Optimization Of Availability Of Water Spring Debit For Customer In Kolhua Village, Maulafa District, Kupang City

Ramzy GGL Sayonara, Sutirto, Arnoldus Nama
{sayonararamzy@gmail.com, sutirtojatayu@gmail.com, n.arnold.Id@gmail.com}

Politeknik Negeri Kupang, Indonesia

Abstract. Water is a basic need that can support the activities of human life and all living things on earth.. Utilization of water is not only limited to household needs, but also for public, social, and economic facilities. The people of Kolhua Village consist of residents or people from Kolhua Village and the people from the Lopo Indah Permai shelter. Following the results of the analysis, the water discharge needed according to population growth in Kolhua Village, MaulafaSubdistrict, Kupang City is 12.56 liters / second with complete customer service of 6,679 people. An alternative solution to the problems if there is a lack of water discharge to meet the needs of drinking water service customers in Kolhua Village, MaulafaSubdistrict, Kupang City,is that PDAM Kupang in the coming year must add water debit from the spring with a spring discharge of 3.56 liters / second.

Keywords: Basic water needs, increasing water requirements, trapping surface water flow.

1. Intruduction

In the effort to supply clean water, a distribution network is essential because it provides water from production installations to consumers of freshwater, in this case, the community [1]. Regarding the increasing need for clean water in the future, it is necessary to have an excellent freshwater planning system and routine maintenance to ensure customer satisfaction/drinking water services [2].

In Kolhua Village, MaulafaSubdistrict, Kupang City, there is a very densely populated settlement which is increasing year by year and increasing. The people of Kolhua Village consist of residents or people from Kolhua Village and the people from the Lopo Indah Permai residential facilities. The Lopo Indah Permai residential facility was built since 1986 until now where the development of residential facilities is still ongoing. The drinking water facilities used are using water facilities from the Kupang District drinking water company. The source of the spring used comes from a spring in the village of Kolhua. Every year, there is an increase in population.

Following the problem described above, it is necessary to have a study on optimizing the availability of spring water discharges used by the needs of water services in Kolhua Village, Maulafa District, Kupang City.

The problem formulations in this research are:

1. How much water flow is needed in relation to population growth in Kolhua Village, Maulafa District, Kupang City?

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2. What is the alternative solution to the problem if there is a lack of water discharge to meet the needs of customers of drinking water services in Kolhua Village, Maulafa District, Kupang City?

2. Research Methodology

2.1 Research sites

The location of this research is in Kolhua Village, Maulafa District, Kupang City, East Nusa Tenggara Province, and is presented on the map below.

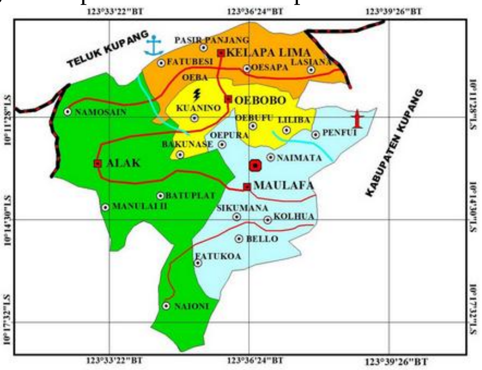

Fig. 1. Research Location

2.2 Flow Chart

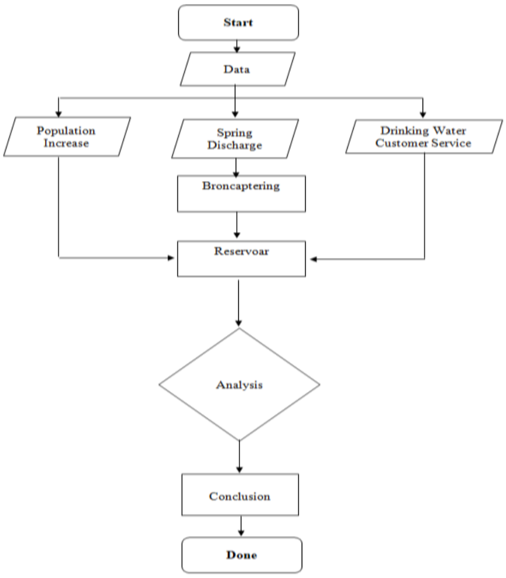

Fig. 2. Research Flow Chart

3. Results and Discussion

3.1 Calculation of Projection of Population

Arithmetic Method

Pn = Po + Ka (Tn – To). Ka = $\frac{P2-P1}{T2-T1}$

Calculation of Ka value (Arithmetic constant)

Planning Year 2020:

Ka = $\frac{P2-P1}{T2-T1} = \frac{P2010-P2010}{T2010-T2010} = \frac{6679-6679}{2010-2010} = \frac{0}{0} = 0{,}00$

Planning Year 2021 :

Ka = $\frac{P2-P1}{T2-T1} = \frac{P2011-P2010}{T2011-T2010} = \frac{6766-6679}{2011-2010} = \frac{87}{1} = 87$

Planning Year 2029:

Ka = $\frac{P2-P1}{T2-T1} = \frac{P2019-P2010}{T2019-T2010} = \frac{8394-6679}{2019-2010} = \frac{1715}{9}$

= 190.56

Obtained Arithmetic equation:

Planning Year 2020 :

Pn = P0 + Ka (T2– T1) . 2020 = P2010 + 0.00 (2020 - 2019)= 6,679 +0.00 (2020 -2019) = 6,679 +0.00 (1) = 6,679 people.

Planning Year 2021 :

Pn = P0 + Ka (T2-1) . 2021 = P2011 + 87 (2021 - 2019)

= 6,766 + 87 (2021 –2019) = 6,766 + 87 (2) = 6,940 people.

Planning Year 2029 :

Pn = P0 + Ka (T2 – T1) . 2029 = P2019 + 1 90 .56 (2029 - 2019)= 8.394 + 190.56 (2029 –2019) = 8.394 + 190.56 (10)= 10,299.6 people.

Further calculations can be seen in Table 1 below.

Table 1. Population Projection by the Arithmetic Method

No	Year	Ka (Arithmetic Constante)	Total Population
1	2010	0	6,679
2	2011	87	6,766
3	2012	131.5	6,942
4	2013	181	7,222
5	2014	200.75	7,482
6	2015	183	7,608
7	2016	176.83	7,774
8	2017	160	7,802
9	2018	193.12	8,262
10	2019	190.56	8,466

Source: Calculation Results, 2019

3.2 Geometric Method

Further calculations can be seen in Table 2 below.

Table 2. Population Projection by the Geometric Method

No	Year	I (Population Growth Rate)	Total Population
1	2010	0.0000	6,679
2	2011	0.0130	6,766
3	2012	0.0050	6,942
4	2013	0.0130	7,222
5	2014	0.0080	7,482
6	2015	0.0020	7,608
7	2016	0.0030	7,774
8	2017	0.0008	7,802
9	2018	0.0060	8,262
10	2019	0.0256	8,466

Source: Calculation Results, 2019

Leasts Square Method :
Y = a + Bx

Table 3. Population Projection by Least Square Method

Year	Year To (X)	Total Population (Y)	XY	X^2
2010	1	6.679	6.679	1
2011	2	6.766	13.532	4
2012	3	6.942	20.826	9
2013	4	7.222	28.888	16
2014	5	7.482	37.410	25
2015	6	7.594	45.564	36
2016	7	7.740	54.180	49
2017	8	7.799	62.392	64
2018	9	8.224	74.016	81
2019	10	8.394	83.940	100
Jumlah	ΣX = 55	ΣY = 74.842	ΣXY = 427.427	$\Sigma X^2 = 385$

Source : Calculation Results, 2019
Where:
Y = the value of the variable is based on the regression line
X = independent variable
a = Constant
b = coefficient of regression direction

Further calculations can be seen in Table 4 below.

Table 4. Leats Square Method

No	Year	a (Constante)	b (Linear Regression Coefficient)	Total Population (Soul)
1	2020	2.007,10	1.396,92	34.040
2	2021	2.349,78	1.445,00	41.752
3	2022	1.901,20	977,10	13.626
4	2023	2.394,10	1.047,50	16.011
5	2024	3.232,20	1.167,20	19.573
6	2025	4.972,50	1.415,80	26.209
7	2026	10.773,80	2.244,60	46.687
8	2027	6.464,30	8.529,20	20.963
9	2028	8.080,30	448,80	16.158
10	2029	64,22	279,56	6.531

Source: Calculation Results, 2019

According to the calculation results of the three methods above, all the results can be seen in table 5 below.

Table 5. Calculation of Population Using 3 Method

No	Year	Method		
		Aritmatic (Soul)	Geometric (Soul)	Least Square (Soul)
1	2020	6.679	6.679	34.040
2	2021	6.940	6.943	41.752
3	2022	7.336	7.011	13.626
4	2023	7.946	7.507	16.011
5	2024	8.486	7.721	19.573
6	2025	8.692	7.670	26.209
7	2026	8.978	7.880	46.687
8	2027	9.079	7.842	20.963
9	2028	9.962	8.626	16.158
10	2029	10.299	10.811	6.531

Source: Calculation Results, 2019

From the results of the recapitulation calculations in table 10above, the method used for the next calculation reference is the method that has greatest number of population projections, which is the Geometric method, where the total population projection in 2029 is 10,811 people

3.4 Calculation of Clean Water Needs

Domestic Water Needs (D)

Calculation of the domestic sector is a critical aspect in calculating future supply needs [3]. Calculation of the domestic sector for the future is carried out based on the estimate of population growth in the planned area. Based on the standard clean water requirements and clean water planning criteria listed in table 2.1. up to table 2.4. On pages 11-13 of Chapter II, the residents of Kolhua Urban Village are classified in the Small Town category with a population of 10.811 people and water use of 130 Lt /person/day and the population served is 80% of the total population.

Domestic Water Needs (D)
D = Pn x Pa x Tp
Where:
D = Domestic Water Needs (L / sec)
Pn = Number of Population (soul)
Pa = Use of Water = 1 3 0 liters / person / day (T abel 2)
Tp = Level of Services = 80% (Table 2 2 . P.1 3)

Domestic water needs are as follows:
Planning Year2020 :

D = 6679 x 130 x 0,80= 694616 liter/per day

$= \frac{694616 \text{ liter}}{24 \text{ x } 60 \text{ x } 60 \text{ second}}$=8,03953liter/second

= 0,00803953 m³/second

Planning Year2021 :

D = 6943 x 130 x 0,80

= 722072 liter/day

$= \frac{722072 \text{ liter}}{24 \text{ x } 60 \text{ x } 60 \text{ second}}$= 8,3573 liter/second

= 0,0083573 m³/second

Planning Year 2029 :

D = 10.811 x 130 x 0,80

= 1.124.344 liter/day

$= \frac{1124344 \text{ liter}}{24 \text{ x } 60 \text{ x } 60 \text{ second}}$

= 13,01324liter/second = 0,01301324 m³/second

So, the domestic water demand for the 2029 planned year is 13,01324 liters / second = 0.01301324 m ³ / second.

Non-Domestic Needs (ND)

Non-Domestic Needs are assumed to be 25% or 30% of domestic needs [4]. In this calculation 25% is used as follows:

ND = 25% x D

Planning Year2020 :

where:

ND = Non-Domestic Water Needs

D = Domestic Water Needs= 8,03953 liter/second

Non-domestic water needs as follows:

ND = 25% x D

= 0,25 x 8,03953 liter/second

= 2,00988 liter/second = 0,00200988 m³/second

Planning Year2021 :

where:

ND = Non-Domestic Water Needs

D = Domestic Water Needs = 8,3573 liter/second

Non-domestic water needs as follows:

ND = 25% x D

= 0,25 x 8,3573 liter/second

= 2,089325 liter/detik = 0,002089325 m³/second

Planning Year2029 :

where:

ND = Non-Domestic Water Needs

D = Domestic Water Needs= 13,01324 liter/second

Non-domestic water needs as follows:

ND = 25% x D

= 0,25 x 13,01324 liter/second

= 3,25331 liter/second = 0,00325331 m³/second

Therefore the demand for non-domestic water for the 2029 planning year is 3.25331 liter / second = 0.00325331 m ³ / second

Water Loss (Ka) and Total Water Needs (T)

Calculation of total needs is based on domestic, non-domestic water needs and water losses. Water loss is assumed to be 20% of total water requirements [5].

KA = 20% x T,Total needs (Q)= D + ND + KA

where:

KA = water loss. , Q= total needs.

Planning Year2020 :

Total water need as follows:

Q = D + ND + KA

= 8,03953liter/second + 2,00988 liter/second + 0,20 T

Q – 0,20 T= 8,03953 liter/second + 2,00988 liter/second

0,8 T= 10,049 liter/second

$Q = \frac{10{,}049 \text{ liter/second}}{0{,}8}$

= 12,56 liter/second = 0,01256 m³/second

Water loss (KA) as follow:

KA = 20 % x T

= 0,20 x 12,56 liter/second

= 2,512 liter/second = 0,002512 m³/second

Planning Year 2021 :

Total water need as follows:

Q = D + ND + KA

= 8,3573liter/second + 2,089325 liter/second + 0,20 T

Q – 0,20 T = 8,3573 liter/second + 2,089325 liter/second

0,8 Q = 10,44 liter/second

$Q = \frac{10{,}44 \text{ liter/second}}{0{,}8}$= 13,058 liter/second

= 0,013058 m³/second

Water loss (KA) as follows:

KA = 20 % x T

= 0,20 x 13,058 liter/second

= 2,6116 liter/second = 0,0026116 m³/second

Planning Year2029 :

Total water need as follows:

Q = D + ND + KA

= 13,0132liter/second + 3,25331 liter/second + 0,20 T

Q – 0,20 T= 13,0132 1liter/second + 3,25331 liter/second

0,8 Q = 16,266 liter/second

$Q = \frac{16{,}266 \text{ liter/second}}{0{,}8}$= 20,3325 liter/second

= 0,0203325 m³/second

Water loss (KA) as follow:

KA = 20% x T

= 0,20 x 20,3325 liter/second

= 4,0665 liter/second = 0,0040665 m³/second

The rest can be seen in Table 6 below.

Table 6. Analysis of Water Needs

No	Year	Total Population (Soul)	D (ltr/Secon)	D (m3/Secon)	ND (ltr/Secon)	ND (m3/Seconds)	KA (ltr/Secon)	KA (m3/Secon)	Q Total (ltr/Secon)	Q Total (m3/Secon)
1	2020	6,679	8.0395	0,0080395	2,00988	0,000200988	2,512	0,00251	12,56	0,0125
2	2021	6,943	8.3573	0,0083573	2,08932	0,00208932	2,611	0,00261	13,058	0,0130
3	2022	7,011	8.4391	0,0084391	2,10977	0,00210977	2,635	0,00263	13,175	0,0137
4	2023	7,507	9.0362	0,0090362	2,25905	0,00225905	2,835	0,00283	14,118	0,0141
5	2024	7,721	9.2937	0,0092937	2,23234	0,00223234	2,881	0,00288	14,407	0,0144
6	2025	7,670	9.2324	0,0092324	2,3081	0,0023081	2,885	0,00288	14,425	0,0144
7	2026	7,880	9.4851	0,0094851	2,3712	0,0023712	2,964	0,00296	14,82	0,0148
8	2027	7,842	9.4394	0,0094394	2,35985	0,00235985	2,949	0,00294	14,74	0,0147
9	2028	8,626	10.3831	0,0103831	2,58827	0,00258827	3,242	0,00324	16,23	0,0162
10	2029	10,811	13.0132	0,0130132	3,25331	0,00325331	4,066	0,00406	20,332	0,0203

Source: Calculation Results, 2019

From the calculations, clean water needs for the Kolhua village for the 2029 planned year are as follows:

a) Domestic Clean Water Needs = 13,0132 l / sec.
b) Non Domestic Domestic Water Needs
= 3.25331 l/ sec.
c) Loss of water = 4.0665 l / sec.
d) Total Water Needs (Q) = 20,3325 l / sec.

Table 7. Relationship between Total Q and Projected Number of Population for the Year 2020 to 2029

Year	Total Population (Soul)	Q Total (ltr/secon)
2020	6,679	12,56
2021	6,943	13,058
2022	7,011	13,175
2023	7,507	14,118
2024	7,721	14,407
2025	7,670	14,425
2026	7,880	14,82
2027	7,842	14,74
2028	8,626	16,23
2029	10,811	20,332

Source: Calculation Results, 2019

3.6 Dimensioning of the Reservoir

The reservoir is intended to accommodate the excess water produced when water usage is smaller than the flowing spring and provides water shortages when water usage is greater than the flowing spring water [6]. For a rural water supply system, the reservoir is calculated to hold water that is flowed from the spring for 12 hours [7]. This is because, at night, it is estimated that almost all residents in rural areas do not use water. Total discharge amount (Q total) needed for = 12.56 liters / sec. In order to obtain the total water requirements for consumers per day are:

T = 0.01256 m^3/second x 12 x 60 x 60
= 542,592 m^3/day

In planning this reservoir, 40% of the water needs are taken 24 hours (1 day).

Then the volume of water in the reservoir
= 40% x volume of water in 1 day
= 40% x 542,592 m 3 = 217.04

To accommodate the total water volume of 217.04 m 3 , the reservoir tank planning in Kolhua Village, Maulafa District, Kupang City uses a ratio of 2: 2: 1 (Table 1) which is as follows:

Reservoir tub length = 8 m
The width of the reservoir body = 8 m
Reservoir height = 4 m

So the reservoir volume is obtained:
V = PXLXT
= 8 mx 8 mx 4 m

Water Availability from the existing Springs and Reservoirs

The water discharge from Kolhua springs, whose water is taken by the PDAM to meet the needs of drinking water customer services in 2019, is = 9.00 liters/second (Measurement Results) .

In order to get the total water needs for consumers per day are:

T = 0.009 m 3 / sec x 12 x 60 x 60
= 388.80 m 3 / day

In planning this reservoir, 40% of the water needs are taken 24 hours (1 day).

Then the volume of water in the reservoir
= 40% x volume of water in 1 day
= 0.40 x 388.80 m 3 = 155.52 m 3

To accommodate the total water volume of 155.52 m^3, the reservoir basin planning in Kolhua Village, Maulafa District, Kupang City uses a ratio of 2: 2: 1 (Table 1) is as follows:

Reservoir tub length = 7 m
The width of the reservoir body = 7 m
Reservoir height = 3.5 m

So the reservoir volume is obtained:

V = P x L xT
= 7 mx 7 mx 3.5 m
V = 171.5 m 3 > 155.52 m 3 ...... (safe)

3.7 Requirements and Availability Analysis

Water needs to meet the drinking water customer service of Kupang PDAM in 2020 required debit = 12.56 liters / second with a population of 6,679 inhabitants with reservoir planning that is a building that is intended to accommodate the excess water produced when water usage is smaller than discharge springs that are drained and provide water shortages when water usage is greater than the flowing springs. The results of the calculation of reservoir building planning with length = 8 m, width = 8 m and height = 4 m with a storage volume of = 256 m 3. As for the availability of water from springs whose water is taken by the Kupang PDAM, the debit is = 9.00 liters / second to fulfill the water supply service (resident) of Kolhua Village. The calculation results of reservoir building planning to accommodate a total water volume of 155.52 m 3 , reservoir planning length = 7 m, width = 7 m and height = 3.50 m with a storage volume of = 171.50 m^3 .

From the results of the above calculation, Kupang PDAM in serving their customers experiences a shortage, where the total water needed according to the population of 6,679 people requires a spring flow of 12,56 liters / second. The availability of water discharges in the existing spring is of 9.00 liters / second. Accordingly, there is a lack of discharge of 3.56 liters / second.

The reservoir building is intended to be able to serve customers of drinking water services to accommodate excess water that will be flowed from springs for 12 hours at night with water debit of 12.56 liters / second with a total customer service of 6,679 people. 8 m, width = 8 m and height = 4 m can accommodate = 256 m 3. As for the results of identification of existing discharge conditions available at the spring is of 9.00 liters / sec. Calculation of reservoir building planning to accommodate a total water volume is of 155.52 m 3 , planning reservoir length length = 7 m, width = 7 m and height = 3 , 50 m with a storage volume of = 171.50 m 3 . In accordance with the existing conditions at the moment, the reservoir building will be able water that is accommodated in reservoirs from springs with a discharge of 155.52 m 3 and with the reservoir volume of 450 m 3 , water flowed with a turn system that flows on Tuesday and

Friday (4 x in 1 week). The results of the analysis that for Kupang PDAM to meet the service requirements of drinking water customers in 2020, they must add water debit from the spring with a spring discharge of 3.56 liters / second. The reservoir is enough to accommodate the excess water that will be flowed from the spring for 12 hours at night. With this service, 6,679 people will be served every day.

4. Conclusion

Based on the analysis results according to the discussion in Chapter V, the following conclusions can be drawn:

1. The required water discharge according to population growth in Kolhua Village, Maulafa District, Kupang City is 12.56 liters / second with complete customer service of 6,679 people.
2. An alternative solution to the problem of lack of water discharge to meet the needs of drinking water service customers in Kolhua Village, MaulafaSubdistrict, Kupang City PDAM Kupang in the coming year must add water debit from a spring with a spring discharge of 3.56 liters/second

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