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Analysis of Drinking Water Needs on the Availability of Krueng Buloh River Discharge in Lhokseumawe City

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Abstract: The objective of this study is to assess the accessibility of water from the Krueng Buloh River for fulfilling the potable water requirements of Lhokseumawe City. This study utilizes a quantitative research approach and leverages structural equation modeling (SEM) for analysis. The population and sample for this study consist of residents from the Blang Mangat, Muara Dua, Muara Satu, and Banda Sakti districts, spanning the years 2009 to 2019. The research findings indicate that the presence of water resources, particularly from the Krueng Buloh River, significantly contributes to fulfilling the clean water requirements of Lhokseumawe City. The analysis of water demand discharge emphasizes the significance of factors such as population growth and socio-economic conditions in affecting the overall water demand in the region. The Real Demand Survey (RDS) is undertaken to acquire insight into the daily water usage patterns and preferences of city inhabitants. This survey helps understand current water consumption trends and the expectations of consumers about clean drinking water services provided by local utility companies. While the Krueng Buloh River holds potential as a water source for the needs of Lhokseumawe City, it is crucial to implement efficient measures for managing the river in order to guarantee consistent access to clean water for the city's expanding population. This study highlights the significance of implementing integrated water resource management strategies to fulfill the water requirements of urban areas, specifically Lhokseumawe City, both presently and in the future.

Key words: Analysis, water needs, river discharge

1. Introduction

Lhokseumawe City, which is the second largest city in Aceh Province after Banda Aceh City, consists of four sub-districts, namely Banda Sakti, Muara Satu, Muara Dua, and Blang Mangat, with a population reaching 181,713 people in 2020, according to the Lhokseumawe Central Statistics Agency in 2021. One of the crucial needs in urban areas is the availability of clean water, both for household needs and as drinking water. PDAM Ie Beusaree Rata Lhokseumawe established itself through a regional government regulation called Qanun is the name in Aceh Province which means Regional Regulations in Indonesia country, Number 04 of 2011 and started operating in 2012. However, until 2017, PDAM Ie Beusaree Rata's service coverage only reached 31.72% of service achievements. 100% only serves one sub-district, namely Muara Satu District. Meanwhile, three other sub-districts, including Muara Dua, Banda Sakti, and Blang Mangat, are still served by PDAM Tirta Mon Pasee, which is owned by the North Aceh Regency Government. PDAM Ie Beusare continues to strive to improve its services and customer numbers in accordance with its duties and functions. However, to date, the Lhokseumawe City Government has not succeeded in achieving this target because it is hampered by a lack of adequate raw water sources. Continuing efforts to increase access to clean water are an important priority for the Lhokseumawe City Government.

In an effort to increase access to clean water, the Lhokseumawe City Government needs to take strategic steps. First and foremost, it is necessary to increase PDAM Ie Beusaree Rata's infrastructure capacity, which includes increasing the number of water distribution channels and providing adequate water storage facilities. Apart from that, it is important to diversify water sources by utilizing alternative water sources such as small rivers, wells, and springs around the city. This step will help to reduce pressure on the main water source and increase the water supply's reliability. Apart from infrastructure, the Lhokseumawe City Government also needs to improve the management and maintenance of the existing water distribution system. This includes regular water quality monitoring, leaky pipe system repair, and increased water use efficiency. Improving training for PDAM officers and raising public awareness about the importance of sustainable water management is essential.

The drinking water needs of the city of Lhokseumawe have been served by the drinking water company owned by North Aceh Regency, the Regional Drinking Water Company (PDAM), Tirta Mon Pasee, which has raw water sources in North Aceh Regency. In 2023, the service will be stopped and handed over to PDAM. the Krueng Buloh river. Rivers as a source of raw water are very rare in Lhokseumawe; rivers that meet the requirements are generally located in North Aceh Regency. Although the need for clean water is closely related to location, type of water source, and system size, which can be used to estimate drinking water supply, it greatly influences services (Samadi dkk., 2022; K. Sari & Sulaeman, 2020). Currently, PDAM Ie Beusaree Rata, in serving drinking water to the community, can only use raw water sources purchased from PT. Perta Arun Gas (PAG), with an average of 7.5 liters per second. To meet the need for clean water, one source of raw water that can be utilized is the Krueng Buloh River, which is located in Blang Mangat District. Therefore, this research intends to analyze the availability of water in the Krueng Buloh River as a source of raw water to meet the drinking water needs of the people of Lhokseumawe City. The novelty of this research is the polder design created in a river flow to meet drinking water needs. This study aims to analyze water needs in terms of Buloh river discharge availability in Lhokseumawe City.

The need for drinking water in Lhokseumawe City has now become a major concern, especially with the transition of services from PDAM Tirta Mon Pasee to PDAM Kota Lhokseumawe, which is scheduled for 2023. In Aceh Regency North, PDAM Tirta Mon Pasee, which previously served this city, has raw water sources. However, the decision to stop services from PDAM Tirta Mon Pasee brings new challenges, considering that Lhokseumawe city only has a limited source of raw water, namely the Krueng Buloh river. The availability of rivers as a source of raw water is very important because location, type of water source, and size of the system affect the supply of drinking water that can be produced. Currently, PDAM Ie Beusaree Rata can only rely on raw water sources from PT. Perta Arun Gas (PAG), with an average capacity of 7.5 liters per second.

To overcome this challenge, one option is to utilize the river Krueng Buloh as an additional source of raw water. However, this requires a comprehensive analysis of the water availability in the river. This research aims to carry out this analysis with a focus on understanding the water needs and availability of Buloh river discharge in Lhokseumawe City. One of the innovative aspects of this research is the proposed polder design to increase water availability in river flows so that it can meet the community's drinking water needs more efficiently. All of these efforts must be carried out in a sustainable manner and integrated with various related parties, including local communities, non-governmental organizations, and the private sector. With solid cooperation and strong commitment, the Lhokseumawe City Government can achieve its goal of providing sufficient access to clean water for its entire population, supporting sustainable growth and development in the future.

Researchers need to carefully consider the findings from previous studies. Previous studies may have identified factors influencing water availability in the region, evaluated potential alternative water sources, or proposed effective water management strategies. This research can enrich the analysis and optimize the implementation of the proposed solution by utilizing previous findings. Furthermore, considering previous research results can help avoid duplication of efforts, speed up the decision-making process, and increase the efficient use of available resources. Therefore, this research will serve as a logical continuation of previous efforts, with the aim of making a greater contribution to solving the water availability problem in Lhokseumawe City.

Thus, this study has objectives that are highly relevant to the practical needs of cities in ensuring adequate drinking water supplies for their residents. This research aims to provide valuable insights and sustainable solutions for water management in Lhokseumawe City, serving as a foundation for making appropriate decisions in future water resource management. Furthermore, researchers need to delve deeper into the hydrological conditions and potential water sources in the Lhokseumawe region. This research can help identify innovative solutions to overcome future water availability challenges, including the development of environmentally friendly and sustainable water treatment technology. Based on the explanation above, researchers are interested in conducting research with the title Analysis of Drinking Water Needs on the Availability of Discharge from the Krueng Buloh River in Lhokseumawe City.

2. Methods

This research employs a quantitative research method. This research uses primary and secondary data. Researchers obtained primary data by directly surveying the field for river geometry measurements, water speed, Real Needs Survey (RDS) data collected through questionnaires or community interviews, rainfall data, climatology data, etc. [1]–[3]. PDAM, le Beusaree Rata, and Lhokseumawe City Government provided the secondary data. For data analysis, researchers used SEM analysis. Real Demand Survey data derived from the questionnaire and the number of respondents is calculated based on the Slovin formula [4]. The sample size of a population is as follows:

$$n = \frac{N}{N.d^2 + 1} \quad (1)$$

where: n is samples; N is Population and d is margin error

The water requirement is determined by analyzing population data and comparing it with water availability which is calculated based on rain data with hydrological analysis [5]. Domestic and non-domestic water needs are calculated using the equation:

$$Q_{hm} = F_{hm} \cdot Q_m \quad (2)$$

$$Q_{jm} = F_{jm} \cdot Q_m \quad (3)$$

Where

Q m = Daily average water requirement

Q *h*m = Maximum daily water requirement

*F h*m = Maximum daily factor, ranging from 115 –120%.

Q jm = Maximum hourly water requirement

F jm = Maximum hour factor, ranging from 175–210%.

Level of water demand from year to year until the 2050 forecasting is analyzed based on regional zones and calculated using the following components [6]:

1. Water needs for households (Domestic), namely the supply of raw water for household purposes is calculated based on the projected population using the method:

a. Arithmetic Method

$$P_n = P_0 + K_a(T_n - T_0) \quad (4)$$

$$K_a = \frac{P_2 - P_1}{T_2 - T_1} \quad (5)$$

where: P_n is the population in the n_{th} year, Po is the population in the initial year, Tn is the n_{th} year, to is the initial year, Ka is the arithmetic constant, P_1 is the number of inhabitants in the year I, P_2 is the number of residents in the year II, T_1 is known year I and T_2 is known year II

b. Geometric Method

$$P_n = P_0 + (1+r)^n \quad (6)$$

Where: Pn is the population in the nth year, Po is the population in the initial year, r is the average percentage increase per year (%) and n is the projection period.

c. Least Square Method

$$P_n = a + (bxn) \quad (7)$$

Where: Pn is the population in the nth year, n is the difference in years calculated from the initial year, a, b are constants, which are calculated by the formula:

$$a = \frac{(\sum y)(\sum x2) - (\sum x)(\sum y)}{n(\sum x2) - (\sum x)2} \quad (8)$$

$$\sum b = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x2) - (\sum x)2} \quad (9)$$

Determination of the method used in population projections is done by calculating the standard deviation of each method using the following formula [7]

$$S = \sqrt{\frac{\sum(y_i + \bar{y})^2}{n}} \quad (10)$$

where n < 20

After calculating the standard deviation of the three methods, the method that will be used in the calculation of population projections will be chosen, namely, the method that has the smallest standard deviation value.

2. Water needs for non-domestic purposes are calculated at 20% of domestic needs [8].

3. Loss of water is estimated to be constant from the beginning to the end of the design year and is assumed to be 20% of the population's average clean water requirement [9].

4. Fluctuations in the use of clean water, using the Cipta Karya Standard [10], are:

Maximum day = 1.15daily average water requirement

Peak hours = 1.75 daily average water requirement

Water balance is a balance between water demand and water availability or often called water balance. To maintain this balance, it is necessary to engineer water sources while maintaining environmental conditions [11]. Engineering treatment of water sources can be carried out with the concept of hydraulics such as river hydraulics so that the balance of the water system can be maintained [12].

To determine the area's discharge, a hydrological analysis was carried out based on 37 years of rainfall data as shown in Table 1.

Table 1. Rainfall data at the Krueng Buluh river basin area

No	Year	Jan	Feb	Marc	Apr	May	June	July	August	Sept	Oct	Nov	Dec
1	1984	0	0	0	0	190	27	75	64	197	218	178	336
2	1985	169	245	203	284	190	11	11	5	130	108	97	153
3	1986	188	108	173	252	84	44	74	47	83	211	481	130
4	1987	115	27	131	136	243	138	39	113	130	331	694	221
5	1988	365	247	282	92	128	48	402	9	76	88	192	221
6	1989	0	0	0	0	0	23	51	167	0	0	183	0

No	Year	Jan	Feb	Marc	Apr	May	June	July	August	Sept	Oct	Nov	Dec
7	1990	0	0	0	0	0	0	0	0	36	17	0	0
8	1991	0	0	0	0	20	12	0	16	45	0	0	330
9	1992	111	134	82	120	85	14	0	0	46	85	200	208
10	1993	155	23	210	192	83	181	32	86	106	67	184	212
11	1994	418	220	81	135	108	225	5	0	25	0	0	0
12	1995	0	0	0	0	0	0	77	11	156	164	336	432
13	1996	170	46	34	278	149	20	0	123	97	264	105	0
14	1997	318	294	127	229	28	33	118	198	94	86	205	194
15	1998	336	91	236	223	50	103	63	35	379	265	256	124
16	1999	77	180	114	141	153	54	38	151	116	77	199	314
17	2000	0	0	0	0	101	0	0	89	0	0	0	0
18	2001	134	169	78	46	0	47	47	43	103	78	80	92
19	2002	96	174	76	49	0	53	47	62	103	76	71	89
20	2003	103	70	52	41	0	49	40	102	98	104	63	130
21	2004	65	102	174	51	0	40	162	88	102	86	39	103
22	2005	47	116	81	86	24	48	68	58	71	90	39	84
23	2006	60	95	19	116	37	53	59	94	29	105	83	28
24	2007	31	84	50	66	50	44	39	130	73	80	79	0
25	2008	38	22	47	60	11	44	36	108	32	36	57	0
26	2009	20	9	150	45	8	41	109	83	17	24	32	0
27	2010	7	12	200	22	6	37	0	82	2	18	15	0
28	2011	23	10	28	13	5	45	0	71	0	12	89	143
29	2012	50	10	63	0	5	49	0	63	0	19	75	289
30	2013	39	10	56	50	5	64	0	54	0	0	0	0
31	2014	41	26	46	14	0	61	0	54	0	4	0	0
32	2015	58	18	36	58	0	61	0	73	0	8	0	0
33	2016	65	26	40	70	4	63	0	89	0	87	52	64
34	2017	64	29	47	78	8	61	0	70	10	95	107	84
35	2018	63	30	46	83	44	12	0	81	13	50	33	36
36	2019	63	123	131	86	67	28	0	79	202	129	215	193
37	2020	82	140	93	86	60	18	0	84	205	128	224	244

To obtain the return period discharge using the equation [13]:

$$Q = 0{,}278\ C.I.A \tag{11}$$

Where: Q is Regional Debit; C is the flow coefficient; I is the intensity of rain and A is the area of the watershed

3. Result

a. Water Requirement Discharge

Based on field findings, it was found that water needs in an area are largely determined by the conditions of the area such as population size, population growth, and the socio-economic level of the population which influence water use patterns [14]. The flow of the Krueng Buloh River is as shown in Figure 1.

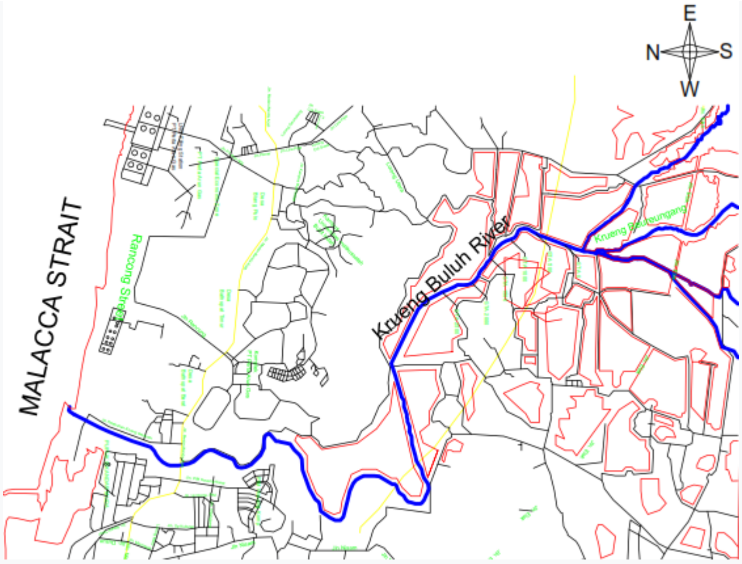

Figure 1. Krueng Buloh river flows

The division of the city of Lhokseumawe consists of 4 districts with 68 villages. Banda Sakti sub-district consists of 18 villages, Blang Mangat sub-district consists of 22 villages, Muara Dua sub-district consists of 17 villages and Muara Satu sub-district consists of 11 villages [15]. If the coverage of water access in a city has not been fulfilled, efforts must be made to fulfill it as soon as possible [16].

Fulfillment in Lhokseumawe City causes the need for adequate drinking water discharge for the needs of Lhokseumawe City. One source of raw water in the Lhokseumawe city government area which is expected to meet these needs is the Buloh River. The source of raw water from the Krueng Buloh River will be analyzed to meet the needs of raw water in terms of quantity and continuity.

b. Real Demand Survey

The Real Demand Survey (RDS) was conducted in the Lhokseumawe city area which consists of 4 sub-districts, namely the Banda Sakti sub-district, Blang Mangat sub-district, Muara Satu sub-district, and Muara dua sub-district. According to [17], In this study, the population size of 42,972 with an estimation error of 10%, the sample size is 100 respondent. Based on the population in the study area, the sample size can be determined using the Slovin formula. According to Rani, (2022), SEM analysis (structural equation model) requires a sample of at least 5 times the number of indicator variables used [19] and [20]. The maximum likelihood estimation technique requires samples ranging from 50 – 100 samples. Another opinion suggests that the maximum likelihood estimation technique is effective for samples ranging from 50 to 100 samples [21]. So to get high precision, proportionally each sub-district according to the population of the community sample is proportionally taken as many as 320 households and the average sub-district is 80 households. Furthermore, to obtain research results that are close to factual conditions by empirical data, the respondents are determined to consist of multi-stakeholders, namely: individual community groups in the form of households [22]. The proportion of respondents is shown in Table 2.

Table 2. Respondent proportion

Sub District	Respondents/ Informants (Household)
Blang Mangat	80
Banda Sakti	80
Muara Dua	80
Muara Satu	80
Totaly	320

Based on the results of the Real Demand Survey (RDS), it can be seen the condition of the water used by the people of Lhokseumawe city daily, the amount of water consumption, the level of desire of the people of Lhokseumawe to be able to enjoy clean and quality drinking water that will be served by PDAM. The number of questions asked to the respondents was 23 questions and the respondents were Lhokseumawe people with a total sample of 320 domestic and non-domestic RDS respondents who were distributed evenly based on the stratified random sampling method [23]. The identity of the respondent is described as a representative of the household with several dominant conditions from the total respondents [24]. Where the average household income accumulation each month ranges from 1 – 2 million as much as 45%, with the number of family members in the household varying from 2 to 4 people, and the condition of the building area of the house occupied by 45% of respondents is smaller than 36 m2 and 50% of them with a level of electricity usage of 900 watts.

The condition of water quality used was stated by respondents as 90% odorless, 69% good water taste, 67% good color, and 72% good water clarity. The average condition of the water from the smell, taste, color and clarity of the water is in good condition. Water conditions for the community must be in good condition and suitable for consumption [25], [26]. It is estimated that the level of water consumption per person per day is 48% from 100 liters to 120 liters, 78% uses refilled gallon water for cooking and drinking needs, and 56% of the total costs 25 thousand to 50 thousand rupiah per month. The use of refilled water will certainly increase the cost every month and become a high cost. From the survey results, it is known that as many as 87% of the total respondents already have their own homes, but 79% of them state that they are not PDAM customers, it is known that 80% of the total use dug/bored well water for their clean water needs, with 93% of people who have not subscribed. It is feared that the use of well water by the community will lead to reduced groundwater and landslides in the soil layer [27]. On average, PDAMs use pumps for their daily water needs, thus providing additional expenditures in electrical power ranging from 25 thousand to 100 thousand rupiah. Meanwhile, from 21% of community households who have become PDAM customers, it can be explained that 51% of them pay an average of 50 thousand smaller than 100 thousand.

Based on the analysis, it is known that the reason people do not want to become PDAM customers is 71% because the quality of the water used is still good, while another 59% stated that there was already a PDAM pipe network around their residence and 26% had a desire to become PDAM customers with an enthusiastic level. PDAM pipe installation 88% want to be installed immediately in 1 week. As many as 97% stated that they were able to pay in the range of 50 thousand to 100 thousand rupiah per month and 83% chose the method of paying PDAM accounts by cash.

c. City Population Forecasting

Based on data from the Central Statistics Agency from 2009 to 2018, the population by sub-district for 10 years is shown in Table 3.

Table 3. Population by sub-district for 10 years

Year	Sub-district				Totaly
	Blang Mangat	Muara Dua	Muara Satu	Banda Sakti	
2009	18,869	37,132	31,489	71,749	159,239
2010	21,689	44,209	31,723	73,542	171,163
2011	22,186	45,221	32,449	75,226	175,082
2012	22,850	46,646	32,975	77,336	179,807
2013	23,236	47,601	33,492	78,903	183,232
2014	25,122	50,576	32,917	78,840	187,455
2015	26,000	52,184	33,162	80,061	191,407
2016	26,870	53,766	33,363	81,187	195,186
2017	27,758	55,375	33,551	82,296	198,980
2018	28,734	57,150	33,807	83,593	203,284

The population of the city of Lhokseumawe from year to year has increased with a population growth rate of 2% per year [15]. The method used to project the population in the future is 3 methods for comparison. The three methods include Arithmetic, Geometric, and Least Square [28]. The planning for water demand in this study is projected for the year, namely from the year 2050. Figure 2 shows the calculation results from the comparison of the three methods used as population projections with the actual data (2009 – 2018) and forecast data (2019 – 2050) available in Lhokseumawe City. The correlation values and standard deviations based on these various methods are summarized to determine the method used in forecasting the population as shown in Table 4.

Table 4. Correlation value and Deviation Standard

Metode	SD	R^2
Aritmatic Method	5,397	0.827996
Geometric Method	6,152	0.784231
Least Square Method	1,959	0.973735

Based on the calculation of the population projection using 3 methods, the selected forecasting method is the Least Square method [29], [30]. The selection of the Least Square Method based on the largest correlation value (R^2) is 0.973735 and the smallest standard deviation value is 1.959. The results of the projected population until 2050 are shown in Figure 2.

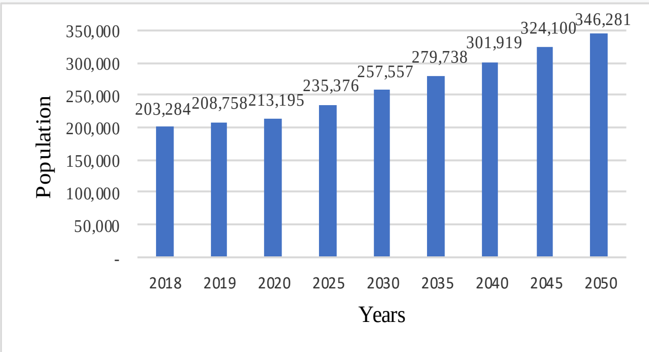

Figure 2. The forecasting of population graph of Lhokseumawe City until the Year 2050

d. Water Requirement

From the population forecasting, as shown in the previous table, the calculation of water demand for Lhokseumawe City is carried out using several data and assumptions as shown in Table 5.

Table 5. Basis for calculating water demand

Description	Value	Unit
Total Population	203,284	Person
Population Growth	2.0	%
Person per Household	4.53	Person
Total Non-Domestic Properties	12,058	Unit
Water Consumption Average	20.71	m^3/SR/month
	100	liter/Person/day
Non-Domestic Water Consumption Average	98.37	m^3/Unit/Month

As a basis for water requirement forecasting, the current population and number of non-household properties use BPS data in 2018 [31] so for the water demand in the initial year before the forecasting as shown in Table 6.

Table 6. Water Requirement in Lhokseumawe before forecasting

Household			Non-Household			
Total Population	Water consumption average (ltr/person/day)	Household requirements (ltr/sec)	Total property	Water consumption average (m^3/unit/month)	Non-Household demand (Ltr/sec)	Total demand (Ltr/sec)
203,284	171.38	388	12,058	98.37	436	824

Forecasting water Requirement until 2050 based on population, population growth, person per household and total non-domestic properties, the Water Consumption Average is obtained and the demand from year to year is shown in Figure 3.

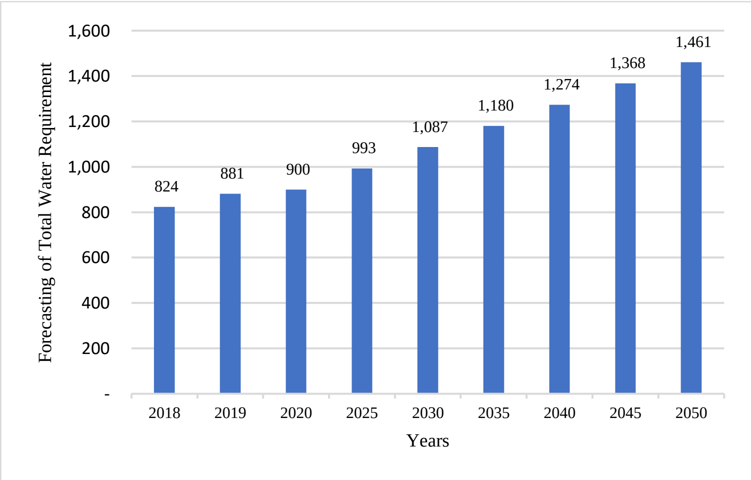

Figure 3. Forecasting of Total Water Requirement in Lhokseumawe

e. Water Discharge Availability

Hydrology Analysis

Hydrological analysis was carried out to ensure the amount of water availability in the Buloh watershed based on rain data and controlled for the distribution of data using the Distribution Suitability Test Smirnov Kolmogorov Test [32]. In addition, a hydraulic analysis was also carried out on the river's ability to become a water source for PDAM Ie Beusare Rata and the treatment that needed to be carried out on the Krueng Buloh river to meet the water demand of 230 liters per second. It is necessary to analyze the rain data with an adequate amount of data to determine the discharge in each return period which is the regional water availability in the study area [33], [34].

Rain data analyzed is from 1984 - 2020 from January to December. This means that there are 37 years of rain data series analyzed. Other data used are in the form of watershed data, service area, river length, and distance from the closest flow to the river and slope as follows: Watershed area as 523.27 km^2; Service Area as 1 km^2; Length L_1 as 5,500 m; Length L_0 as 2000 m and Slope (i) 0.0002. Based on the results of the analysis, the following results were obtained:

Table 7. Return Period Water Discharge

Return Period	R_{24}	I_T	Flow Coefficient (C)	Discharge (Q) (m^3/sec)	liter/sec
5	18.547	2.432	0.7	1.7024	1702.4
10	27.444	3.598	0.7	2.5186	2518.6

Service area 1 km2, river length 10,500 km, based on the table above, it is known that by using a 5-year return period, the resulting discharge of 1.7024 m^3/s or 1,702.4 liters/s illustrates that PDAM Ie Beusare's planned average water requirement of 230 liters/sec can be met, especially if it takes into account the rainfall period. 10 years with a return period discharge of 2.5186 m^3/s or 2,518.6 liters/sec will better guarantee the discharge requirement.

f. Hydraulic Forecasting

To find out the discharge in the river, it is necessary to measure the geometric cross-section of the river and determine the flow velocity so that later the river discharge is the flow velocity that is directly proportional to the cross-sectional area of the river [35]. The depth of the Krueng Buloh river at the deepest intake is 0.85 m or 85 cm with an average depth of 0.65 meter from the existing river cross-section as shown in Figure 4.

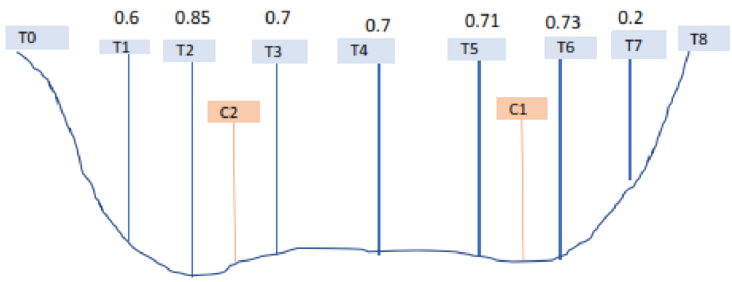

Figure 4. Cross-section of the Krueng Buloh river at the intake location

Based on the cross-section of the river and measurement of flow velocity using a Current Meter, it can be estimated that the flow rate in the Krueng Buloh river can be estimated as shown in Table 8.

Table 8. Krueng Buloh river discharge calculation

Point	Cross Section area (m^2)	Velocity (m/sec)	Discharge (m^3/sec)	Discharge (liter/sec)
T_T-C_1	1.42	0.89	1.2894	1,258.94
C_1-T_6	0.71	1.77		
T_6-T_7	1.241	1.01		
T_7-T_8	0.104	12.11		
T_T-C_2	1.475	0.85		
C_2-T_2	0.738	1.71		
T_2-T_1	1.275	0.99		
T_1-T_0	0.6	2.10		
Average		2.68		

To anticipating community water needs at least in dry conditions can collect water to meet needs for 6 hours [36]. Based on the planned discharge of PDAM Ie Beusare Rata average water demand of 230 liters/second, it can be estimated that the availability of water in the intake area must ensure that the need is for at least 6 hours so that the level of service will also ensure that the community will be able to obtain water for 6 hours without running out. The average flow velocity based on Table 8 is 2.68 m/sec The water requirement for approximately 6 hours is estimated at 4,968,000 liters or equivalent to 4,968 m^3, while the width of the existing river is 10.72 m with an average depth of 0.65 m. The capacity of the river distance 500 m is 1,393.6 m^3 while the volume requirement is 4,968 m^3, it is necessary to prepare treatment for a direct reservoir on the river for 6 hours at a distance of 500 m, excavation with a depth of 2 m.

g. Water Balance

The water balance is the balance between inflow and outflow in an area at a certain period and by knowing the water balance [37], it can be estimated whether the area has surplus or deficit, and to estimate it, an analysis is carried out supply and demand.

h. Supply and Demand Analysis

Supply and demand analysis is an analysis of water needs compared to water availability. Lhokseumawe city's water needs for the community from 2018 to 2050:

Table 9. Supply and demand

Year	Discharge Needs (ltr/Sec)	Discharge Availability (ltr/Sec)		Surplus/Defisit (ltr/Sec)	
		5 Return Period	10 Return Period	5 Return Period	10 Return Periode
2018	824	1,702.4	2,518.6	878.4	1,694.6
2019	881	1,702.4	2,518.6	821.4	1,637.6
2020	900	1,702.4	2,518.6	802.4	1,618.6
2025	993	1,702.4	2,518.6	709.4	1,525.6
2030	1,087	1,702.4	2,518.6	615.4	1,431.6
2035	1,180	1,702.4	2,518.6	522.4	1,338.6
2040	1,274	1,702.4	2,518.6	428.4	1,244.6
2045	1,368	1,702.4	2,518.6	334.4	1,150.6
2050	1,461	1,702.4	2,518.6	241.4	1,057.6

The water availability debit is very sufficient, even in 2020 there is a surplus of 802.4 liters/second in the 5-year return period while in the 10-year return period there is a surplus of 1,618.6 liters/second. In forecasting 2050, there is also a surplus of 241.4 liters/second for the 5-year return period and a surplus of 1,057.6 liters/second for the 10-year return period, this illustrates that the water needs in Lhokseumawe city based on hydrology can still meet the needs until 2050.

i. Krueng Buloh river capacity

The results of the geometric measurements of the river are described as longitudinal sections of the river at the location of the transverse measurement of the river as shown in Figures 5.

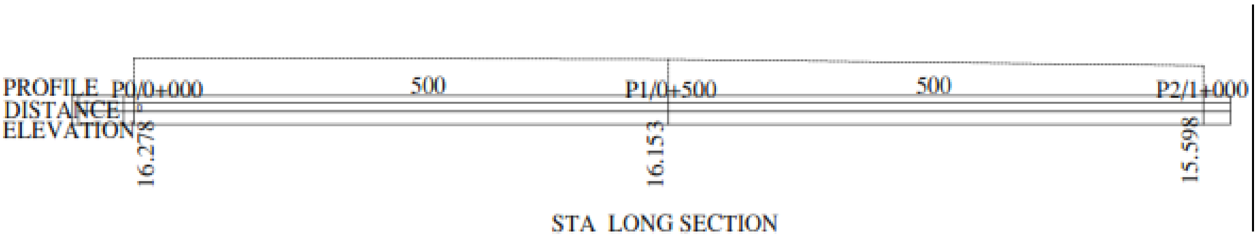

Figure 5. Long Section of Krueng Buloh river

The Krueng Buloh river discharge is based on geometric river measurements using GPS Geodetic and velocity measurements using a Current Meter, and the results are as shown in Table 10

Table 10. Krueng Buloh river capacity

Sta	River cross-section area	Velocity	Discharge	
	(m^2)	(m/Sec)	(m^3/Sec)	(liter/Sec)
0.000	31.06	0.223	6.93	693
0.500	40.99	0.223	9.14	914
1.000	33.78	0.223	7.53	753

Total	105.83	0.669	23.60	2,360
Average	35.28	0.22	7.87	787

The cross-sectional capacity of the river can flow an average discharge of 787 liters/second while the intake discharge requirement when used maximally is 824 liters/second in 2018 and 900 liters/second in 2020, for 2025 it is 993 liters/second and 1,461 liters/sec for the estimated demand for the year 2050. From these estimates, it can be illustrated that the geometry and cross-section of the river are not able to serve the needs optimally, so handling of the river is needed, especially at the intake location. The treatment carried out is to emphasize the location of the river or make a reservoir for a water volume of at least 50% of the demand in the year 2050, which is 63,115,200 m^3. The storage pond made along the river can at least accommodate 50% of the 63,115,200 m^3 which is 31,557,600 m^3 and widening the river to 25 m with a depth of 3 m and is made along the river which is 500 m resulting in a storage volume of 37,500,000 m^3.

4. Conclusion

Based on the findings and discussions presented in this study, it is evident that the availability of water resources, particularly from the Krueng Buloh River, plays a crucial role in meeting the clean water needs of Lhokseumawe City. The analysis of water requirement discharge highlights the significance of factors such as population growth and socio-economic conditions in determining the overall water demand in the region. Through surveys like the Real Demand Survey (RDS), conducted to understand the daily water usage patterns and preferences of the city's residents, insights into the current water consumption trends and expectations for clean drinking water services from the local utility company, PDAM, were gained. Furthermore, the population forecasting for the city until 2050 underscores the importance of anticipating future water demand trends to ensure sustainable water management practices. Despite the projected increase in population, various calculation methods indicate that the water availability from the Krueng Buloh River is expected to be sufficient to meet the city's needs.

Hydrological analyses confirm the adequacy of water discharge from the river to fulfill the requirements of PDAM Ie Beusaree Rata. However, it is essential to consider seasonal variations and potential river expansion to maintain consistent water availability. Additionally, the assessment of water balance emphasizes the need for proactive measures in river management to optimize water resources for the city's long-term sustainability. In conclusion, while the Krueng Buloh River presents a promising source of water for Lhokseumawe City's needs, effective river management strategies are vital to ensure reliable access to clean water for the growing population. This study underscores the importance of integrated water resource management practices to meet the present and future water needs of urban communities like Lhokseumawe City.

5. Recommendation

Based on the conclusion of this study, there are several recommendations that can be proposed for further research in this field. Firstly, further research could be conducted to deepen the understanding of the impact of population growth and socio-economic development on the demand for clean water in urban areas, as well as the potential influence on community water usage patterns. Secondly, further research could also focus on analyzing the projection of water needs for longer timeframes, considering factors such as climate change and industrial growth.

Thirdly, further research on river management and water resources could be undertaken to identify effective strategies in maintaining sustainable water availability, including the management of dry season risks and river expansion. Fourthly, further research could also explore innovative solutions to enhance water usage efficiency and wastewater management, such as the utilization of green technologies and other environmentally friendly practices. By conducting further research in this field, it is hoped that significant contributions can be made in addressing sustainability challenges in the provision of clean water for urban areas in the future.

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References

[1] D. Lailani, “Analysis of the Need and Availability of Clean Water in PDAM Tangerang City” s1, Universitas Mercu Buana Jakarta, 2019. Accessed: Mar. 12, 2024. [Online]. Available: https://repository.mercubuana.ac.id/57193/

[2] V. Noperissa and R. S. B. Waspodo, “Analysis of Domestic Water Needs and Availability Using Regression Methods in Bogor City” *Jurnal Teknik Sipil dan Lingkungan*, vol. 3, no. 3, Art. no. 3, Dec. 2018, doi: 10.29244/jsil.3.3.121-132.

[3] M. N. H. Sulistiono, “Analysis of the Need and Availability of Clean Water in Depok City” 2020, Accessed: Mar. 12, 2024. [Online]. Available: http://repository.ipb.ac.id/handle/123456789/115243

[4] P. J. Osly, F. Dwiyandi, I. Ihsani, and R. E. Ririhena, “Analysis of Water Needs and Availability in Manokwari Regency Using Mock Models” *Jurnal Infrastruktur*, vol. 5, no. 2, Art. no. 2, Dec. 2019, doi: 10.35814/infrastruktur.v5i2.1025.

[5] G. I. Mangare, I. R. Mangangka, and R. R. I. Legrans, “Analysis of Water Needs and Availability in the Drinking Water Supply System in Matuari District, Bitung City” *TEKNO*, vol. 21, no. 85, Art. no. 85, Jul. 2023.

[6] I. M. A. D. Hadryana, I. G. N. K. Arsana, and I. P. G. S. P, “Analysis of Water Balance in the Tukad River Watershed, Tabanan Regency” *Jurnal Ilmiah Teknik Sipil*, Oct. 2016, Accessed: Mar. 12, 2024. [Online]. Available: https://ojs.unud.ac.id/index.php/jits/article/view/24103

[7] Y. Kaplan, “Determination of Weibull parameters with using Standard Deviation Method and performance comparison at different locations,” *Scientia Iranica*, vol. 0, no. 0, pp. 0–0, Apr. 2019, doi: 10.24200/sci.2019.50323.1632.

[8] S. A. Sari and A. Y. Koswara, “Analysis of Water Availability and Needs in Prigen District, Pasuruan Regency Based on Water Balance” *JTITS*, vol. 8, no. 2, pp. B94–B99, Jan. 2020, doi: 10.12962/j23373539.v8i2.47942.

[9] R. Honda *et al.*, “Estimated discharge of antibiotic-resistant bacteria from combined sewer overflows of urban sewage system,” *npj Clean Water*, vol. 3, no. 1, p. 15, Dec. 2020, doi: 10.1038/s41545-020-0059-5.

[10] Directorate General of Human Settlements, *Technical Guidelines for Clean Water Implementation*. Jakarta: Department of Public Works, 1994.

[11] D. N. Admadhani, A. T. S. Haji, and L. D. Susanawati, “Analysis of Water Availability and Needs for Environmental Carrying Capacity (Case Study of Malang City)” *Jurnal Sumberdaya Alam dan Lingkungan*, vol. 1, no. 3, Art. no. 3, Sep. 2014.

[12] T. E. Valweswari, W. Winardi, and K. P. Utomo, “Analysis of the Availability and Quality of Sekayam River Water as Raw Water for Perumda Tirta Pancur Aji, Sanggau Regency” *Jurnal Teknologi Lingkungan Lahan Basah*, vol. 11, no. 1, pp. 109–116, Feb. 2023, doi: 10.26418/jtllb.v11i1.59771.

[13] W. Wesli, *Urban Drainage*, 2 rd Edition. Yogyakarta: Grahan Ilmu, 2021.

[14] L. A. Fauzi, A. Yutrisya, N. Rachmatiyah, and K. Sapanli, “Analysis of Water Use for Industry in the city of Tangerang” *Seminar Nasional Hari Air Sedunia*, vol. 1, no. 1, Art. no. 1, Jul. 2018.

[15] Central Bureau of Statistics Lhokseumawe, “Lhokseumawe Minicipality In Figures 2021,” Lhokseumawe, 2021. Accessed: Dec. 29, 2022. [Online]. Available: https://lhokseumawekota.bps.go.id/pencarian.html?searching=lhokseumawe+dalam+angka+2021&yt1=Car

[16] S. Srinivasan and G. W. Harrington, “Biostability analysis for drinking water distribution systems,” *Water Research*, vol. 41, no. 10, pp. 2127–2138, May 2007, doi: 10.1016/j.watres.2007.02.014.

[17] M. L. H. Thomas-Possee, “Domestic drinking water availability in Sub-Saharan Africa: Investigating drivers and indicators,” phd, University of Southampton, 2023. Accessed: Mar. 12, 2024. [Online]. Available: https://eprints.soton.ac.uk/476791/

[18] S. Rani, “Evaluating the regional disparities in safe drinking water availability and accessibility in India,” *Environ Dev Sustain*, vol. 24, no. 4, pp. 4727–4750, Apr. 2022, doi: 10.1007/s10668-021-01631-6.

[19] M. Carmen Valls Martines and P. Antonio Martin Cervantes, *Partial Least Squares Structural Equation Modeling (PLS-SEM) Applications in Economics and Finance*. MDPI, 2021. doi: 10.3390/books978-3-0365-2621-8.

[20] A. Z. Arifin and A. N. Salam, “Analysis of Millennial Generation Behavior in Consuming Halal Products:

Structural Equation Model-Partial Least Square (SEM-PLS) Method," *IQTISHADIA*, vol. 12, no. 2, p. 266, Dec. 2019, doi: 10.21043/iqtishadia.v12i2.5725.

[21] M. A. Alim, A. Rahman, Z. Tao, B. Samali, M. M. Khan, and S. Shirin, "Feasibility analysis of a small-scale rainwater harvesting system for drinking water production at Werrington, New South Wales, Australia," *Journal of Cleaner Production*, vol. 270, p. 122437, Oct. 2020, doi: 10.1016/j.jclepro.2020.122437.

[22] A. J. Pickering and J. Davis, "Freshwater Availability and Water Fetching Distance Affect Child Health in Sub-Saharan Africa," *Environ. Sci. Technol.*, vol. 46, no. 4, pp. 2391–2397, Feb. 2012, doi: 10.1021/es203177v.

[23] W. Van Der Hoek, F. Konradsen, J. H. J. Ensink, M. Mudasser, and P. K. Jensen, "Irrigation water as a source of drinking water: is safe use possible?," *Tropical Medicine & International Health*, vol. 6, no. 1, pp. 46–54, 2001, doi: 10.1046/j.1365-3156.2001.00671.x.

[24] M. Mashuri, M. Fauzi, and A. Sandhyavitri, "Study of the Availability and Need for Raw Water using Ihacres Modeling in the Tapung Kiri River Basin" Journal:eArticle, Riau University, 2015. Accessed: Mar. 12, 2024. [Online]. Available: https://www.neliti.com/publications/188920/

[25] F. Fiandra and H. Wardono, "Study of the Availability and Need for Raw Water in Mesuji Regency" *Jurnal Rekayasa Lampung (JRL)*, vol. 1, no. 1, Art. no. 1, Jan. 2022, doi: 10.23960/jrl.v1i1.5.

[26] L. Ismail, S. Mukramin, and M. Muhammadong, "Growing Awareness of Environmental Love In Youth: An Action Towards A Prosperous Village In Lambai Village, Lambai District, North Kolaka District" *TOPLAMA*, vol. 1, no. 2, pp. 54–65, Jan. 2024, doi: 10.61397/tla.v1i2.96.

[27] S. H. Sumantri, sukoso Sukoso, I. Hanafi, and R. B. E. Wibowo, "Maintaining Availability of Raw Drinking Water in Surabaya under the System Dynamics Approach," *Scientific & Academic Publishing*, vol. 6, no. 5, Art. no. 5, May 2016.

[28] M. S. Aini, A. Fakhrul-Razi, O. Mumtazah, and J. C. M. Chen, "Malaysian households' drinking water practices: A case study," *International Journal of Sustainable Development & World Ecology*, vol. 14, no. 5, pp. 503–510, Oct. 2007, doi: 10.1080/13504500709469749.

[29] R. Bain, R. Johnston, S. Khan, A. Hancioglu, and T. Slaymaker, "Monitoring Drinking Water Quality in Nationally Representative Household Surveys in Low- and Middle-Income Countries: Cross-Sectional Analysis of 27 Multiple Indicator Cluster Surveys 2014–2020," *Environmental Health Perspectives*, vol. 129, no. 9, p. 097010, Sep. 2021, doi: 10.1289/EHP8459.

[30] A. S. A. Dosinaen and M. Musafa, "Local Community Participation in Citalutug Tourism Destination Promotion" *Multifinance*, vol. 1, no. 2 November, Art. no. 2 November, Nov. 2023, doi: 10.61397/mfc.v1i2.83.

[31] Central Bureau of Statistics Lhokseumawe, "Lhokseumawe Minicipality In Figures 2020," Lhokseumawe, 2020. Accessed: Oct. 09, 2019. [Online]. Available: https://lhokseumawekota.bps.go.id/pencarian.html?searching=lhokseumawe+dalam+angka+2019&yt1=Cari

[32] M. Isnin, H. Basri, and R. Romano, "Economic Value of Water Availability from the Krueng Jreu Watershed (DAS), Aceh Besar Regency" *Jurnal Manajemen Sumberdaya Lahan*, vol. 1, no. 2, Art. no. 2, 2012.

[33] Sarnia, A. S. Titing, and Hendrik, "The Influence of Work Life Balance And Job Stress On Job Satisfaction In Honorary Nurses In South Buton District Hospital" *Multifinance*, vol. 1, no. 2 November, pp. 142–154, Nov. 2023, doi: 10.61397/mfc.v1i2.58.

[34] C. T. Walter, M. Kooy, and I. Prabaharyaka, "The role of bottled drinking water in achieving SDG 6.1: an analysis of affordability and equity from Jakarta, Indonesia," *Journal of Water, Sanitation and Hygiene for Development*, vol. 7, no. 4, pp. 642–650, Aug. 2017, doi: 10.2166/washdev.2017.046.

[35] J. C. Padowski and J. W. Jawitz, "Water availability and vulnerability of 225 large cities in the United States," *Water Resources Research*, vol. 48, no. 12, 2012, doi: 10.1029/2012WR012335.

[36] M. Cabral, D. Loureiro, and D. Covas, "Using economic asset valuation to meet rehabilitation priority needs in the water sector," *Urban Water Journal*, vol. 16, no. 3, pp. 205–214, Mar. 2019, doi: 10.1080/1573062X.2019.1648528.

[37] Wesli, "Peudada Reservation Contribution to Water Needs of Bireuen District," vol. 6, no. 1, pp. 66–72, 2016, doi: 10.29103/tj.v6i1.87.