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- The theoretical framework needs to be improved, with more citations and more discussion of previous work

- The tables have problems. They need to be resubmitted considering the margins of the article.

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A STUDY ON THE PROJECTION OF DRINKING WATER 2023-2033 IN DKI JAKARTA INDONESIA

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ABSTRACK

Purpose: The purpose of this research is to analyze the drinking water needs and raw water availability of DKI Jakarta Province.

Theoretical framework: The theoretical basis for the population projections uses mathematical modeling (arithmetic, logarithmic, exponential, and geometric) for the next 10 years. Drinking water demand projections are obtained by calculating the demand for drinking water and the results of the population projections. Then compared to raw water availability. Potable water demands are calculated based on design criteria

Method/design/approach: The method used is research and development by projecting the population of the last 10 years to predict the population of the next 10 years. The total projected drinking water needs obtained were compared with the availability of raw water.

Results and conclusion: The results show that the demand for drinking water in DKI Jakarta in 2023 will be 30,892 liters/second, while the raw water capacity will only be 16,850. This shows that the level of drinking water service in DKI Jakarta is only 54.54%. When compared to 2015, DKI Jakarta's drinking water access service decreased from 65.13% in 2015 to 54.54% in 2023.

Research implications: If DKI Jakarta does not succeed in finding raw water sources, it is estimated that drinking water services will drop dramatically to 35.68% in 2033.

Originality/value: Studies on the projection of drinking water in DKI Jakarta, Indonesia for the next 10 years have not been conducted. So this study has good originality and becomes a study with high novelty. This study can also be utilized by DKI Jakarta government authorities in formulating environmental and health management policies.

Keywords: DKI Jakarta, drinking water, raw water projection, water safety.

UM ESTUDO SOBRE A PROJECÇÃO DE ÁGUA POTÁVEL 2023-2033 EM JACARTA INDONÉSIA DKI

RESUMO

Objetivo: O objectivo desta investigação é analisar as necessidades de água potável e a disponibilidade de água bruta da Província de Jacarta DKI.

Referencial teórico: A base teórica para as projecções populacionais usa modelação matemática (aritmética, logarítmica, exponencial, e geométrica) para os próximos 10 anos. As projecções da procura de água potável são obtidas através do cálculo da procura de água potável e dos resultados das projecções da população. Depois, em comparação com a disponibilidade de água crua. As necessidades de água potável são calculadas com base em critérios de concepção.

Método: O método utilizado é a investigação e desenvolvimento, projectando a população dos últimos 10 anos para prever a população dos próximos 10 anos. As necessidades totais projectadas de água potável obtidas foram comparadas com a disponibilidade de água bruta.

Resultados e conclusão: Os resultados mostram que a procura de água potável em Jacarta DKI em 2023 será de 30.892 litros/segundo, enquanto a capacidade de água bruta será de apenas 16.850. Isto mostra que o nível de serviço de água potável em Jacarta DKI é de apenas 54,54%. Quando comparado com 2015, o serviço de acesso à água potável da DKI Jacarta diminuiu de 65,13% em 2015 para 54,54% em 2023.

Implicações da pesquisa: Se a DKI Jacarta não conseguir encontrar fontes de água bruta, estima-se que os serviços de água potável irão cair drasticamente para 35,68% em 2033.

Originalidade/valor: Estudos sobre a projecção de água potável em Jacarta DKI, Indonésia, nos próximos 10 anos não foram realizados. Portanto, este estudo tem boa originalidade e torna-se um estudo com grande novidade. Este estudo também pode ser utilizado pelas autoridades governamentais da DKI de Jacarta na formulação de políticas de gestão ambiental e de saúde.

Palavras-chave: DKI Jacarta, água potável, projecção de água bruta, segurança da água.

1 INTRODUCTION

Water is abundant in nature, with many sources that humans can utilize to meet their daily water needs. Water is a mandatory component in human survival. Every day humans use water for many things to fulfill their needs. Humans make use of water sources from existing nature, to then process it into water that is suitable for their use(Jamwal, 2019). Raw water for drinking water is an important factor in the continuation of human life and other living matters(Karimi Alavijeh et al., 2021). Raw water for human drinking water must meet several characteristics, including physical, chemical, and biological characteristics(Chhabra, 2017; Luby et al., 2018; Muharemi et al., 2019).

Contaminated drinking water can lead to various waterborne diseases(Cifuentes et al., 2002; Nafi'u & T K, 2016; Njiru et al., 2016; Nyagwencha et al., 2013). Study review conducted by Firmansyah et al. (2021) drinking water quality contaminated with E. coli can cause diarrhea in toddlers (Firmansyah et al., 2021). Diarrhea disease globally is one of the waterborne diseases with a mortality of 1.8 million people with the number of cases per year reaching 4 billion(WHO, 2014). Study in underdeveloped countries, diarrhea in children causes up to 90% mortality(WHO\UNICEF, 2021). WHO revealed that 6.3% of deaths in the world are caused by access to unsafe drinking water, hygiene, sanitation facilities, and poor water management(Prüss-Üstün et al., 2008). In line with WHO, the United Nation announced that 780 million people of the world's total population lack access to safe clean water, and 2.5 billion people in developing countries live with inadequate sanitation facilities (WHO, 2014).

Water usage can be grouped into several purposes such as household needs which are usually used for drinking, cooking, bathing, washing purposes, and others(Haghiabi et al., 2018). Meanwhile, for industrial purposes, water is used as a staple in the beverage or food industry, besides that water is also used as an auxiliary material, such as cooling water, washing water, and others(Raux-Defossez et al., 2018). Water is also used for public purposes such as for the maintenance of city parks, drainage of city channels, water supply for fire fighting, and many more(Kondo et al., 2019).

The availability of drinking water that meets the requirements for human needs is relatively small because it is limited by various factors(EL-Nwsany et al., 2019). Such exploitation of natural resources can lead to reduced groundwater reserves in the future(Susilo & Jafri, 2019). The magnitude of human needs for water leads us to be able to design drinking water supply systems, to provide drinking water that continues to meet human needs. Many sources of water can be utilized, such as springs, rivers, and even seawater and wastewater have been further treated to be consumed as drinking water. Water from various sources is further treated before being distributed to consumers.

Communities in the current era are no longer the object of development, but rather the subject of development(Goel et al., 2020). Therefore, for drinking water and sanitation issues, it must be carefully carried out as well as possible by the relevant parties. This can be done with the Acceleration of Sanitation and Settlement Development. District sanitation working groups, which are the pioneers in implementing the Acceleration of Sanitation and Settlement Development in the regions, need to instill sanitation ideology in stakeholders, the private sector, and the community to achieve universal access to the sanitation and water supply sectors(Muller et al., 2017). The lack of regional readiness to achieve this is a challenge in this universal access program. therefore,.

Drinking water with good quality and quantity is related to environmental conditions. The damaged environment can be caused by the increasing population. The increasing population increases the need for drinking water. Therefore, good handling is needed in processing, supplying and distributing drinking water, to meet the needs of the community for drinking water. So it is necessary to collect data on the drinking water needs of an area and the availability of raw water for a drinking water supply system design. So that a drinking water supply system is formed that is able to meet the needs of the community continuously and has a good level of service. The purpose of this research is to analyze the drinking water needs and raw water availability of DKI Jakarta Province.

2 THEORETICAL FRAMEWORK

The secondary data collected was the population for the last 10 years of DKI Jakarta Province. This data is used to project the population to determine the need for drinking water in the next few years. The population of the last 10 years of DKI Jakarta province can be seen in table 1,

Table 1. The Population of DKI Jakarta Province 2011-2020

No	Year	Total Population
1	2011	9,752,101
2	2012	9,862,088
3	2013	9,969,948
4	2014	10,075,310
5	2015	10,177,924
6	2016	10,277,628
7	2017	10,374,235
8	2018	10,467,629
9	2019	10,557,810
10	2020	10,644,986

Source: (Nuraini and Jatmiko, 2015)

In addition to 10-year population data, the data needed is the availability of raw water in DKI Jakarta Province. The availability of raw water processed by two PAM Jaya operators, Palyja and Aaetra, can be seen in Table 2,

Table 2. The Availability of Raw Water Sources in DKI Jakarta 2023

No	Operator	Units	Debit (Liters/Second)
1	Palyja*)	IPA Pejompongan 1	2,650
		IPA Pejompongan 2	3,650
		IPA Cilandak	400
		City Park IPA	150
2	Aetra**)	IPA Buara 1	3,000
		IPA Round 2	3,000

	IPA Pulo Gadung	4,000
Total		16,850

Source:*) (Palyja, 2022), **) (Aetra, 2022)

The population for the next few years will be projected using several methods. The methods to be used are arithmetic, logarithmic, exponential, and geometric. The methods will be compared and the best method will be selected to be used in projecting the population of DKI Jakarta for the next 10 years. Projections of drinking water demand are obtained by calculating the demand for drinking water and the results of population projections. Then compared with the availability of raw water. Drinking water needs are calculated based on design criteria. Drinking water supply design criteria can be seen in table 3,

Table 3. Indonesian Community Drinking Water Needs Standard in 2022

No	Description of Criteria	Category Metro (>1000k)souls	large (500k-1000k)souls	Medium (100-500k) souls	small (20-100k)souls	Village (<20k)souls
1	Service Coverage (%)	90 Piping 60 BPJ 30	90 Piping 60 BPJ 30	90 Piping 60 BPJ 30	90 Piping 60 BPJ 30	90 Piping 60 BPJ 30
2	SR Consumption (L/o/h)	190	170	150	130	30
3	HU Consumption (L/o/h)	30	30	30	30	30
4	Number of Souls /SR	5	5	6	6	10
5	Number of Souls / HU	100	100	100	(100-200)	200
6	SRs: HU	(50:50) to (80:20)	(50:50) to (80:20)	80:30	70:30	70:30
7	Non Domestic Consumption (%)	(20-30)	(20-30)	(20-30)	(20-30)	(20-30)
8	Water Loss (%)	(20-30)	(20-30)	(20-30)	(20-30)	20
9	Max day factor	1.1	1.1	1.1	1.1	1.1
10	Peak hours factor	1.5	1.5	1.5	1.5	1.5
11	Min & max water pressure in pipe (mka)	10 & 70	10 & 70	10 & 70	10 & 70	10 & 70
12	Hours of Operation	24	24	24	24	24

Source: (Ministry of Settlement and Regional Infrastructure Indonesia, 2003)

The study was also used in water scarcity, water demand, water resources, water pollution until 2050 in several countries such as Pakistan, India, Bangladesh, Angola, Malawi, and Uganda (Boretti & Rosa, 2019). In line with this method, in Myanmar, it is used to determine the needs of irrigation water use, domestic activities, and drinking water (Re et al., 2021). Study in the City of Dili East Timor-Leste using geometry model projections for water utilities in the 2017-2027 timeframe (Santos & Santosa, 2020). Geometric modeling is also used in Germany for drinking water reservoirs and potential adaptation strategies (Mi et al., 2020). This study will be helpful in supporting effective water supply and the achievement of sustainable development goals (Grejo & Lunkes, 2022). In addition, it can be used as an environmental instrument to inform policy formulation (Silva et al., 2022).

3 METHOD

This study used a research and development method. The research conducted in this study is the availability of raw water in the DKI Jakarta province of Indonesia in 2023. The first development conducted in this study is population projection and population comparison using arithmetic, logarithmic, exponential, and geometric modeling in 2011-2033. The second is the projection of drinking water needs in DKI Jakarta province, Indonesia in 2023-2033. Third is the existing drinking water services in DKI Jakarta province. This study uses secondary data, with data sources from the journal for the total population in DKI Jakarta province during 2011-2020; data sources for the availability of raw water sources are obtained from the Jaya DKI Jakarta drinking water treatment agency.

4 RESULT AND DISCUSSION

4.1. The Projection of Total Population

The projection of the future population serves to estimate the need for drinking water. The population of DKI Jakarta will be projected for the next 10 years using four projection methods, namely,arithmetic method, logarithmic method, exponential method, geometry method. Determination of the best method is obtained by comparing the four methods, namely by looking at the standard deviation value (S) which is the smallest and the correlation coefficient (R) which is close to 1 for each method. Population growth projections with the 4 methods can be seen in Table 4. From the four population projection methods a comparison of population growth can be obtained as shown in table 5 and figure 1 ,

Table 4. DKI Jakarta Population Growth Projection with 4 Methods

Year	Population Projection				Population
	Arithmetic	Logarithm	Exponential	geometric	
2011	9,768,941	9,619,725	9,774,162	9,630,136	9,752,101
2012	9,868,280	9,893,342	9,869,801	9,892,906	9,862,088
2013	9,967,619	10,053,398	9,966,376	10,049,928	9,969,948
2014	10,066,958	10,166,959	10,063,895	10,162,847	10,075,310
2015	10,166,296	10,255,044	10,162,369	10,251,306	10,177,924
2016	10,265,635	10,327,015	10,261,806	10,324,153	10,277,628
2017	10,364,974	10,387,866	10,362,216	10,386,149	10,374,235
2018	10,464,313	10,440,577	10,463,609	10,440,152	10,467,629
2019	10,563,652	10,487,071	10,565,994	10,488,020	10,557,810
2020	10,662,991	10,528,662	10,669,381	10,531,025	10,644,986
2021	10,762,329	10,566,285	10,773,779	10,570,080	
2022	10,861,668	10,600,632	10,879,199	10,605,860	
2023	10,961,007	10,632,229	10,985,651	10,638,882	
2024	11,060,346	10,661,483	11,093,144	10,669,547	
2025	11,159,685	10,688,717	11,201,688	10,698,176	
2026	11,259,023	10,714,194	11,311,295	10,725,025	
2027	11,358,362	10,738,125	11,421,975	10,750,307	
2028	11,457,701	10,760,688	11,533,737	10,774,199	
2029	11,557,040	10,782,031	11,646,593	10,796,847	
2030	11,656,379	10,802,279	11,760,553	10,818,377	
2031	11,755,717	10,821,538	11,875,628	10,838,897	
2032	11,855,056	10,839,902	11,991,830	10,858,497	
2033	11,954,395	10,857,449	12.109.168	10,877,260	

Table 5. Comparison of DKI Jakarta Population Growth Analysis Methods 2011-2033

Method	Standard Deviation (S)	Correlation Coefficient (R)
Arithmetic	11211.08	1.00
Logarithm	82,800.56	0.96
Exponential	14,922.90	1.00
Ge	79013.25	0.96

ometry

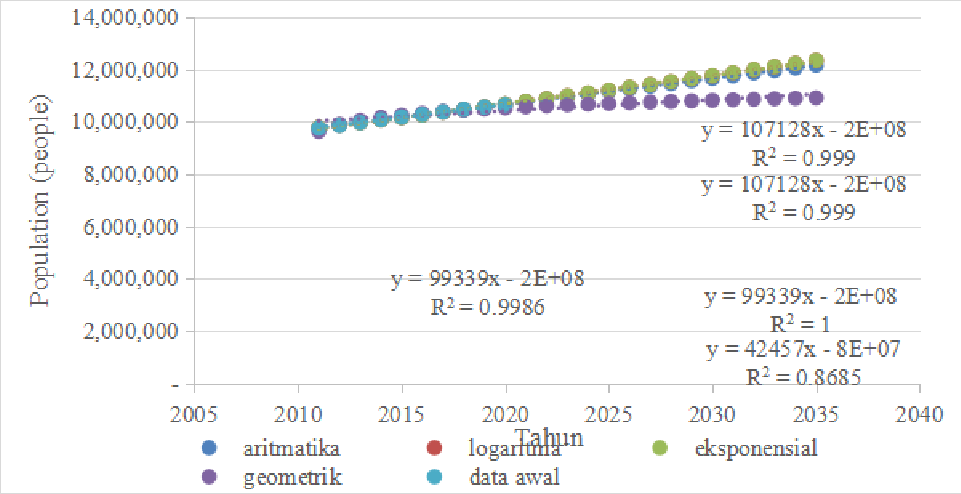

Figure 1. Comparison of DKI Jakarta Population Growth Analysis Methods 2011-2033

Based on the S and R values, it can be seen that the arithmetic method has the smallest S value, namely 0 and the R value is 1. Then the population projection method chosen is the arithmetic method. The projected results of the selected population can be seen in table 6,

Table 6. Results of Population Growth Analysis with Selected Methods 2011 to 2033

Year	**Population**	**Arithmetic**
2011	9,752,101	9,768,941
2012	9,862,088	9,868,280
2013	9,969,948	9,967,619
2014	10,075,310	10,066,958
2015	10,177,924	10,166,296
2016	10,277,628	10,265,635
2017	10,374,235	10,364,974
2018	10,467,629	10,464,313
2019	10,557,810	10,563,652
2020	10,644,986	10,662,991
2021		10,762,329
2022		10,861,668
2023		10,961,007
2024		11,060,346
2025		11,159,685
2026		11,259,023
2027		11,358,362
2028		11,457,701
2029		11,557,040
2030		11,656,379
2031		11,755,717
2032		11,855,056
2033		11,954,395

4.2. Projection of Drinking Water Needs

The projected need for clean water is calculated based on the projected population which will be served until the end of the planning year and water demand standards drink for all kinds of customers. Basic calculation for a capacity system, the stages are determination of service areas, population projections, total population served, comparison of SR and HU, determination of water consumption and water loss, loss of water, factor maximum days and peak hours. The final capacity of clean water products besides being determined by the amount to be served, on the other hand is limited by the availability of raw water and financial feasibility from the results of a socio-economic survey. From the results of this study it can be seen that the ability and willingness to become a customer will ultimately determine the service ratio between house connections and public faucets.

Determination of the ratio between the house connection and the public faucet determines the amount of water capacity needed for domestic use directly and the total need for clean water indirectly. Calculation of domestic needs increases in line with the increase in population(Jaiswal et al., 2018). The steps for calculating the need for clean water, firstly calculating the required water discharge according to the potential of the customer exist in the service area until the end of the planning year. Secondly, allocating water discharge according to the results of the calculation after taking into account the crest factor and water leakage(Luo et al., 2018, 2019; Myronidis et al., 2018). There are several standards for drinking water issued by national and international institutions. One of the drinking water demand standards issued by the Ministry of Settlement and Regional Infrastructure in 2003 can be seen in Table 3. The projected demand for drinking water for DKI Jakarta can be seen in table 7.

Table 7. Projection of Drinking Water Needs for DKI Jakarta 2023-2033

No	Description	Unit	Year		
			2023	**2028**	**2033**
Population					
1	Total population	Soul	10,961,007	11,457,701	11,954,395
2	Resident Services	%	71.35	85,67	100
3	Served Residents	Soul	7,820,678	9,815,812	11,954,395
Donestic Needs					
4	SR Service	%	80	80	80
		Soul	6,256,543	7,852,650	9,563,516
		Soul/ s	5	5	5
		Number of SRs	1,251,309	1,570,530	1,912,703
	Water Usage	liters/person/day	190	190	190
		Liters/sb/day	950	950	950
		Liters/second	13,758.60	17,268.56	21030.88
5	HU Services	%	20	20	20
		Soul	1,564,136	1,963,162	2,390,879
	Water Usage	liters/person/day	30	30	30
		Liters/second	543,10	681.65	830,17
7	Domestic Totals	Liters/second	14,301.70	17950.21	21,861.05
Non-Domestic Needs					
7	Total Non-Domestic	%	20	20	20
		Liters/second	2860.34	3590.04	4,372.21
Water Needs					
8	Total Water Needs	Liters/second	17162.04	21,540.26	26,233.26
9	Loss of Water	%	20	20	20
		Liters/second	3,432.41	4308.05	5,246.65
10	Water Needs				
	Average	Liters/second	20,594.45	25,848.31	31,479.91
	Peak Daily	Factor	1,2	1,2	1,2
		Liters/second	24,713.34	31017.97	37,775.89
		m^3/sec	24,71	31.02	37,78

No	Description	Unit	Year		
			2023	2028	2033
	Peak Hour	Factor	1.5	1.5	1.5
		Liters/second	30,891.68	38,772.46	47,219.86
		m^3/sec	30.89	38,77	47,22

4.3. Analysis of Raw Water Availability

DKI Jakarta in the provision of drinking water is the responsibility of water company Jaya. Water company Jaya has two operators that share the service area. The operators are Palyja and Aetra. Palyja serves West Jakarta, South Jakarta and parts of Central Jakarta, while Aetra serves East Jakarta, North Jakarta and parts of Central Jakarta. The division of service areas can be seen in Figure 2. In 2015 the raw water capacity processed by the two operators was around 17,000 liters/second, while the demand for drinking water at that time was 26,100 liters/second. This means that DKI Jakarta is short of drinking water of around 9,100 liters/second. Or only fulfilled by 65.13% serving 5,804,500 people out of the total population of DKI Jakarta 10,177,924 people (DPMPTSP DKI Jakarta, accessed 2023)

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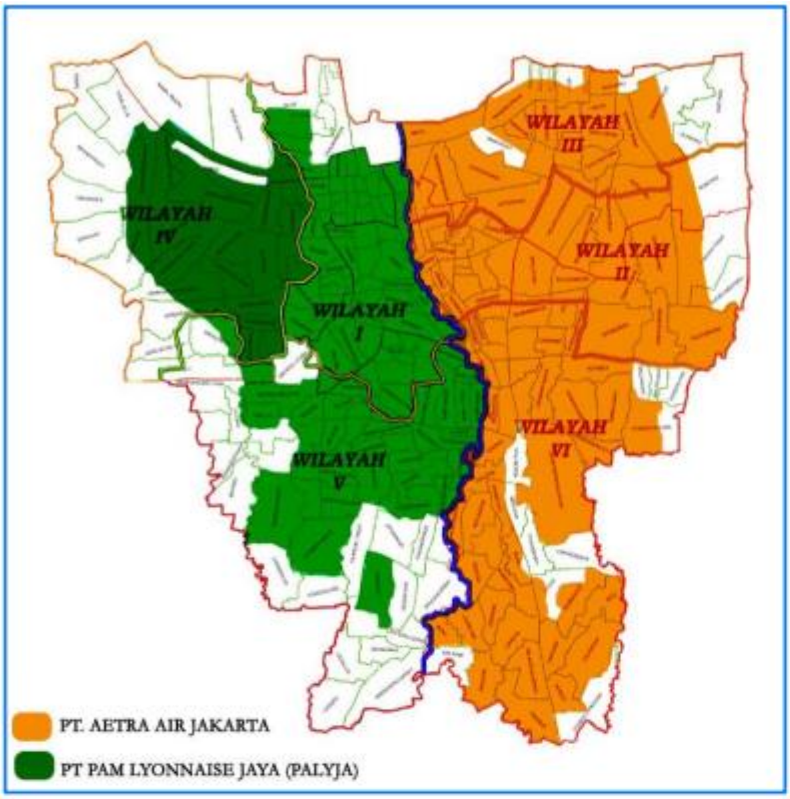

Figure 2.Distribution of Service Areas Water Company Jaya 2023
Source: (DPMPTSP DKI Jakarta, accessed 2023)

The availability of raw water in 2022 by the two operators is still at 16,850 liters/second. It consists of 6,850 liters/second from Palyja (Palyja, 2022) and 10,000 liters/second from Aetra (Aetra, 2022). Meanwhile, the need for drinking water in 2023 is 30,892 liters/second. The deficit that was met was 14,042 liters/second. In 2023 the population of DKI Jakarta served by access to drinking water is estimated to be around 54.54% of the total population. This figure has decreased by around 10.59% from 2015 with drinking water services of 65.13%. If water company Jaya does not look for new raw water sources, it is estimated that in 2023-2033 DKI Jakarta's drinking water services will drop drastically. For more details can be seen in table 8,

Table 8. DKI Jakarta Drinking Water Services 2023-2033

Year	Water Needs (Litres/ sec)	Availability of Water (Liters/second)	Deficit (Liters/second)	Service (%)
2015	26,100	17,000	9,100	65,13
2023	30,892	16,850	14,042	54,54
2028	38,772	16,850	21,922	43,46
2033	47,220	16,850	30,370	35,68

Sources of raw water to fulfill drinking water in DKI Jakarta come from within the province and outside Jakarta(Ardhianie et al., 2022; Gumelar et al., 2020; Nahib et al., 2022). Water sources originating from DKI Jakarta are the Krukut river 4% and Cengkraeng Drain 1.7%. Meanwhile, other fulfillment comes from outside Jakarta which comes from Jatiluhur Reservoir 62.5%, water treatment plant Serpong 31%, and water treatment plant Cikokol 0.8% (DPMPTSP DKI Jakarta, accessed 2023). Actually there are 13 rivers in DKI Jakarta that have not been properly utilized as raw water sources. This is because the river is polluted. So it requires processing technology that is better than what already exists in Indonesia. Related to this, several countries have made efforts to treat domestic wastewater for reuse as drinking water.

5 FINAL CONSIDERATIONS

The projected results for DKI Jakarta's drinking water needs in 2028 and 2023 are 38,772 liters/second and 47,220 liters/second. The availability of raw water in 2023 is only 16,850 liters/second. That means if DKI Jakarta does not look for alternative raw water sources, DKI Jakarta's drinking water services will drop drastically from 65.13% and 54.54 in 2015 and 2023 to 43.46% and 35.68% in 2028 and 2033 respectively. will come. For this reason, it is necessary to develop drinking water treatment technologies that can process river water, which is already the fastest in DKI Jakarta. So that drinking water services for DKI Jakarta can be fulfilled.

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- The tables have problems. They need to be resubmitted considering the margins of the article.

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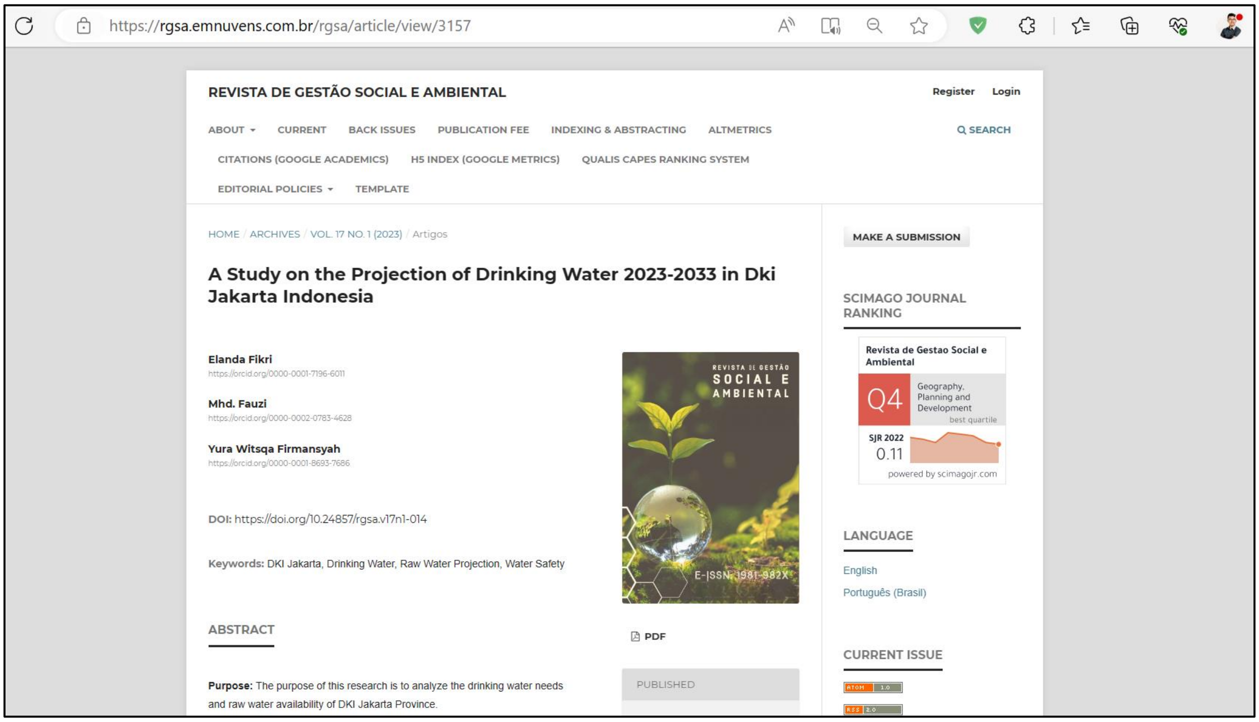

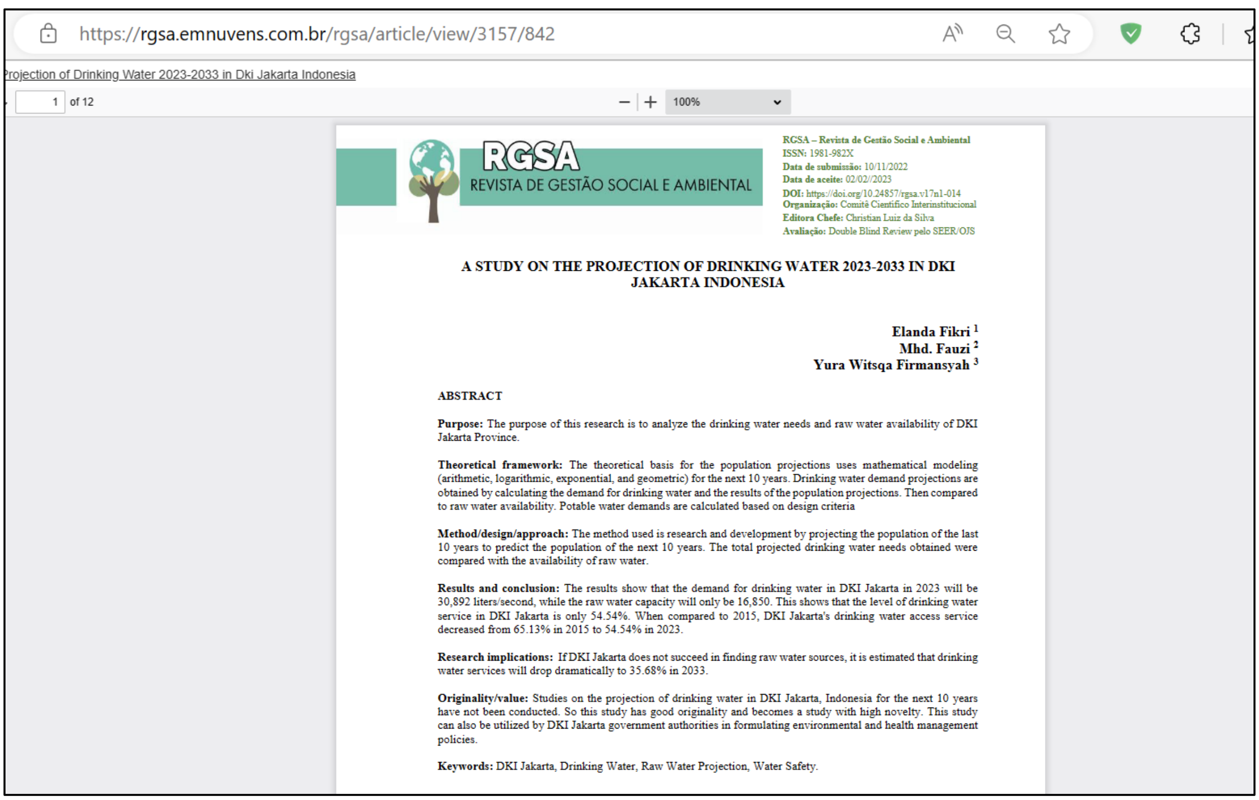

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A STUDY ON THE PROJECTION OF DRINKING WATER 2023-2033 IN DKI JAKARTA INDONESIA

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Mhd. Fauzi [2]
Yura Witsqa Firmansyah [3]

ABSTRACT

Purpose: The purpose of this research is to analyze the drinking water needs and raw water availability of DKI Jakarta Province.

Theoretical framework: The theoretical basis for the population projections uses mathematical modeling (arithmetic, logarithmic, exponential, and geometric) for the next 10 years. Drinking water demand projections are obtained by calculating the demand for drinking water and the results of the population projections. Then compared to raw water availability. Potable water demands are calculated based on design criteria

Method/design/approach: The method used is research and development by projecting the population of the last 10 years to predict the population of the next 10 years. The total projected drinking water needs obtained were compared with the availability of raw water.

Results and conclusion: The results show that the demand for drinking water in DKI Jakarta in 2023 will be 30,892 liters/second, while the raw water capacity will only be 16,850. This shows that the level of drinking water service in DKI Jakarta is only 54.54%. When compared to 2015, DKI Jakarta's drinking water access service decreased from 65.13% in 2015 to 54.54% in 2023.

Research implications: If DKI Jakarta does not succeed in finding raw water sources, it is estimated that drinking water services will drop dramatically to 35.68% in 2033.

Originality/value: Studies on the projection of drinking water in DKI Jakarta, Indonesia for the next 10 years have not been conducted. So this study has good originality and becomes a study with high novelty. This study can also be utilized by DKI Jakarta government authorities in formulating environmental and health management policies.

Keywords: DKI Jakarta, Drinking Water, Raw Water Projection, Water Safety.