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Articles

PDF

Sustainable Agricultural Practices and Environmental Stewardship: A Global Analysis of Farmer Adoption and Impact

Amruddin Amruddin, Yovita Yovita, Kuswarini Sulandjari, Evelin Anggelina Tanur, Liz Yanti Andriyani

595-603

PDF

Adapting to Digital Transformation: Challenges and Strategies for Traditional Businesses

Syamsuddin Syamsuddin, Sugeng Marsudi, Bakri Hasanuddin, Akmal Umar, Degdo Suprayitno

704-711

PDF

Quality of Life of Chronic Renal Failure Patients Undergoing Hemodialysis During Post Covid 19 Pandemic

Sofiana Nurchayati, Hafizah Che Hassan, Santhna Letchmi Panduragan, Tukimin bin Sansuwito

577-584

PDF

Digital Privacy Rights in the Age of Big Data: Balancing Security and Civil Liberties

Tamaulina Br. Sembiring, Fransisca Ully Marshinta, RM. Armaya Mangkunegara, Ichwani Siti Utami, Hendrikus Haipon

712-720

PDF

Pterocarpus Erinaceus Leaf Extracts Phytochemical Composition And Its Effect On Growth Performance And Intestinal Microbial Population of Weaned Rabbits

Alagbe Olujimi John

585-598

PDF

Implementation of Inclusive Education in Regular Schools

Wiwi Purnama Dewi, Sudadio Sudadio, Fadlullah Fadlullah

624-638

PDF

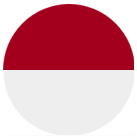
Analysis of The Need and Availability of Clean Water in The Karo Regency Area

Wati Asriningsih Pranoto, Oei Fuk Jin, Kezia Demelia Khovi Br Tarigan

652-665

PDF

 Canada (284)

 Indonesia (183)

 China (173)

 East Timor (231)

 Nigeria (111)

 Philippines (63)

 Vietnam (44)

 Australia (26)

 Malaysia (16)

 Brunei (31)

 United Kingdom (11)

 South Africa (18)

Menu

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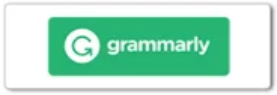
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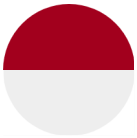 Indonesia	(183)
 China	(173)
 East Timor	(231)
 Nigeria	(111)
 Philippines	(63)
 Vietnam	(44)
 Australia	(26)
 Malaysia	(16)
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Analysis of The Need and Availability of Clean Water in The Karo Regency Area

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Access to clean water is a fundamental and sustainable necessity for the well-being of human beings, requiring consistent provision. Given the ongoing population growth in Karo Regency, especially in terms of the use of clean water, a significant increase in demand for clean water is anticipated in the coming years. This research aims to understand the demand and availability of clean water required by the community in Karo Regency until the year 2033. The study involves an analysis of the demand for clean water at the PDAM Tirta Malem unit in Karo Regency, using data such as population figures from the last decade, the number of customers over the past ten years, and information on the water needs of the population in Karo Regency. The research findings indicate that the projected increase in the number of customers in Karo Regency will result in a demand for 212,644.7 liters per second of clean water in the service area. However, it is anticipated that the existing sources of clean water will be sufficient to meet this demand by the year 2033. This statement is supported by the total demand for clean water based on projections for various types of customers in the service area of Karo Regency in 2033, which is 212,644.7 liters per second, still within the total availability of water that can be produced by the existing springs, which is 373 liters per second

1. Introduction

The availability of water is crucial in human daily life, encompassing activities such as consumption, sanitation, and other domestic needs. In the Karo Regency, particularly in the city of Kabanjahe as the regional administrative center, the demand for water is increasing steadily due to ongoing population growth. However, local communities may not always have the capacity to adequately process water to meet their daily needs. Therefore, the government, through the Regional Water Supply Utility (PDAM), plays a role in providing access to clean water. In this context, it is necessary to conduct an analysis of water availability projections for the next 10 years to assess whether the current capacity remains sufficient. Water availability analysis is essential hydrological information for the development and management of water resources, as stipulated in Government Regulation No. 121 of 2015 concerning water resources utilization. The Regional Water Supply Utility (PDAM) operating in the Karo Regency is PDAM Tirta Malem, which serves seven Subdistrict Capitals (IKK). All raw water sources utilized originate from springs located in several areas of the Karo Regency, involving the Subdistricts of Kabanjahe, Juhar, Tigapanah, Kutabuluh, Barusjahe, Munte, and Tigabinanga. According to the 2019 data from PDAM Tirta Malem, the total intake from raw water sources is approximately 242 liters per second. PDAM Tirta Malem utilizes water sources from the Lau Peceran River, Lau Berneh River, Lau Melas River, Lau Bengap River, and Aek Bolon River. By the end of 2021, the service coverage reached a new high of 80% of the total population of the Karo Regency, as reported by PDAM Tirta Malem. With reference to the provided information, the objective of this study is to estimate the demand for and availability of clean water in the Karo Regency for the coming decade. The rapid population growth expected in the upcoming years has the potential to influence an increased demand for clean water. There is a possibility that the current water resources will not be sufficient to meet the continuously growing demand, thus necessitating further research. This study is expected to provide insights into efforts to meet the demand for clean water in the Karo Regency over the next 10 years.

Based on the background, this journal will identify problemsuch as:

1. Estimation of the total demand for and availability of clean water in the Karo Regency area at present.
2. Coverage of PDAM services regarding water demand in the Karo Regency at present.
3. Coverage of PDAM services regarding water demand in the Karo Regency for the next 10 years.

Based on the problem identification, the objective of this journal research is to:

1. To ascertain the availability of water in the Karo Regency area.
2. To determine the total demand for clean water in the Karo Regency area for the next 10 years.
3. To analyze whether the water sources can meet the water demand in the service area of the Karo Regency until the year 2033.

1.1 Clean water

Clean water is water that does not contain contaminants that may endanger human health. In other words, clean water refers to water used for daily purposes and can be used as drinking water after undergoing the process of boiling. [1]

1.2 Water source

Water sources refer to the location or origin from which water is obtained. This can encompass various sources such as rivers, lakes, springs, wells, snow, rain, and others, which provide a water supply for meeting the needs of humans, animals, and plants. Water sources are highly significant in the context of environmental sustainability and fulfilling daily life requirements. The sustainability of water resource utilization is a primary focus to ensure that water resources can be sustained and managed wisely for the present and future generations. [2]

1.3 Water needs

The need for clean water refers to the human requirement for water that is clean and safe for consumption, as well as for use in daily activities. The need for clean water encompasses various necessities such as consumption, sanitation, industrial needs, and environmental preservation. [3]

1.4 Water availability

The availability of water refers to the quantity and quality of water that is accessible to meet the needs of humans and ecosystems in a particular region or location. Water availability is a key factor in sustainability and human well-being, and it has direct impacts on agriculture, industry, health, and ecosystems. [4]

1.5 The theory of population estimation

Population projection is the determination of estimated population figures for several upcoming years, in accordance with the desired planning period. The required data include both the population figures and the percentage increase in the population obtained from the analysis of population data over the past 10 years, as well as the average population increase over the past 10 years. There are three formulas used to determine population projection: arithmetic, geometric, and linear regression methods. The criterion for selecting one of these methods is by using the Standard Deviation (SD) formula. The standard deviation should be the smallest, as a smaller standard deviation value indicates that the data obtained from the projection is not significantly different from the original data.

1.6 The theory of clean water needs

In accordance with the Millennium Development Goals (MDG), guidelines that need to be considered, besides population projection, in predicting the quantity of clean water needed include the level of community services, household connection services, indirect connections (public taps), clean water consumption, water loss, analysis of PDAM water needs, analysis of maximum daily needs, and analysis of water usage during peak hours.

2. Research Method

1. Literature Review

The author conducted a literature review through journals and books.

2. Problem Identification, Formulation of Problems, and Objectives

The current need for and availability of clean water in the Karo Regency area, as well as its prediction for the next 10 years

3. Field Observation

Sampling of necessary data was carried out in the field for the preparation of research results.

4. Analysis Using Data Processing Methods

To determine whether water sources can meet the water demand in the service area of the Karo Regency until the year 2033.

5. Discussion of Analysis Results

Using arithmetic calculation analysis method

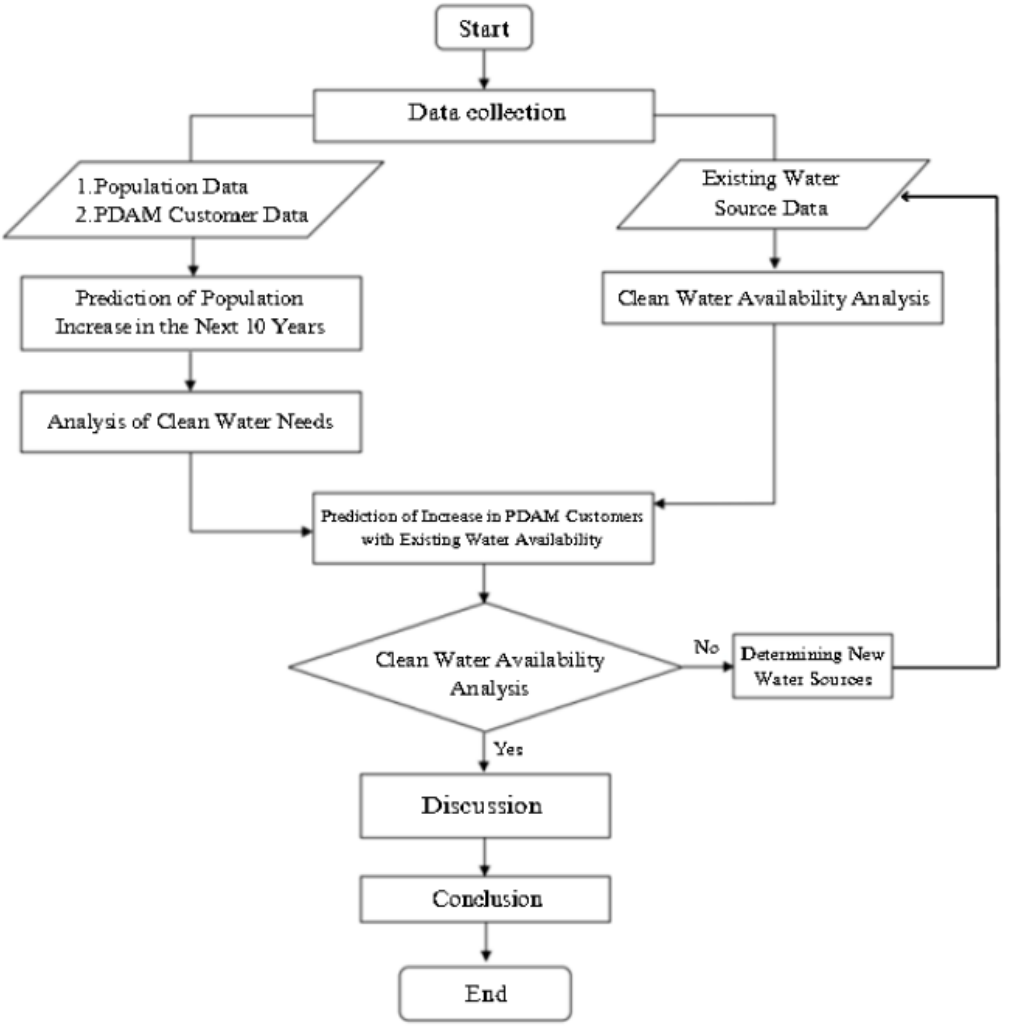

Fig. 1. Research flow diagram.

3. Result and Discussion

Hasil 3.1 Population data

Data was obtained through field observations as well as databases held by the Karo Regency Local Government and PDAM Tirta Malem. Data sampling was conducted from June to August 2023. The population data over the last 10 years is as follows:

Table 1. Population data for 7 districts.

District Area	Population									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Kabanjahe	63.918	64.746	65.635	70.890	72.246	73.479	74.704	75.899	77.052	77.052
Juhar	13.368	13.540	13.726	13.877	14.090	14.384	14.623	14.858	15.083	15.368
Tigapanah	29.593	29.976	30.388	32.500	33.207	33.687	34.249	34.799	35.325	35.133
Kutabuluh	10.685	10.823	10.972	11.124	11.327	11.531	11.723	11.911	12.091	12.802
Barusjahe	22.304	22.593	22.904	23.010	23.515	23.850	24.247	24.636	25.009	25.203
Munte	19.870	20.127	20.404	20.672	20.949	21.428	21.785	22.135	22.469	23.358

Tigabinanga	20.086	20.346	20.626	21.329	21.763	22.108	22.476	22.836	23.183	22.634

3.2 Total population growth

The analysis of population growth will utilize improved data obtained from population samples over the past decade from villages or neighborhoods within the service area of PDAM Tirta Malem. This analysis will be conducted using arithmetic formulas, which will then be projected until the year 2033. Data processing will be carried out utilizing the following formulas :

$$Pn = Po\ (1 + r)^n \quad (1)$$

With Pn = Population in year n projection, Po = Population at the beginning of the projection, r = Average population growth per year, and n = Time (years).

Below is a graph showing the percentage of population growth in the districts of Kabanjahe, Juhar, Tigapanah, Kutabuluh, Barusjahe, Munte, and Tigabinanga. The data has been adjusted due to outliers that rendered the original data inconsistent, prompting calculations to obtain more consistent adjusted data.

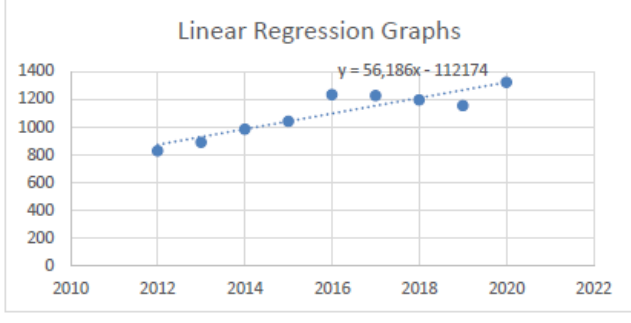

Fig. 2. Chart of population growth improvement for Kabanjahe District.

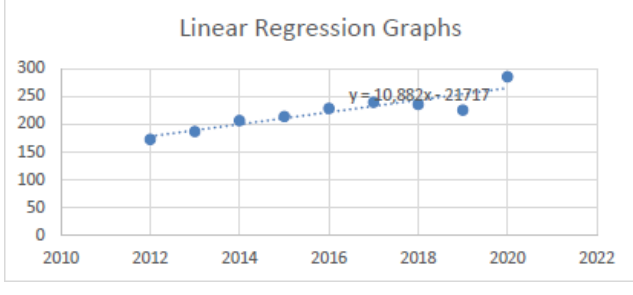

Fig. 3. Chart of population growth improvement for Juhar District.

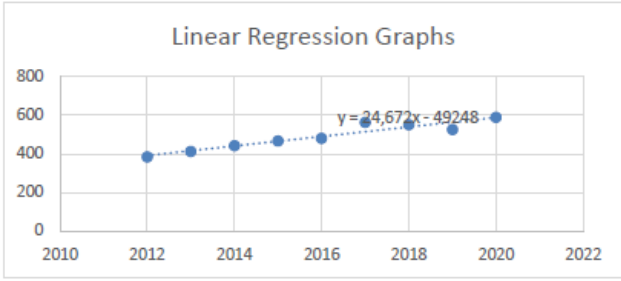

Fig. 4. Chart of population growth improvement for Tigapanah District.

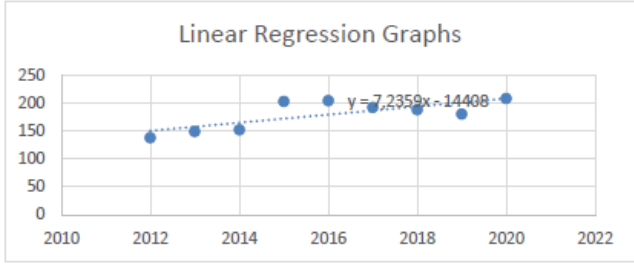

Fig. 5. Chart of population growth improvement for Kutabuluh District.

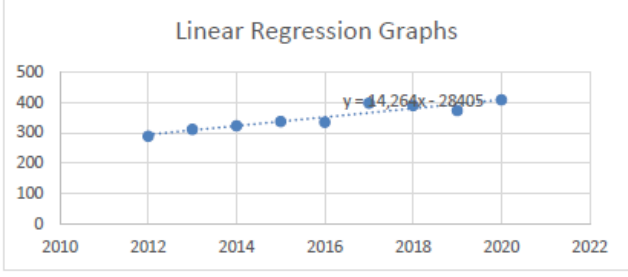

Fig. 6. Chart of population growth improvement for Barusjahe District.

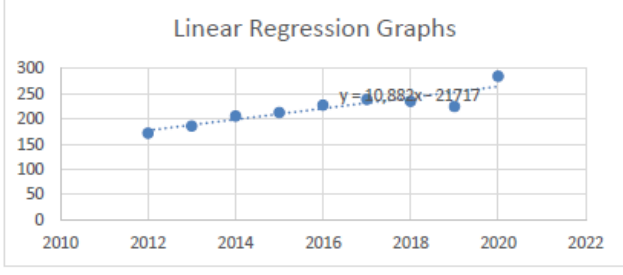

Fig. 7. Chart of population growth improvement for Munte District.

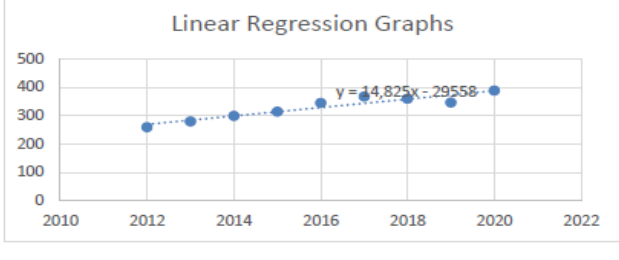

Fig. 8. Chart of population growth improvement for Tigabinanga District.

Based on the population increase data shown in the graph above, a calculation analysis was carried out to obtain predictions of population increase in the 7 sub-districts as follows:

Table 2. Prediction of population increase in Karo Regency.

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
2020	73785	15357	34002	12299	25466	22670	23048	2020	73785
2021	75203	15641	34633	12530	25915	23068	23471	2021	75203
2022	76621	15925	35263	12762	26364	23465	23894	2022	76621
2023	78039	16210	35894	12993	26813	23863	24317	2023	78039
2024	79457	16494	36524	13224	27262	24260	24740	2024	79457
2025	80875	16778	37155	13455	27712	24658	25163	2025	80875
2026	82293	17063	37785	13686	28161	25055	25586	2026	82293
2027	83711	17347	38415	13918	28610	25453	26009	2027	83711
2028	85129	17631	39046	14149	29059	25850	26432	2028	85129
2029	86547	17916	39676	14380	29508	26248	26855	2029	86547
2030	87965	18200	40307	14611	29957	26645	27278	2030	87965
2031	89383	18484	40937	14843	30406	27043	27701	2031	89383
2032	90801	18769	41568	15074	30855	27440	28124	2032	90801
2033	92219	19053	42198	15305	31304	27837	28547	2033	92219

3.3 Clean Water Needs Based on PDAM Customer Data

The estimated need for clean water for 2033 will be calculated by referring to the projected population growth and increase in the number of customers in the service area. A comparison between the results of projected population growth and the increase in the number of customers served will produce two different sets of input data. This information can be an important consideration in designing a strategic plan. Projections of clean water needs for the 2033 planning year, based on various categories of PDAM customers in Kabanjahe District, can be seen in the table presented below:

Table 3. Prediction of water needs for Kabanjahe District.

No	Data	Needs (Liter/second)
1	Domestic	79,564
2	Non-Domestic	40,328
3	Social	10,009
4	Goverment	1,5000
5	Water Lost	32,8502
Total Needs		164,2512

The predicted need for clean water in the Kabanjahe service area in 2033, based on predicted customer growth, includes a need of 164.2512 liters per second, a maximum daily need of 180.6763 liters per second, and a peak discharge of 246.3768 liters per second.

Predictions of clean water needs for Juhar District for the 2033 planning year can be seen in the following table:

Table 4. Prediction of water needs for Juhar District.

No	Data	Needs (Liter/second)
1	Domestic	4,0680
2	Non-Domestic	1,0278
3	Social	4,8319
4	Goverment	0,0000
5	Water Lost	2,4819
Total Needs		12,4096

Based on growth projections for various types of customers, the need for clean water in the Juhar service area in 2033 is estimated to reach 12.4096 liters per second. Maximum daily demand is projected to be around 13.6506 liters per second, while peak flow is anticipated to reach 18.6144 liters per second.

Predictions of clean water needs for Tigapanah District for the 2033 planning year can be seen in the following table:

Table 5. Prediction of water needs for Tigapanah District.

No	Data	Needs (Liter/second)
1	Domestic	10,5135
2	Non-Domestic	2,9677
3	Social	8,0861
4	Goverment	0,0000
5	Water Lost	5,3918
Total Needs		26,9592

The predicted need for clean water in the Tigapanah service area in 2033, based on growth in customer types, is estimated to reach 26.9592 liters per second, with a maximum daily need of around 29.6551 liters per second, and

peak discharge reaching 40.4388 liters per second.

Predictions of clean water needs for Kutabuluh District for the 2033 planning year can be seen in the following table:

Table 6. Prediction of water needs for Kutabuluh District.

No	Data	Needs (Liter/second)
1	Domestic	4,4936
2	Non-Domestic	0,3375
3	Social	4,1910
4	Goverment	0,0000
5	Water Lost	2,2555
Total Needs		11,2775

Based on predictions of growth in customer types, clean water demand in the Kutabuluh service area in 2033 is estimated to reach 11.2775 liters per second, with a maximum daily demand of around 12.4053 liters per second, and peak discharge reaching 16.9163 liters per second.

Predictions of clean water needs for Barusjahe District for the 2033 planning year can be seen in the following table:

Table 7. Prediction of water needs for Barusjahe District.

No	Data	Needs (Liter/second)
1	Domestic	7,2707
2	Non-Domestic	2,2174
3	Social	6,6069
4	Goverment	0,0000
5	Water Lost	4,0238
Total Needs		20,1188

Referring to the predicted growth in customer types, the need for clean water in the Barusjahe service area in 2033 is estimated to reach 20.1188 liters per second. The maximum daily demand is projected to be around 22.1307 liters per second, while the flow at peak hours is estimated to reach 30.1782 liters per second.

Predictions of clean water needs for Munte District for the 2033 planning year can be seen in the following table:

Table 8. Prediction of water needs for Munte District.

No	Data	Needs (Liter/second)
1	Domestic	2,9462
2	Non-Domestic	0,8813
3	Social	5,2264
4	Goverment	0,0000
5	Water Lost	2,2634
Total Needs		11,3172

According to the projected growth in customer types, it is estimated that the need for clean water in the Munte service area in 2033 will reach 11.3172 liters per second. Maximum daily demand is anticipated to be around 12.4490 liters per second, while peak hour discharge is predicted to reach 16.9759 liters per second.

Predictions of clean water needs for Tigabinanga District for the year 2033 can be seen in the following table:

Table 9. Prediction of water needs for Tigabinanga District.

No	Data	Needs (Liter/second)
1	Domestic	7,8333
2	Non-Domestic	2,2222
3	Social	5,5222
4	Goverment	0,0000
5	Water Lost	3,8944
Total Needs		19,4722

Based on predictions of growth in customer types, the need for clean water in the Tigabinanga service area in 2033 is estimated to reach 19.4722 liters per second. Maximum daily demand is estimated to be around 21.4194 liters per second, while peak hour discharge is predicted to reach 29.2083 liters per second.

The following graph predicts water needs in Karo Regency:

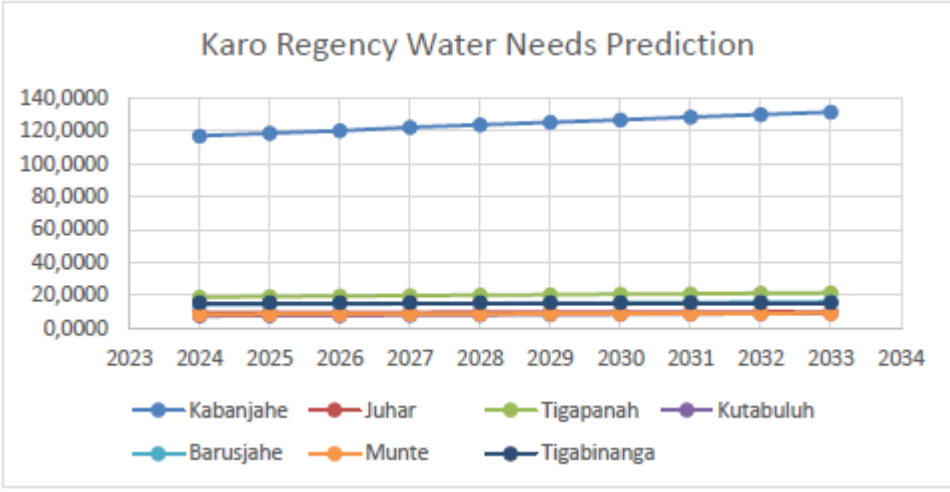

Fig. 8. Karo Regency Clean Water Needs Graph..

10.4 Analysis results

Based on the evaluation of the predicted results of clean water needs in 2033 using the 80% service coverage method, and assuming the number of villages/sub-districts served is constant, the need for clean water in the service area in that year is in line with the projected increase in the number of customers for the seven sub-districts. which are included in PDAM Tirta Malem services, can be described as follows:

Table 10. Prediction of Water Needs for Tigabinanga District

No	District Area	Water Needs	Intake	Water Productions (L/sec.)
1	Kabanjahe	131,4010	Lau Berneh	255
2	Juhar	9,9277	Lau Nageri	9
3	Tigapanah	21,5674	Lau Melas Tirtanadi, Lau Riman I	50
4	Kutabuluh	9,0220	Lau Pagar Besi	10
5	Barusjahe	16,0951	Lau Badigulen	14
6	Munte	9,0538	Gunung Manumpak I	10
7	Tigabinanga	15,5778	Lau Namo Suro	25

Based on a comparison between current water needs and availability, it can be concluded that the number of available water sources is still sufficient to meet predicted needs in the next 10 years, but for certain sub-districts where this is no longer sufficient, new water sources are needed.

4. Conclusion

The conclusions drawn by researchers are:

1. From the results of the analysis that has been carried out, it can be concluded that the need for clean water is based on an increase in the number of customers in the Karo Regency area, including Kabanjahe District, Juhar District, Munte District, Kutabuluh District, Tigapanah District, Barusjahe District, and Tigabinanga District for a 10 year projection going forward is documented in the following table:

Table 11. Data on clean water needs for Karo Regency.

No	District Area	Water Needs
1	Kabanjahe	20,04373
2	Juhar	1,068208
3	Tigapanah	2,715623
4	Kutabuluh	1,172002
5	Barusjahe	1,889301
6	Munte	0,794265
7	Tigabinanga	2,024306

2. From the results of the evaluation carried out, it can be concluded that data regarding water availability from each spring in the service area of the seven sub-districts covered for the next 10 year projection is presented in the following table:

Table 12. Data on clean water needs for Karo Regency.

No	District Area	Water Needs	Intake	Water Productions (L/sec.)
1	Kabanjahe	Lau Berneh	40	1
2	Juhar	Lau Nageri	5	2
3	Tigapanah	Lau Melas Tirtanadi, Lau Riman I	50	3
4	Kutabuluh	Lau Pagar Besi	5	4
5	Barusjahe	Lau Badigulen	10	5
6	Munte	Gunung Manumpak I	10	6
7	Tigabinanga	Lau Namo Suro	5	7

3. Based on the evaluation of the predicted results of clean water needs and the projected increase in the number of customers in the seven sub-districts served by PDAM Tirta Malem, it can be concluded that the availability of water sources for Kabanjahe District, Tigapanah District, Kutabuluh District, Munte District and Tigabinanga District is currently still adequate to meet projected water needs in the next 10 years. For Juhar District and Barusjahe District, the existing springs will no longer be able to meet existing water needs for the next 10 years, so new springs are needed.

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