A STUDY OF URBAN WATER DEMAND IN SOUTH KALIMANTAN PROVINCE

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ABSTRACT

This research projected the citizens and water demand in 13 regencies/cities in South Kalimantan Province from 2013 to the next 20 years. The results of the project were compared with the intake capacity to meet the demand in upcoming years. In projecting the population growth, five methods were used, namely aritmethic method, geometric method, linier regression method, exponential method and logarithmic method. The most appropriate method for projecting the population growth is the method which has the minimum value of standard deviation and the correlation value close to 1. Water demand was calculated based on some factors, such as the average water demand, the maximum level of water demand, and the water demand at peak hours. The existing intake capacity was then compared with the water demand projection. In almost all PDAM (Munipical Tap Water Company) observed, the capacity of water processing installation could not fullfill the water demand at the peak hours. The adequate intake capacity of PDAM was only in Balangan regency and Banjarmasin city.

Keywords: intake capacity, South Kalimantan Province, urban water demand

INTRODUCTION

Water resource plays an important role in supporting individual life, community, socio-economic development of a region and environmental ecosystem. Various economic activities such as supplying raw water for household, agriculture, municipality, industry and energy always require not only the proper quantity and quality but aLo the reliable and sustainable service. The management of water resource manufacturing faces several complex issues in line with the population growth and the social and economic growth. In one part, the population growth increases the water demand for various purposes; on the other hand it leads to exploitation of water resources and its supports. The increasing water demand is in line with the population growth, social life standard improvement and economic development. Economic development in a region affects the population growth through the increase in vertility, chance of survival and mobility.

The high rate of economic development will be followed by the increase in urban water demand. Hence, the study of urban water demand in thirteen (13) regencies and cities in South Kalimantan province in the near future needs to be carried out.

The purposes of this study were to find out the percentage of the existing population growth based on the data of population for 5 years in order to predict the number of citizens for the next 5, 10, 15 and 20 years, to calculate the recent water demand until the next 20 years with an interval of 5 years, and to compare the intake capacity with the amount of water consumption in PDAM until the next 20 years.

METHODS

The percentage of population growth is needed to determine the average rate of population growth each year. The percentage of population growth can be calculated using the formula:

$$r = \frac{\sum((P2-P1)/P1)}{(T2-T1)} \text{ x } 100\%$$

Explanation:

r = percentage of population growth

P_1 = number of first-year population (known)

P_2 = number of last-year population (known)

T_1 = first year (known)
T_2 = last year (known)

The projection of population in the future is very important in calculating the amount of drinking water demand in the future. This projection is based on the rate of urban development trend, direction of land use and availability of land to accommodate population growth.

Regarding to the rate of population growth in the past, statistical method is the most approriate method to estimate the number of citizens in the future. There are several methods that can be used to analyze the population growth in the future, namely arithmetic, geometric, linear regression, exponential and logarithmic methods.

To establish which method to be used, the determination of the lowest correlation value (r^2) and standard deviation (STD) are needed.

$$r^2 = \frac{n\sum(P.Pn) - (\sum P)(\sum Pn)}{\sqrt{(n\sum(P)^2 - (\sum P)^2)(n\sum(Pn)^2 - (\sum Pn)^2)}}$$

$$\mathbf{STD} = \sqrt{\frac{\sum(\mathbf{P_n} - \bar{\mathbf{P}}_\mathbf{n})^2}{\mathbf{n-1}}}$$

Factors influencing the projection of clean water demand are as follow.

1. The number of population growth every year.
2. Service standard.
3. Water demand for installation and operational needs.
4. Water loss factor.

For analyzing clean water demand, domestic and non domestic water demands need to be taken into account.

The standard of domestic water demand according to Directorate General of Cipta Karya, Department of Public Works (DPU) 1996, can be seen in Table 1. Non domestic water demand based on the planning criteria in DPU can bee seen in Table 2 to 4. These tables display a standard that can be used to calculate urban water demand if the detailed data about city and its facilities can be provided.

Table 1. Criteria of clean water planning

Data	City Category According To Number Of Population				
	>1,000,000	500,000 -1,000,000	100,000 - 500,000	200,000 - 100,000	<20,000
	Metropolis	Big city	Middle Town	Little Town	Village
Household unit (SR) Consumption (L/person/day)	190	170	130	100	80
Hidrant Unit(HU) Consumption	30	30	30	30	30
Non Domestic Consumption Unit(L/person/day)	20-30	20-31	20-32	20-33	20-34
Water Loss (%)	20-30	20-30	20-30	20-30	20-30
Maximum Day Factor	1.1	1.1	1.1	1.1	1.1
Peak Hour Factor	1.5	1.5	1.5	1.5	1.5
The number of citizens in every SR (person)	5	5	5	5	5
The number of citizens in every HU (person)	100	100	100	100-200	200
The rest of water in distribution provider (meter)	10	10	10	10	10
Operational Hours (hour)	24	24	24	24	24
The Volume of Resevoir (%) (Max Day Demand)	15-25	15-25	15-25	15-25	15-25
SR : HU	50 : 50 to 80 : 20	50 : 50 to 80 : 20	80 : 20	70 : 30	70 : 30
The Coverage Service Area (%)	90	90	90	90	70

Source: Directorate General of Cipta Karya, Departement of Public Works (1996)

Table 2. Non Domestic Urban Water Demand Type I, II, III, and IV

Sector	Value	Unit
School	10	L/student/day
Hospital	200	L/bed/day
Local gvt. Clinic	2000	L/day
Mosque	3000	L/day
Office	10	L/officer/day
Market	12000	L/hectare/day
Hotel	150	L/bed/day
Restaurant	100	L/seat/day
Military Base	60	L/man/day
Industrial Area	0.2-0.8	L/sec/hectare
Tourism Area	0.1-0.3	L/sec/hectare

Source: Directorate General of Cipta Karya, Departement of Public Works (1996)

Table 3. Non Domestic Urban Water Demand Type V (village)

Sector	Value	Unit
School	5	L/student/day
Hospital	200	L/bed/day
Local gvt. Clinic	1200	L/day
Mosque	3000	L/unit/day
Little Mosque	2000	L/unit/day
Hotel	90	L/day
Industrial Area	10	L/day

Source: Directorate General of Cipta Karya, Departement of Public Works (1996)

Table 4. Non Domestic Urban Water Demand Other's Type

Sector	Value	Unit
Airport	10	L/sec
Port	50	L/sec
Train Station-Bus Terminal	10	L/sec
Industrial Area	0.75	L/sec

Source: Directorate General of Cipta Karya, Departement of Public Works (1996)

RESULTS AND DISCUSSION

According to Wikipedia Indonesia and the data from BPS South Kalimantan Province about the calculation data of population in 13 regencies / cities, the following are the results of the projection of population in South Kalimantan Province every five years.

Table 5. Population Projection in South Kalimantan Province

Regency/City	Population (person)				
	2013	2018	2023	2028	2033
Balangan	119,171	132,147	147,406	162,665	177,924
Banjar	533,739	563,399	588,310	627,756	662,641
Barito Kuala	289,995	309,789	330,888	353,425	377,496
Hulu Sungai Selatan	224,474	238,674	252,874	267,074	281,274
Hulu Sungai Tengah	155,113	270,658	287,448	304,238	321,028
Hulu Sungai Utara	219,210	237,395	255,580	273,765	291,950
Kotabaru	308,730	325,951	346,784	367,617	388,450
Tabalong	231,718	240,865	247,616	252,283	255,852
Tanah Bumbu	306,185	333,185	353,259	367,133	377,746
Tanah Laut	313,725	337,096	362,153	389,072	417,992
Tapin	176,468	185,281	191,248	195,372	198,527
Banjarbaru	219,758	249,279	282,767	320,752	363,841
Banjarmasin	656,778	676,542	707,896	740,703	775,030

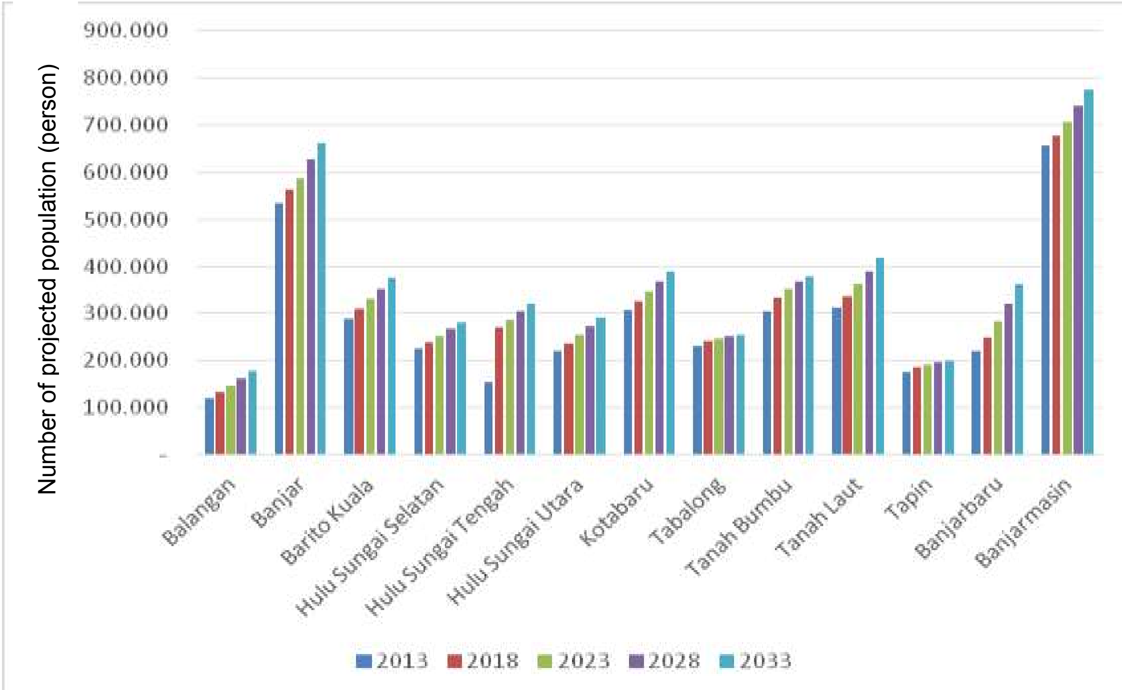

Figure 1. Projection of population in regencies/cities in South Kalimantan Province

In 2033, the lowest number of population is in Balangan regency with total 177,924 people and the highest number in Banjarmasin city by 775,030 people. The average number of population in South Kalimantan Province is 376,135 people.

Table 6. Domestic water demand in regencies/cities in South Kalimantan Province

Regency/City	Domestic water demand (L/sec)				
	2013	2018	2023	2028	2033
Balangan	118.7	134.6	159.5	186.4	203.9
Banjar	92.6	173.6	277.8	421.3	674.1
Barito Kuala	121.1	197.2	252.8	315.0	384.5
Hulu Sungai Selatan	167.3	151.9	193.2	238.0	286.5
Hulu Sungai Tengah	152.1	172.3	219.6	271.1	327.0
Hulu Sungai Utara	121.0	159.0	212.0	270.0	335.0
Kotabaru	242.1	356.2	464.8	585.0	719.5
Tabalong	76.7	130.0	185.4	241.6	298.5
Tanah Bumbu	279.1	313.9	341.8	364.6	384.7
Tanah Laut	39.4	214.6	276.6	346.7	425.7
Tapin	172.1	188.7	199.7	211.4	227.5
Banjarbaru	88.2	182.3	264.9	502.7	730.0
Banjarmasin	1,015.6	1,111.9	1,163.4	1,217.4	1,273.8

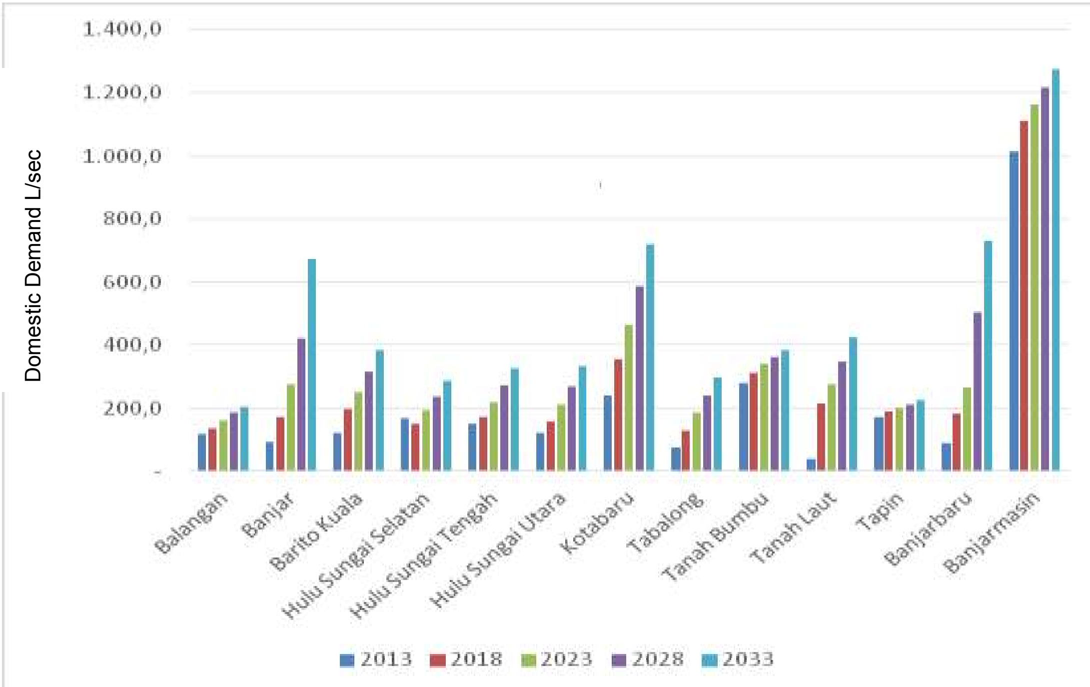

Figure 2. Domestic water demand in regencies/cities in South Kalimantan Province

In 2033, the lowest domestic water demand is in Balangan regency by 204 L/sec and the highest is in Banjarmasin city by 1274 L/sec with the average rate of entire South Kalimantan Province population by 482 L/sec.

Table 7. Non domestic water demand in regencies/cities in South Kalimantan Province

Regency/City	Non Domestic Water Demand (L/sec)				
	2013	2018	2023	2028	2033
Balangan	17.6	19.9	23.6	27.6	30.1
Banjar	28.5	49.4	79.1	119.9	191.8
Barito Kuala	36.8	59.9	76.8	95.7	116.8
Hulu Sungai Selatan	35.2	31.9	40.6	50.0	60.2
Hulu Sungai Tengah	40.0	45.3	57.7	71.3	86.0
Hulu Sungai Utara	35.0	46.0	61.0	78.0	97.0
Kotabaru	35.0	58.6	85.5	115.2	148.0
Tabalong	46.5	112.4	146.5	181.0	112.4
Tanah Bumbu	32.7	36.8	40.1	42.7	45.1
Tanah Laut	39.4	85.8	138.3	198.2	266.1
Tapin	24.1	26.4	28.0	29.6	31.8
Banjarbaru	22.5	46.5	67.5	128.1	186.0
Banjarmasin	63.8	69.8	73.1	76.5	80.0

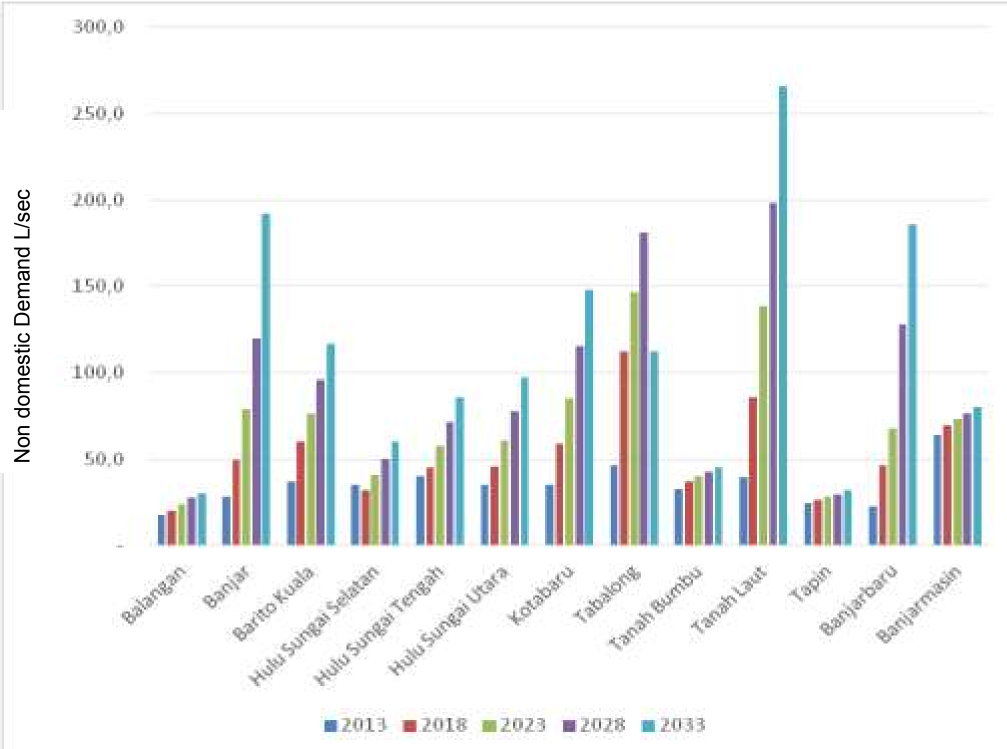

Figure 3. Non domestic water demand in regencies/cities in South Kalimantan Province

In 2033, the lowest non domestic water demand is in Balangan regency by 30 L/sec and the highest in Tanah Laut regency by 266 L/sec with the average rate of the entire South Kalimantan province population by 266 L/sec.

Table 8. Water demand at peak hours in regencies/cities in South Kalimantan Province

Regency/City	Water Demand at Peak Hours (L/sec)				
	2013	2018	2023	2028	2033
Balangan	244.7	278.1	329.6	385.1	421.2
Banjar	318.7	579.9	913.5	1,363.8	2,164.8
Barito Kuala	311.2	501.4	617.9	708.4	827.1
Hulu Sungai Selatan	399.9	355.0	440.8	530.1	627.7
Hulu Sungai Tengah	378.8	414.5	519.9	631.8	743.3
Hulu Sungai Utara	303.0	383.0	511.0	653.0	809.0
Kotabaru	234.7	392.5	571.5	766.4	978.6
Tabalong	221.7	536.1	698.6	863.0	536.1
Tanah Bumbu	546.3	614.4	669.0	713.6	753.0
Tanah Laut	149.4	324.5	514.6	725.2	957.9
Tapin	370.4	403.4	416.5	437.5	466.8
Banjarbaru	291.3	594.7	851.1	1,589.6	2,290.0
Banjarmasin	2,092.1	2,251.2	2,318.5	2,387.1	2,436.8

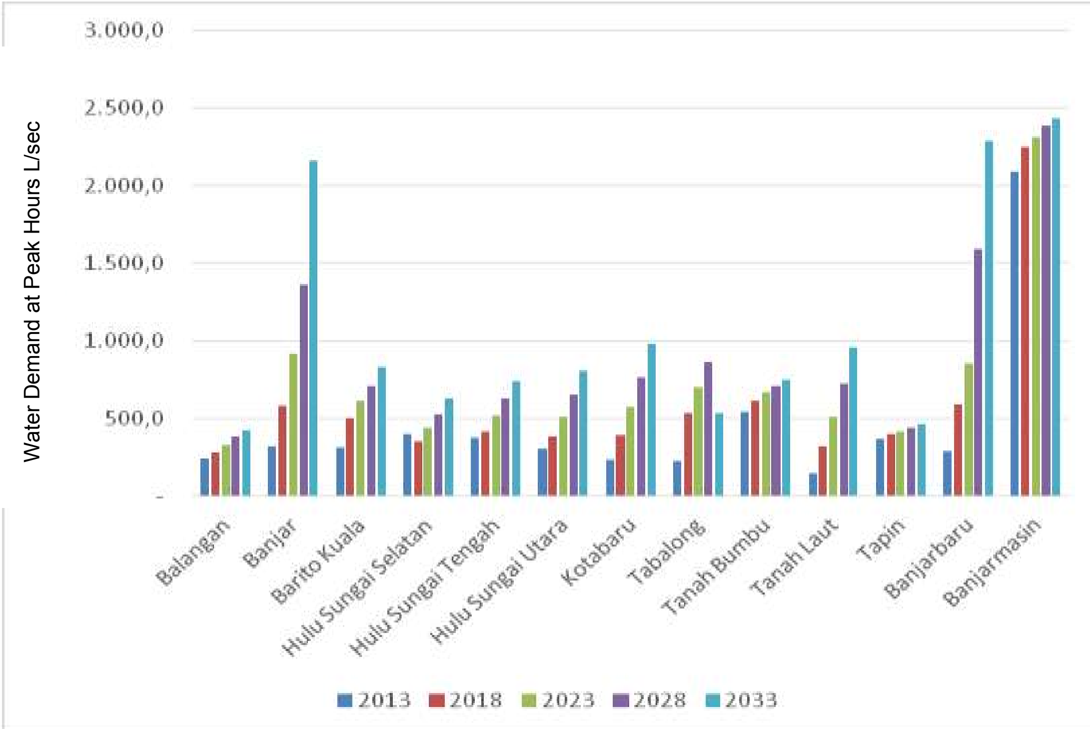

Figure 4. Water demand at peak hours in regencies/cities in South Kalimantan Province.

In 2033, the lowest water demand at peak hours is in Balangan by 421 L/sec and the highest is in Banjarmasin by 2437 L/sec with the average rate of the entire South Kalimantan population by 1078 L/sec.

Table 9. Intake capacity and water processing installation (IPA) capacity in regencies/cities of South Kalimantan Province.

Regency/City	The Total of Intake Capacity (L/sec)	IPA Capacity (L/sec)	Year	
			Intake	IPA
Balangan	420	105	2033	2013
Banjar	360	360	2018	2018
Barito Kuala	310	310	2013	2013
Hulu Sungai Selatan	235	205	2013	2013
Hulu Sungai Tengah	169	169	2013	2013
Hulu Sungai Utara	298	298	2013	2013
Kotabaru	175	175	2013	2013
Tabalong	350	350	2018	2018
Tanah Bumbu	546	546	2013	2013
Tanah Laut	142	107	2013	2013
Tapin	452	328	2018	2013
Banjarbaru	360	360	2018	2018
Banjarmasin	3.500	2.100	Secured	2018

Based on the data in Tables 8 and 9, almost in all PDAM, the water processing installations could not meet the water demand at peak hours. Only Balangan regency and Banjarmasin city could afford it. Thus, the local government has to make new plans to increase the water processing installation (IPA) capacity and the machines in intake. Moreover, they have to think about new location of intake.

From the percentage in 2033, the regency or city which experiences the smallest population increase is Tabalong regency and the highest Hulu Sungai Tengah regency. However, the lowest increase in water demand at peak hours is in Banjarmasin city and the highest is in Banjarbaru city. This is understandable because the province capital has been moved from Banjarmasin to Banjarbaru since 2012.

CONCLUSIONS

From the results of data analysis in this research, it can be concluded that the lowest number of population is in Balangan regency (177,924 persons) and the highest is in Banjarmasin city (775,030 persons). However, the area with the lowest rate of population growth is Tabalong regency and the highest is Hulu Sungai Tengah regency. The lowest rate of water demand at peak hours is in Balangan regeny by 421 L/sec and the highest in Banjarmasin city by 2437 L/sec with the average number of population in South Kalimantan Province by 1,078 L/sec. However, the lowest rate of water demand at peak hours is in Banjarmasin and the highest in Banjarbaru. Almost in all PDAM, the capacity of water processing installation cannot meet water demand at peak hours. Only Balangan regency and Banjarmasin city have sufficient intake capacity.

There are some recommendations for providing clean water in Banjarmasin city. First, PDAM Banjarmasin must surpress the water loss until less than 20% in order to optimalize water distribution to citizens. Second, it needs to maintain the quality and sustainability of the environment near water sources and to prevent deforestation and river pollution. Next, it should maintain the efforts to optimalize the fulfillment of clean water demand such as by increasing both the existing capacity and intake production by adding the water extraction pump and increasing the volume of water processing shelter; increasing the number of intake points in rivers that have the potential for water resources for PDAM; optimalizing the water pump performance by replacing old pumps to maintain the stability of distributed water discharge; establishing a construction plan of artificial basin as the back-up water supply in case the existing water capacity is insufficient to meet water demand continually.

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