SIMULATION OF WATER DEMAND FROM SIMANINDO DISTRICT AND REGIONAL WATER SUPPLY COMPANY (PDAM) IN TOBA LAKE

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ABSTRACT

Water demand is its relentless rise over many years and projections of population growth over coming decades. Water availability is also increasing remains in a catchment area. Human activities gave impact for environmental degradation such as water quality. The volume of Toba lak'se water is getting decline. There is an indication of the decrease of water level from year to year, while the growth of the population living in the water body of Lake Toba has a low increase with an average of almost 3 percent (2009-2017). It will give impact for water demand. Forest destruction around Lake Toba is bad enough where the forest area is only 15.8% of the catchment area. It leads to unstable lake water level and disrupts the utilization of the lake, especially the stability of water supply for PDAMs and people who take the source water from Lake Toba. The purpose of this study is to analyze and estimate water demand of Toba Lake and estimate the consumer and water demand of PDAMs user. The method calculated growth population and water demand using Super Vector Machine (SVM) and growth population model for next two years. The result of the research is a one-dimensional graph relating to community water demand in Toba and PDAMs user.

Findings indicate that in 2020, some villages in Simanindo sub-district will experience a decrease population and some increase in population. It will give impact on the fluctuation of water demand for communities. People are experiencing a decline water deman in some sub-district. PDAMs users will experience an increase in customers and water demand in 2020.

Keywords: Simulation, Water Demand, PDAM, Lake Toba, SVM

INTRODUCTION

Water demand is inclined to the population growth while water demand availability remains in a catchment area. Water quality is decreasing with more human activity causing environmental degradation. Lake Toba is the most significant lake in Southeast Asia. It's the ninth deepest lake in the world and the most significant volcanic lake of the caldera in the world. This lake is located 905 meters above sea level with a length of 275 km, the width of 150 km and an area of 1130 km2. The northern depth is 529 m while the southern extent is 429 m. The Lake Toba lies between 2010 'LU-300' LU and 98020 'BT-99050' BT. The total area of Lake Toba Water Catchment is 379940.35 ha, which consists of Lake Toba area of 104528.25 ha (27.51%) and the land area of 275412.10 ha (72.49%). The primary function of Lake Toba besides tourism are generating hydroelectric power plant and Regional Water Supply Company (PDAM) around Lake Toba.

The problem is the volume of Toba lake water is decreasing (Hotland Sihotang et al., 2012) and the indication of decline water level from year to year (Acreemant et al., 1993). Besides that. Water quality in Lake toba is decrease in some location. It gave impact for water demand from Lake Toba.

Based on data from Central Bureau of Statistics (BPS) Samosir, the growth of the people living in the water bodies of Lake Toba has low increased 3 percent which has an impact on the increase in water demand although it's not significant.

In 2009, the status classification based on the Composite Index of Carlson (TSI), Lake Toba is still oligotrophic (Sulom Nomosatryo et al., 2012). The condition is now worsening if the increased use of Floating Net Cages (KJA) is only 7,136 units and producing fish 35,000 tons/year or less underneath (Lukman et al., 2012, Lukman, et al., 2011). It suspected that the upstream areas of the Lake Toba Water Catchment had experienced severe degradation of environmental quality in the form of land use change and forest conversion. Forest area is decrease with only 15.8% of the catchment area of Lake Toba causing unstable lake water level and disrupt the utilization of the lake. It gives impact less or more for people around lake Toba especially for PDAMs user and the human who does not use PDAM water but take water source from Toba lake.

The purpose of this research is to give simulation the water demand of people around lake Toba (Simanindo District) whose consumption water source from Toba lake and water demand of costumer of PDAMs Toba Samosir and PDAMs Panguruan in the next future.

RESEARCH METHODOLOGY

2.1. Description of Sampling Location and Analyze Data

There are two stages in analyzing the water needs in Lake Toba. (i). The communities of Simanindo district which is not the customer of PDAM but take water resource from Lake Toba (ii) the customers using water from PDAMs Toba Samosir and PDAMs Panguruan where PDAM water source (PDAM Pangururan and PDAM Toba Samosir) comes from Lake Toba.
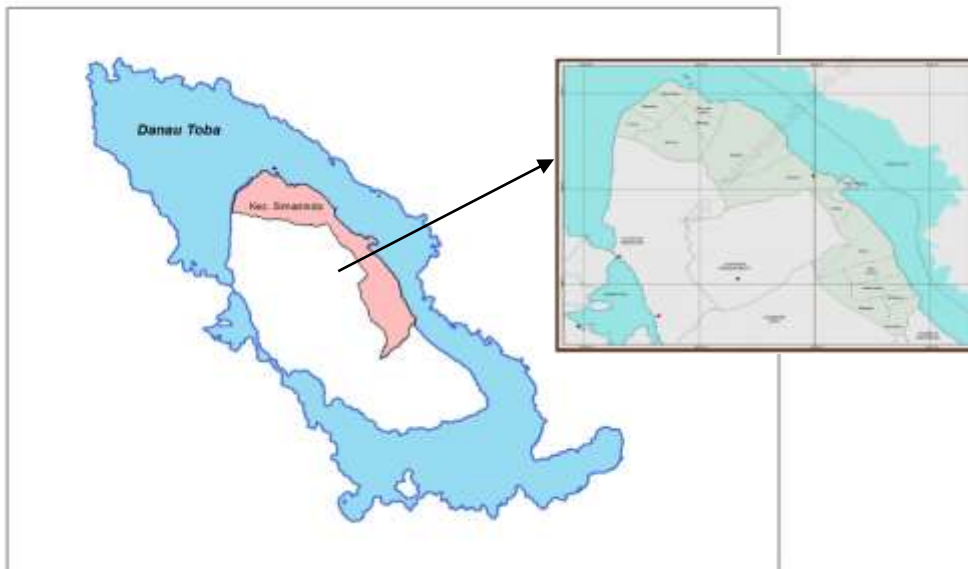
Pict 1. Location of Sampling Data

### 2.1.1. Pertumbuhan Penduduk Terhadap kebutuhan air Non PDAM (Sumber air lainnya selain air PDAM)

The survey conducted to find out how much water demand of Simanindo District is through a questionnaire. The questionnaire distributed with 17 questions.

The population in Simanindo district known through secondary data from BPS of Samosir Regency in 2016. Thus, to find the minimum value of research sample using questionnaire, the Slovin method (Sevilla et al., 1960: 182) is used as follows:

$$n = \frac{N}{1 + Ne^2}$$

Where n = number of samples, N = Number of population and e: tolerance limit, then if the population jump N = 22326 people with a tolerance limit of 10% it will get the number of samples amounted to 99.56 people or rounded for 100 people.

The average on the edge of the lake in this area is still using lake water as a source of water daily with the standard of community work is fishing and farming. One of the sub-districts shows a downward trend in population, and some have increased population.
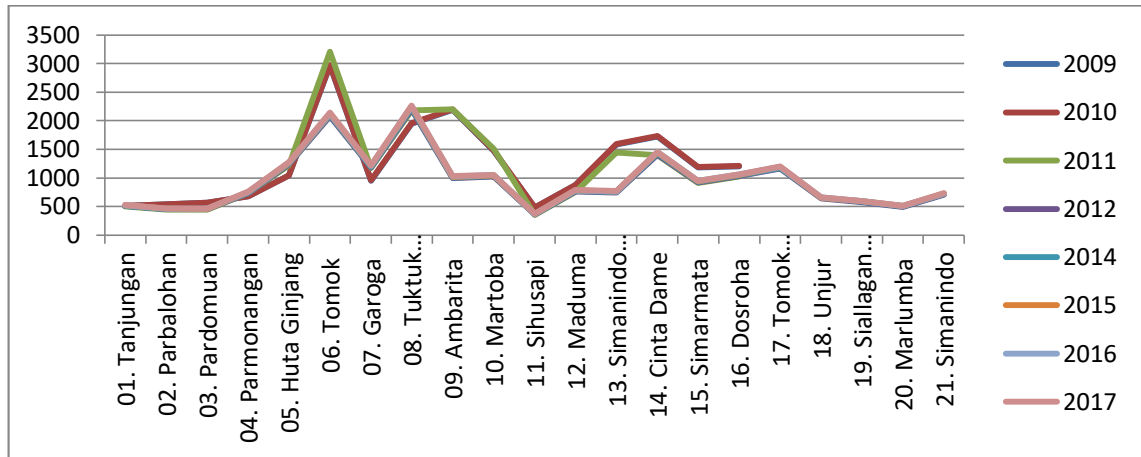
Pict 2. Growth Population in Simanindo District (2009-2017)

2.1.2 Impact of customer growth on water demand in PDAM with source from Lake Toba
The research used secondary data from Central PDAMs North Sumatera Province and BPS of Samosir Regency and also Questionnaires to society in Simanindo District.
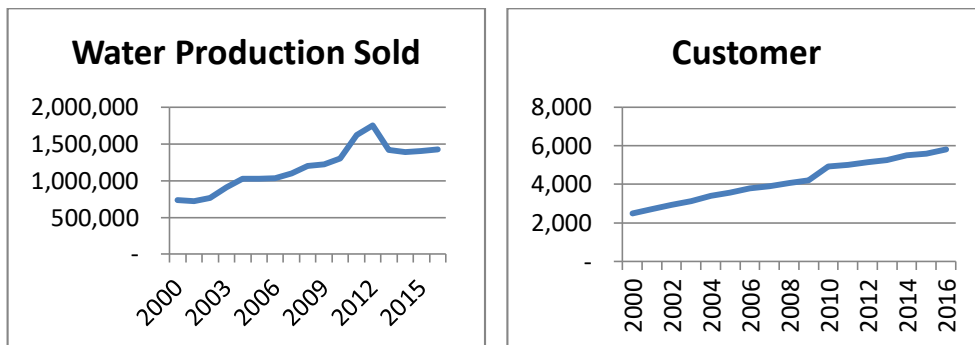
Pict 3. Trend of Water Production Sold And The Number Of Customers In Toba Samosir PDAMs (Tobasa) in year 2000-2016

In the above graph, there is a considerable increase both for the number of PDAM subscribers and the amount of PDAM water use from 2002 to 2016 amounting to 235% and 194% from the first year.
In the graph below, there is a considerable increase in both the number of PDAM subscribers and the amount of water usage from 2002 to 2016 amounting to 261% and 304% respectively since the first year.
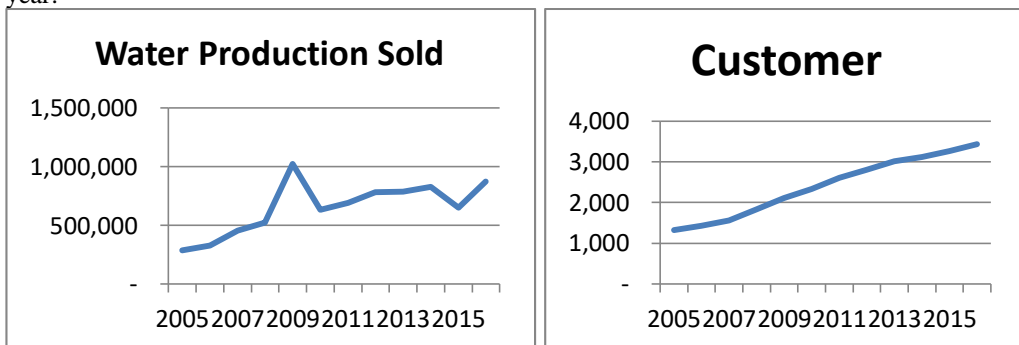
2.2 Solve Problem Method
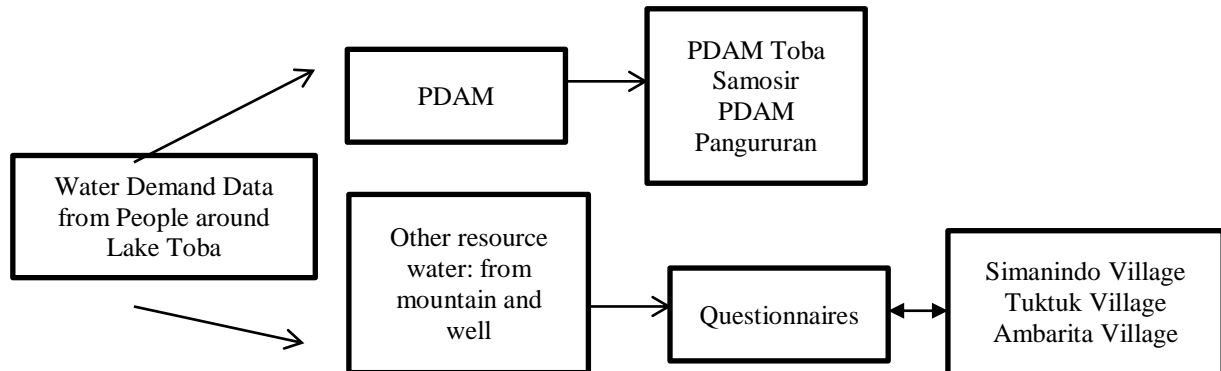
Pict 5.Data Flow Process Diagram

Step in doing the computation of total water demand in urban areas can be predicted by population with formula as below:

1) FORECAST (x, known_y's, known_x's) with equations $a = \bar{y} - b\bar{x}$ and:

$$b = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sum (x - \bar{x})^2}$$

   a. If the number is nonnumeral, then FORECAST returns the error value #VALUE !.
   b. If known_y's and known_x's are empty or contain different number of data points, FORECAST will return the # N / A error value.
   c. If the known_x's variance is equal to zero, FORECAST will return the error value # DIV / 0 !.

2) Beside with the formula above we calculate with the other computation to optimize the calculation population with other model, as seen in below:
   a. $P(t) = B(t) - D(t)$, a possible model for birth and deaths is given by $B(t) = r_b P(t)$, $D(t) = r_d P(t)$,
   b. Total variation of the population $P(t) = rP(t)$, $r = r_b - r_a \rightarrow P(t) = P0e^{rt}$
   c. $P(t)$ and $P(0) = P_0$, number of individuals of a population, $B(t) =$ Number of Birth, $D(t) =$ Number of death

3) Super Vector Machine (SVM) which is one of machine learning method. This method is devoted to Support Vector Regression (SVR).

ADD (x_c, y_c) AT THE TRAININGSET
2. SET $q_c = 0$
3. COMPUTE $f(x_c)$ AND $h(x_c)$
4. IF ($|h(x_c)| < e$)
4.1 ADD NEWSAMPLE TO THE REMAININGSET AND EXIT
5. COMPUTE $h(x_i)$, $i = 1..l$
6. WHILE (NEWSAMPLE IS NOT ADDED INTO A SET)
6.1 UPDATE THE VALUES b AND g
6.2 FIND LEAST VARIATIONS (L_{c1}, L_{c2}, L_s, L_e, L_r)
6.3 FIND MIN VARIATION $Dq_c = \min(L_{c1}, L_{c2}, L_s, L_e, L_r)$
6.4 LET FLAG THE CASE NUMBER THAT DETERMINATES Dq_c
($L_{c1} = 1$, $L_{c2} = 2$, $L_s = 3$, $L_e = 4$, $L_r = 5$)

Table Pict 6. Pseudocode Super Vector Regression (SVR)

Result and Discussion
3.1. Water demand from

6.5   LET x_l THE SAMPLE THAT DETERMINES Dq_c

6.6   UPDATE q_c, q_i, $i=1..l$ AND b

6.7   UPDATE $h(x_i)$, i Î E ÈR

6.8   SWITCH FLAG

6.8.1   (FLAG = 1)

6.8.1.1   ADD NEWSAMPLE TO SUPPORTSET

6.8.1.2   ADD NEWSAMPLE TO R MATRIX

6.8.1.3   EXIT

6.8.2   (FLAG = 2)

6.8.2.1   ADD NEWSAMPLE TO ERRORSET

6.8.2.2   EXIT

6.8.3   (FLAG = 3)

6.8.3.1   IF ($q_l = 0$)

6.8.3.1.1   MOVE SAMPLE l FROM SUPPORT TO REMAININGSET

6.8.3.1.2   REMOVE SAMPLE l FROM R MATRIX

6.8.3.1   ELSE [$q_l = |C|$]

6.8.3.2.1   MOVE SAMPLE l FROM SUPPORT TO ERRORSET

6.8.3.2.2   REMOVE SAMPLE l FROM R MATRIX

6.8.4   (FLAG = 4)

6.8.4.1   MOVE SAMPLE l FROM ERROR TO SUPPORT

6.8.4.2   ADD SAMPLE l TO R MATRIX

6.8.5   (FLAG = 5)

6.8.5.1   MOVE SAMPLE l FROM REMAINING TO SUPPORTSET

6.8.5.2   ADD SAMPLE l TO R MATRIX

Simanindo District based on growth population

The result of analysing of questionnaires indicates that :

1. The pattern of water demand in the water bodies of Lake Toba per day for daily activities is less and more about 30.45 litres/household
2. Water was taken from Lake Toba by pumping and filtered
3. The surrounding community has known the septic tank, and people have an awareness of environmental cleanliness
4. The people know the requirement value of good water quality

The results of the survey concluded that the area around Toba Samosir regency is still dependent on Lake Toba as the primary source of water for daily life. For outside the Toba regency about 500 meters from the edge of the lake body using mountain water and well water.
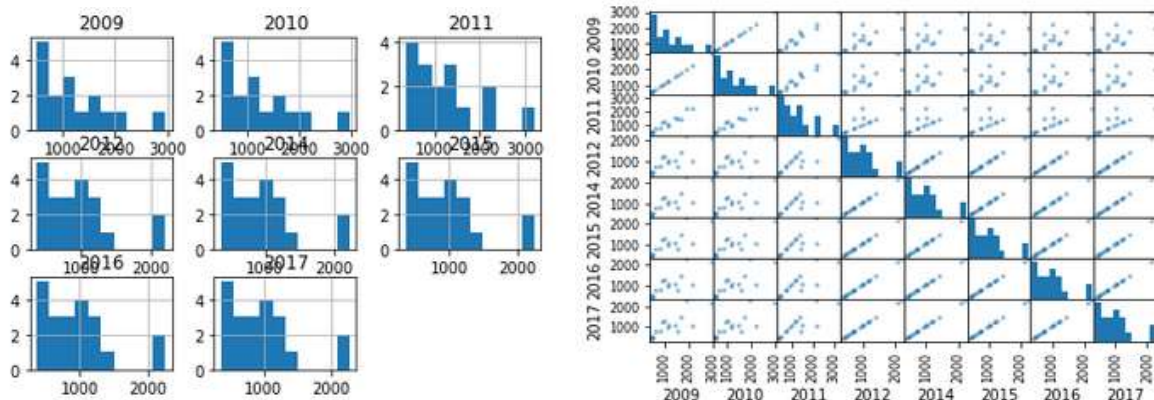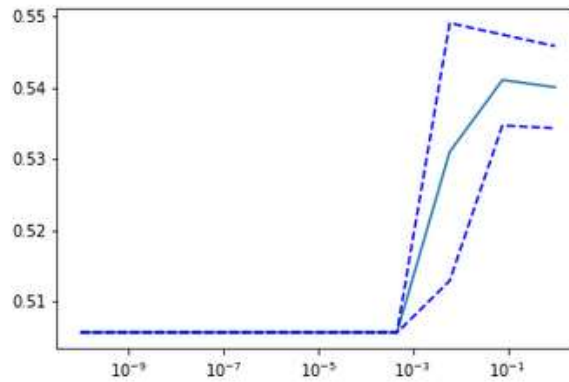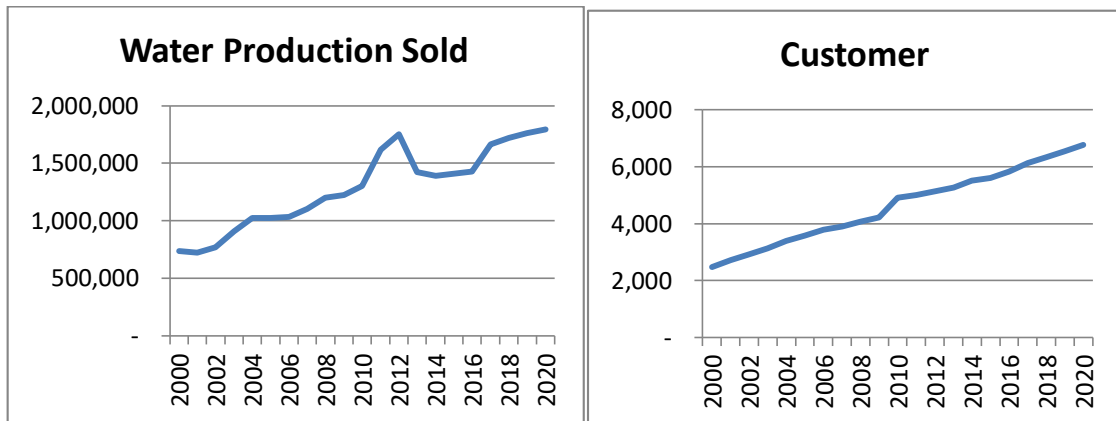
Pict 8. SVM

Water demand from Customers of PDAMs Tobasa and PDAMs Pangururan

From the results of simulations conducted related to the use of water in communities using PDAM water sourced from Lake Toba then obtained the following conclusion:

Pict 9. Trend of Water Production Sold And The Number Of Customers In Tobasa
PDAMs in year 2018-2020

The graph above shows that every year the water and customer needs in Tobasa PDAM will experience an upward trend. By 2020 it is projected that there will be an increase in water demand of approximately 300,000 cubic PDAMs of water compared to 2017 with a need for an increase of approximately 800 customers compared to 2017.
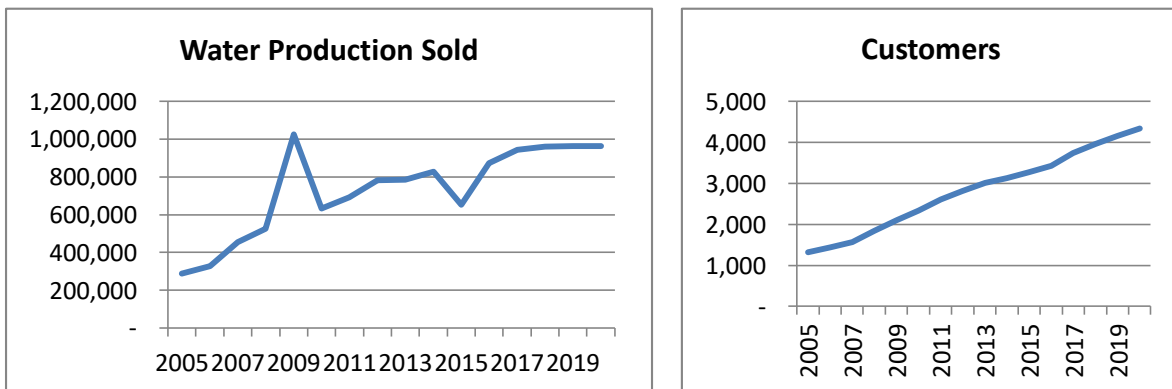
Pict 10. Trend of Water Production Sold And The Number Of Customers In Pangururan
PDAMs in year 2018-2020

The graph above shows that every year the water and customer needs in PDAM Pangururan will experience an upward trend. By 2020 it is predicted that there will be an increase of approximately 20,000 cubic water of PDAM water supply and the need of increasing of 500 customers compared to 2017

Validation of result simulations

Water demand from population growth for Simanindo District

```
In [57]: clf = clf.fit(X_train,y_train)
```

```
In [58]: print ("MSE: %.4f" % mse)
         MSE: 0.4941
```

Water demand from growth Customers for PDAMs Pangururan and PDAMs Tobasa

```
In [65]: print(accuracy_score(y_test, predictions))
         0.9629
```

CONCLUSION

There is an upward trend in water demand for PDAMs users, and there are an upward trend and decrease in water demand in Simanindo sub-district. According to Wesli, Lake Toba has a volume of 82.37 m3 / sec, while rainfall supply is 121.79 m3 / sec. The number of rivers around Lake Toba contributed 87.3 m3 / sec, bringing the total discharge to 209.09 m3 / sec. It suspected that the outflow discharge (output) is less than inflow discharge (input). Then, Lake Toba is still can be used as a source of raw water and does not affect the water level should be. It is also because the population growth in the lake water body is not too significant so that several years ahead the water demand in Toba lake water is still met. However, the water demand from Lake Toba is decreasing due to decreasing water quality. The community began to shift other water sourced than Toba lakes such as mountain water and well water. Although in Toba regency Samosir still depends on Lake Toba as the primary water source for daily life especially population at the edge of the lake, for outside Toba Samosir regency range 200 meters from the side of the lake body already using mountain water and well water. Meanwhile, in the year 2019 indicated some areas such as Simanindo village and Ambarita village decreased population due to urbanization, it's stated a decrease in water in the community. Meanwhile, in 2020, it is indicated that some areas such as Simanindo and Ambarita villages experienced a reduction in population due to urbanization, which showed a decrease in water demand in communities in some villages.

The simulation results related to the use of PDAMs water in the community from Lake Toba increased line with the demand for water quantity and the increasing number of consumers in 2019.

Proposition

The data of tourism visitors both domestic and international has not included yet due to the limited time of the data survey. It expected that from tourism data could provide a more detailed explanation of the research object.

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