/second. There is a water deficit in 2040 in Jembrana Regency of 390.93 l/second. The Jembrana production from PDAM and Non-PDAM only reaches a capacity of 288.05 liters/second. Jembrana Regency is estimated to experience a water shortage of 390.93 liters/second in 2040. To be able to meet this shortage, there are several plans for a Clean Water Supply System that could reach 2040, including:
   • Benel Reservoir with a capacity of 60 liters/second to meet the needs in the Melaya District area
   • Titab Reservoir with an allocated capacity of 50 liters/second to meet the needs in the Gilimanuk area, Melaya District
   • Biluk Poh Longstorage with a capacity of 100 liters/second
   • Yeh Sumbul Longstorage with a capacity of 100 liters/second
   • Balian Longstorage with a capacity of 50 liters/second
   • Pulo Sae Springs with a capacity of 50 liters/second The total capacity of 410 liters/second will be distributed according to the following plan:
   • Melaya sub-district, especially the Gilimanuk port area, gets a water allocation of 50

liters/second from the Titab Reservoir

• Pekutatan sub-district gets a water allocation of 26 liters/second from the development of the Tukad Balian Longstorage

• Mendoyo sub-district gets a water allocation of 100 liters/second

• Jembrana sub-district gets a water allocation of 90 liters/second

• State sub-districts receive a water allocation of 94 liters/second

• The eastern part of the Melaya sub-district gets a water allocation of 50 liters/second from the Pulo Sae Spring Regency Rural Water Supply System is only able to serve the Jembrana community in 2025, around 9.25% of the total needs of Jembrana

Regency in that year, and 6.045% in 2040. To overcome the clean water deficit in Jembrana district, the efforts made are the development of Benel Reservoir 60 litre/second, Titab Reservoir 50 litre/second, Biluk Poh Longstorage 100 litre/second, Yeh Longstorage 100 litre/second, Balian Longstorage 50 litre/second, Pulo Sae spring 50 litre/second.

The development of a clean water supply system in Jembrana Regency will be able to meet the needs of clean water until 2040, resulting in a clean water surplus of 19.06 litre/second.

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