



# The Study of Clean Water Supply System Managed by the Community to Ensure Reliability of the Clean Water Supply System in Tabanan District



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## Abstract

Based on data from the Tabanan Regency Central Bureau of Statistics in 2020 administratively the Tabanan Regency area is 839.33 km<sup>2</sup>, consisting of 133 villages and 816 official banjars, with a population of 448,000 people. Tabanan Regency is one of the regencies in Bali, where the topographical conditions of the existing villages are mostly in remote areas, so they often experience difficulties with clean water distribution problems. For the current condition, the provision of clean water in Tabanan Regency is provided by PDAM (Local Water Company) through the use of springs, ground water and river water, in addition to several areas the water supply is carried out through Pamsimas (Community-Based Drinking Water and Sanitation Provision). Currently Pamsimas Tabanan Regency is divided into 9 service coverage areas for people in rural areas. In general, the condition of drinking water services presents the main problem, namely that not all areas are accessed by adequate water services. This problem is mainly caused by various obstacles such as limited water resources, limited infrastructure and topographical conditions. The research implementation is broadly carried out in the form of information collection (secondary and primary data collection), field surveys, problem analysis, and formulation of the preparation of non-PDAM clean water supply systems for current and future conditions. The research output for the final report is the amount of non-PDAM (Pamsimas) water availability in Tabanan Regency for current conditions by utilizing the potential of water sources from existing springs, which is 73.16 Lt/sec. Meanwhile, the amount of Non-PDAM (Pamsimas) water demand in Tabanan Regency for the current condition is 224.00 Lt/sec, while the projected Non-PDAM water needs in Tabanan Regency until 2040 are as follows, non-PDAM water needs in 2025 are 230.846 Lt/sec, in 2030 it is 237,993 Lt/s, in 2035 it is 245,457 Lt/s and in 2040 it is 253,256 Lt/s. The service level of the non-PDAM clean water supply system (Pamsimas) in Tabanan Regency for the current condition has only reached 21.41%, while the reliability level of the Non-PDAM clean water supply for the current condition has only reached 32.66%. Meanwhile, the service level of the non-

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PDAM clean water supply system (Pamsimas) in Tabanan Regency is projected for 2020-2040 based on the number of people served, as follows, in 2025 it is 21.01%, in 2030 it is 20.63%, in 2035 it is 20, 26% and in 2040 19.89%. For the level of reliability of non-PDAM clean water supply in Tabanan district based on water availability compared to projected water needs in 2020-2040, it has decreased, where in 2025 it reaches 31.69%, in 2030 it reaches 30.74%, in 2035 it reaches 29.81%. and in 2040 it will reach 28.89%.

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## 1 Introduction

Administratively, the area of Tabanan Regency is 839.33 km<sup>2</sup>, consisting of 133 villages and 816 official banjars, with a population of 448,000 people, which later became the reference for the service area for the clean water supply system in Tabanan Regency (Central Bureau of Statistics, 2020).

Water is the main need for living things that is used sustainably in every activity such as drinking water, bathing, cooking, washing, and so on. Daily water needs vary according to the place and standard of living. As the population and standard of living increase, the demand for clean water also increases (Napitu & Diara, 2018).

In general, the condition of drinking water services is faced with the main problem, namely that not all areas have been accessed by adequate water services. This problem is mainly caused by various obstacles such as limited water resources, limited infrastructure and topographic conditions (Parwita et al., 2020).

Since 2014-2019 the Pamsimas Program in Tabanan has been attended by 56 villages with funding reaching Rp. 18,902,746,050,-. The Pamsimas program targets villages that do not have access to low drinking water with conditions that are not yet served by PDAM, partially served by PDAM or have Pamdes that are not yet optimal (Balinese Flash. 2019).

The fulfillment of clean water for good drinking water will affect the quality of life of people in an area. Drinking water services are also a measure of the quality of an area. In the future, there is a need for an in-depth technical study related to the amount of water needed and the mechanism for its supply (Anderson et al., 2010; Teo et al., 2022).

### *Problem formulation*

The formulation of the problem from this research is:

- 1) How much is the availability of clean water supply system managed by community in Tabanan Regency?
- 2) How much is the need for clean water of current and projected water needs in the future in Tabanan Regency?
- 3) How analysis of the clean water supply system managed by community in Tabanan Regency?

### *Research purposes*

The purpose of this study was to obtain answers to the following problems:

- 1) Mapping of clean water supply system by community (Pamsimas) of water availability in Tabanan Regency.
- 2) Mapping of current and projected water needs in the future, as well as analysis of the non-PDAM water supply system (Pamsimas) Kab. Tabanan currently available
- 3) Analysis of the non-PDAM (Pamsimas) water supply system in Tabanan Regency in the future.

*Population number and population projection*

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 in Tabanan Regency, it will be determined with the smallest standard deviation value of the three approaches.

## 1. Arithmetic Method

$$P_n = P_o + K_a (T_n - T_o) \dots\dots\dots (2 - 1)$$

$P_n$  = total population in year n

$P_o$  = population base year

$T_n$  = n year

$T_o$  = Base year

$K_a$  = arithmetic constant

$P_i$  = population of year i

$P_a$  = total population last year

$T_1$  = known year I

$T_2$  = known year II

## 2. Geometric Method

$$P_n = P_o + (1 - r)^n \dots\dots\dots (2 - 2)$$

$P_n$  = total population in year n

$P_o$  = population base year

$r$  = population growth rate

$n$  = number of year intervals

## 3. Least Square Method

$$Y = a + bX \dots\dots\dots (2 - 3)$$

$Y$  = variable value based on regression line

$X$  = independent variable

$a$  = constant

$b$  = linear regression direction coefficient

*Water potential and water availability*

Water potential is the amount of water contained in water bodies both as surface water and as underground water. While the availability of water is the amount of available water that can be used in several water buildings that have been built such as weirs, dams, reservoirs, long storage and drinking water supply system (SPAM) buildings. The carrying capacity of water resources is often used as the basis for regional management, especially for densely populated areas with limited water resources (Linsley & Franzini, 1995). The size of the area greatly affects the amount of water availability, assuming the amount of rain that falls on an area is the potential for water that can be used by local communities for certain needs (Kodoatie & Sjarief, 2005).

*Non-PDAM clean water needs*

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 small towns by 130 liters of people/day, while for villages it's 30 liters of people/day. In detail the allocation of water use for several categories of cities can be seen in Table 1.

Table 1  
Criteria for domestic water use in Indonesia

No.	Description	City	Big city	Medium City	Small City	Village
		Metropolitan				
1	Domestic Water use (liter/person/day)	190	170	150	130	<b>30</b>
2	Non domestic Water Consumption(%)	20-30	20-30	20-30	20-30	<b>20-30</b>
3	Water Loss (%)	20-30	20-30	20-30	20-30	<b>20-30</b>
4	Operation Hour	24	24	24	24	<b>24</b>

Source : Directorate General of Human Settlements , 2000

The types of clean water needs can be divided into two groups, namely domestic water needs and non-domestic water needs. Domestic water demand and non-domestic water demand plus water loss during distribution constitute the total water demand (Soufyan, 2000).

#### *Provision of Non-PDAM clean water*

In Indonesia the management of clean water by the government is entrusted to PDAM which has a function as a drinking water provider operator and at the same time as a regulator of drinking water policy in the regions, while in rural areas it is managed by Pamsimas (Non-PDAM) (Soufyan, 2000).

The Pamsimas program targets villages that do not have access to low drinking water with conditions that are not yet served by PDAM, partially served by PDAM or have Pamsimas that are not yet optimal. With the increasing population, the need for clean water is increasing. This increase causes the coverage of the service area to be even greater (Döll et al., 2003; Gooding et al., 2003).

#### *Level of reliability of non-PDAM clean water supply*

The level of reliability is the percentage between the amount of potential available water compared to the use of existing water (Miller, 2006; Chowdhury et al., 2016). The level of reliability of non-PDAM clean water supply in Tabanan Regency can now be seen from the potential and the distributed discharge.

## 2 Materials and Methods

### *Research design*

The research implementation is broadly carried out in the form of information collection (secondary and primary data collection), field surveys, problem analysis, and formulation of the preparation of non-PDAM clean water supply systems for current and future conditions. The research model design is as shown in Figure 1.

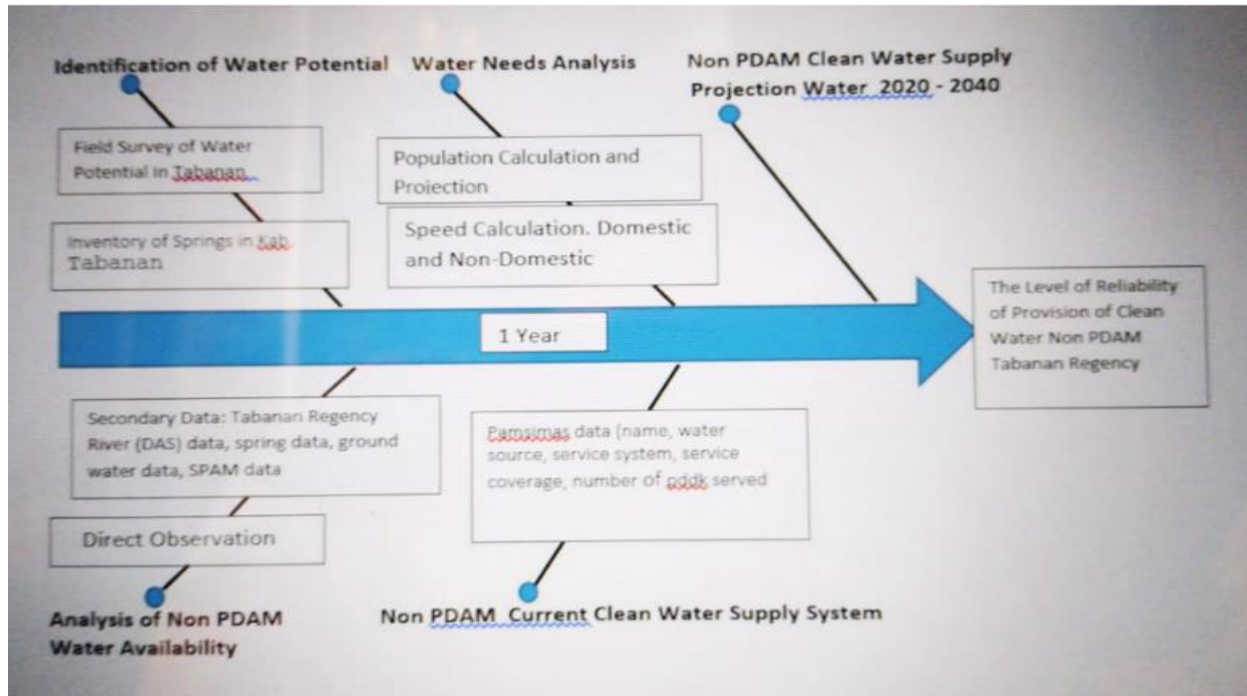


Figure 1. Research model design

### 3 Results and Discussions

#### 3.1 Population analysis and projection

Reverse calculation of population projections for the ten sub-districts in Tabanan Regency shows that the smallest standard deviation is obtained from calculations using the geometric method (Triadi et al., 2023). So that the population projections for 2025, 2030, 2035, and 2040 are obtained as shown in the following table 2.

Table 2  
Projected Population of Tabanan Regency in 2020 – 2040

Regency	Population Projection (Soul)				
	2020	2025	2030	2035	2040
Selemadeg	19,81	20,075	20,344	20,616	20,892
East Selemadeg	21,66	21,894	22,13	22,369	22,61
West Selemadeg	19,6	19,976	20,358	20,748	21,146
Kerambitan	39,36	40,164	40,984	41,822	42,676
Tabanan	75,68	78,261	80,931	83,691	86,546
Kediri	96,26	102,631	109,424	116,666	124,387
Marga	42,34	43,291	44,264	45,258	46,275
Baturiti	48,97	50,227	51,516	52,838	54,194
Penebel	44,95	45,34	45,733	46,13	46,53
Pupuan	39,37	39,833	40,302	40,776	41,255
<b>Tabanan Regency</b>	<b>448,000</b>	<b>461,692</b>	<b>475,985</b>	<b>490,913</b>	<b>506,511</b>

Source: researcher analysis, 2021

### 3.2 Analysis of Non-PDAM Water Availability

The potential for water availability in the river area along Tabanan Regency is quite large. Rural communities in Tabanan Regency through Pamsimas (Non-PDAM) still utilize water sources in the form of springs, where the potential availability of springs in Tabanan Regency is 119.11 million m<sup>3</sup> or equal to 1,691.68 Lt/sec, which has only been utilized by PDAM Tabanan Regency is only 1,6018.52 Lt/sec. The remaining potential water availability of 73.16 Lt/sec can still be utilized by the community through Pamsimas (Non-PDAM) especially for people in remote villages because they cannot be reached by PDAM.

### 3.3 Non-PDAM water demand analysis need

#### *Analysis of the current condition of non-PDAM water needs*

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, while for the village of 30 liters of people/day. Non-domestic water needs are water needs other than for purposes inside the house, outside the house and public faucets. Some people/agencies estimate the amount of non-domestic water needs based on a percentage of the amount of domestic water needs (Vakilifard et al., 2018; Wee & Aris, 2017). The amount of non-domestic water needs is estimated at 20% - 25% of domestic water needs. For the calculation of the need for non-PDAM clean water for the current (existing) condition, which includes Domestic and Non-Domestic water needs in each District, it is shown in Table 3.

Table 3  
Need for clean water non-PDAM Tabanan District Year 2020 – 2040

No	DISTRICT	Water Demand (Lt/ day)		Water Demand (Lt/sec)	Numbers of Leak (Lt/sec)	Total Water Demand Non PDAM (Lt/sec)
		Domestic	Non Domestic			
1	SELEMADEG	594	119	8,254	1,651	9,905
2	EAST SELEMADEG	650	130	9,025	1,805	10,830
3	WEST SELEMADEG	588	118	8,167	1,633	9,800
4	KERAMBITAN	1.181	236	16,40	3,28	19,680
5	TABANAN	2.270	454	31,533	6,307	37,840
6	KEDIRI	2.888	578	40,108	8,022	48,130
7	MARGA	1.270	254	17,642	3,528	21,170
8	BATURITI	1.469	294	20,404	4,081	24,485
9	PENEBEL	1.349	270	18,729	3,746	22,475
10	PUPUAN	1.181	236	16,404	3,281	19,685
	<b>TABANAN REGENCY</b>	<b>13.440</b>	<b>2.688</b>	<b>186,666</b>	<b>37,334</b>	<b>224,000</b>

Source: Analysis result, 2021

*Projected analysis of non-PDAM water needs in 2020 – 2040*

The recapitulation of the projected calculation of non-PDAM water needs in Tabanan Regency is shown in Table 4.

Table 4  
Recapitulation of Projected Non-PDAM Water Demand in Tabanan Regency in 2020 – 2040

No	District	Non PDAM water demand ( Lt / sec )				
		2020	2025	2030	2035	2040
1	SELEMADEG	9,905	10,038	10,172	10,308	10,446
2	EAST SELEMADEG	10,830	10,947	11,065	11,185	11,305
3	WEST SELEMADEG	9,800	9,988	10,179	10,374	10,573
4	KERAMBITAN	19,680	20,082	20,492	20,911	21,338
5	TABANAN	37,840	39,131	40,466	41,846	43,273
6	KEDIRI	48,130	51,316	54,712	58,333	62,194
7	MARGA	21,170	21,646	22,132	22,629	23,138
8	BATURITI	24,485	25,114	25,758	26,419	27,097
9	PENEBEL	22,475	22,670	22,867	23,065	23,265
10	PUPUAN	19,685	19,917	20,151	20,388	20,628
	<b>Total of Tabanan Regency</b>	<b>224,00</b>	<b>230,85</b>	<b>237,99</b>	<b>245,46</b>	<b>253,26</b>

Source: analysis results

*3.4 Analysis of service level of non-PDAM water supply system*

Drinking water services in Bali are generally provided through PDAM drinking water services which are managed by the local government and non-PDAMs managed by the community in the form of rural drinking water services (Pamsimas). The current conditions for each Pamsimas in each sub-district are described as follows:

Pamsimas in each sub-district in Tabanan Regency has not yet reached a service level of 100%, where the highest service level is in Marga District, namely 54.68%, while the lowest service level is in Tabanan District, namely 8.35% and the average Pamsimas service level in Tabanan Regency by 21.41%, as shown in Table 5.

Table 5  
Level of non-PDAM water service Tabanan Regency current condition

No	DISTRICT	Number of Residents served by PAMDES ( Soul )	Number of Residents by District ( Soul )	Service Level ( % )
1	SELEMADEG	2.190	19.810	11,06
2	EAST SELEMADEG	5.655	21.660	26,11
3	WEST SELEMADEG	9.995	19.600	50,99
4	KERAMBITAN	7.242	39.360	18,40
5	TABANAN	6.323	75.680	8,35
6	KEDIRI	0	96.260	0,00
7	MARGA	23.150	42.340	54,68
8	BATURITI	7.559	48.970	15,44
9	PENEBEL	6.435	44.950	14,32
10	PUPUAN	5.794	39.370	14,72
	<b>TOTAL</b>	<b>74.343</b>	<b>448.000</b>	
	<b>AVERAGE</b>	Service Level of PAMDES Tabanan Regency		<b>21,41</b>

Source : Analysis result, 2021

Analysis of the level of non-PDAM clean water supply service projections for 2020 – 2040 as shown in Table 6.

Table 6  
Level of non-PDAM water service in Tabanan Regency Projection for 2020 – 2040

No	DISTRICT	Number of people served by PAMDES ( Soul )	Population ( Soul )					Service Level ( % )					
			Thn 2020	Thn 2025	Thn 2030	Thn 2035	Thn 2040	Thn 2020	Thn 2025	Thn 2030	Thn 2035	Thn 2040	
1	SELEMADEG	2.190	19.810	20.075	20.344	20.616	20.892	11,06	10,91	10,76	10,62	10,48	
2	EAST SELEMADEG	5.655	21.660	21.894	22.130	22.369	22.610	26,11	25,83	25,55	25,28	25,01	
3	WEST SELEMADEG	9.995	19.600	19.976	20.358	20.748	21.146	50,99	50,04	49,10	48,17	47,27	
4	KERAMBITAN	7.242	39.360	40.164	40.984	41.822	42.676	18,40	18,03	17,67	17,32	16,97	
5	TABANAN	6.323	75.680	78.261	80.931	83.691	86.546	8,35	8,08	7,81	7,56	7,31	
6	KEDIRI	0	96.260	102.631	109.424	116.666	124.387	0,00	0,00	0,00	0,00	0,00	
7	MARGA	23.150	42.340	43.291	44.264	45.258	46.275	54,68	53,48	52,30	51,15	50,03	
8	BATURITI	7.559	48.970	50.227	51.516	52.838	54.194	15,44	15,05	14,67	14,31	13,95	
9	PENEBEL	6.435	44.950	45.340	45.733	46.130	46.530	14,32	14,19	14,07	13,95	13,83	
10	PUPUAN	5.794	39.370	39.833	40.302	40.776	41.255	14,72	14,55	14,38	14,21	14,04	
	<b>TOTAL</b>	<b>74.343</b>	<b>448.000</b>										
	<b>Average</b>	PAMDES Service Level Tabanan Regency Projection Year 2020 - 2040					<b>21,41</b>	<b>21,01</b>	<b>20,63</b>	<b>20,26</b>	<b>19,89</b>		

Source : Analysis Result

### 3.5 Analysis of the level of reliability of non-PDAM clean water supply

The level of reliability is the percentage between the amount of potential water available compared to the use of existing water. The level of reliability of non-PDAM clean water supply in Tabanan Regency can now be seen from the potential and the distributed discharge (Aisopou et al., 2012; Vieira & Ramos, 2009). Rural communities in Tabanan Regency through Pamdes (Non-PDAM) still utilize water sources in the form of springs, where the potential availability of springs in Tabanan Regency is 1691.68 Lt/sec which is utilized by PDAM for 1618.52 Lt/s. The remaining water availability used by the community through Pamdes (Non-PDAM) is 73.16 Lt/sec. While the total water demand (domestic and non-domestic) for non-PDAM in Tabanan Regency, the existing condition is 224.00 Lt/sec, so that the reliability level of non-PDAM clean water supply in Tabanan Regency is 32.66%, while the reliability level of clean water supply is Non PDAMs in Tabanan Regency are projected for 2020 - 2040 as shown in Table 7 and Figure 2.



Table 7  
Level of reliability of provision of clean water non-PDAM Tabanan Regency projection year 2020 – 2040

No	District	Water availability (Lt/dtk)	Non-PDAM water needs (Lt/dtk)					Reliability Level (%)				
			2020	2025	2030	2035	2040	2020	2025	2030	2035	2040
1	Tabanan	73,16	224,00	230,85	237,99	245,46	253,26	32,66	31,69	30,74	29,81	28,89

Source: Analysis Results

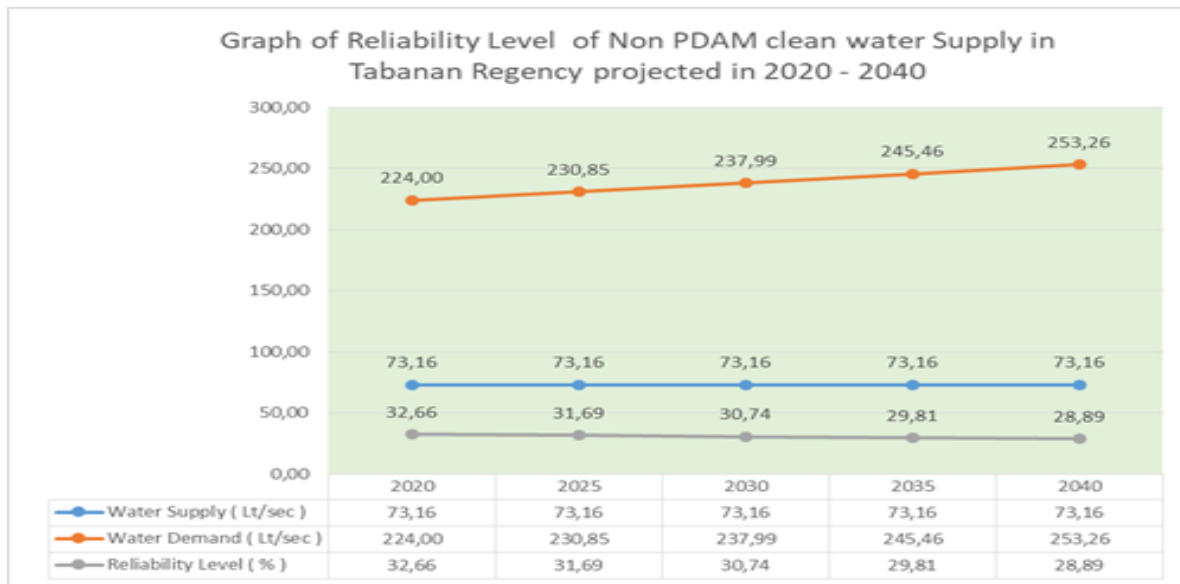


Figure 2. Graph of the projected level of reliability of water supply Non-PDAM Tabanan District

### 4 Conclusion

Based on the results of the field review and the study of the Non-PDAM Clean Water Supply System to Ensure the Reliability of the Clean Water Supply System in Tabanan Regency at the 70% progress report stage, the researchers can conclude as follows:

- 1) The amount of non-PDAM (Pamsimas) water availability in Tabanan Regency for current conditions by utilizing potential water sources from existing springs is 73.16 Lt/sec
- 2) The amount of Non-PDAM (Pamsimas) water demand in Tabanan Regency for the current condition is 224.00 Lt/sec, while the projected non-PDAM water demand in Tabanan Regency until 2040 is as follows, non-PDAM water needs in 2025 are 230.846 Lt /sec, in 2030 it is 237,993 Lt/s, in 2035 it is 245.457 Lt/s and in 2040 it is 253,256 Lt/s. Where is the non-PDAM (Pamsimas) clean water supply system in Tabanan Regency for the current condition, the service level has only reached 21.41%.
- 3) The service level of the non-PDAM clean water supply system (Pamsimas) in Tabanan Regency, the projections for 2020-2040 based on the number of people served are as follows, in 2025 it is 21.01%, in 2030 it is 20.63%, in 2035 it is 20 .26% and 19.89% in 2040.

For the level of reliability of non-PDAM clean water supply in Tabanan district based on water availability compared to the projected water demand in 2020-2040 it has decreased, where in 2025 it reaches 31.69%, in 2030 it reaches 30.74%, in 2035 it reaches 29.81%. and in 2040 it will reach 28.89%

*Conflict of interest statement*

The authors declared that they have no competing interest.

*Statement of authorship*

The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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