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To cite this article: A W Hasbiah and D Kurniasih 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **245** 012030

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# Analysis of water supply and demand management in Bandung city Indonesia

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**Abstract** Water consumption in Bandung city is increasing as the impact of population growth and development activities. In 2017, Bandung city water utility only serves 73.13% of its population. Whereas the national target of drinking water services for big cities is 100% in 2019. Management of water resources in Bandung city is required in order to achieve the national target and sustainable water resources. This study aims to analyses the water resources supply and demand management in Bandung city. The study was conducted by analyzing the existing water resources and its potential as well as the city's water demand from domestic sector. Based on the water demand projection, Bandung city water demand will exceed its supply in 2034. The city will not be able to meet the water demand projected if it does not manage both of its water supply and demand. Water resources management in Bandung city is oriented mostly on the supply side. A paradigm shift from conventional water supply management to water demand management is required. Government commitment plays a very important role in the successful implementation of supply and demand management strategies.

## 1. Introduction

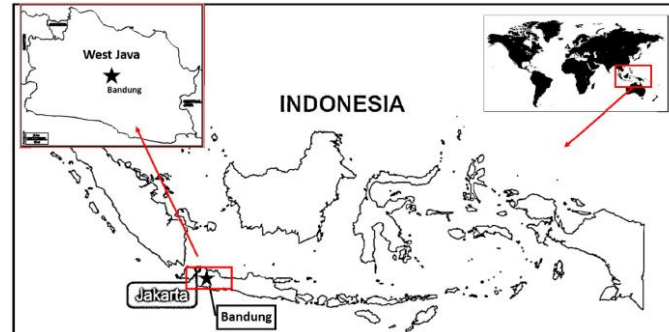
Bandung city, the capital city of West Java is the third most populous city in Indonesia with total population of 2.5 million [1]. The city experienced increasing water consumption as the impact of population growth and development activities. Whereas, the availability of clean water resources is decreasing due to water pollution. Population growth in Indonesia increases the number of houses on the river banks with inadequate sanitation facilities [2] which exacerbate the water pollution. Difficulty of water availability in the future [3] and the effect of climate change will intensify water shortage in the urban area [4].

The national target of drinking water services for big cities in Indonesia is 100% in 2019. Currently Bandung city water utility only serves 73.13% of its population [5]. This is due to un-optimal existing water management in Bandung city. Efforts of water resources management have been conducted, especially in river management. However, the result is insignificant [6]. In general, the development and management of water resources in Indonesia is still oriented on the supply side.

This study aims to assess the management of water availability and water demand from domestic sector in Bandung city. The concept of water supply and demand needs to be well understood in order to achieve sustainable water resources. Efficient use of existing water resources and water demand management should be promoted in order to mitigate water resources problem [7]. The study was conducted by analyzing the existing water resources and its potential as well as the city's water



demand from domestic sector. Variety of water supply sources and water demand management is required to prevent increasing water demand [7].



**Figure 1.** Bandung City in West Java Province and Indonesia [1]

## 2. Methodology

Identification of existing water sources used by water utility and potential water in Bandung Basin area is conducted through secondary data collection. The data covers water quantity (minimum discharge, maximum discharge, and reliable debit), raw water quality, location of water sources, and allocation of each water sources. The data are obtained from Bandung city water utility and West Java province water resources center.

Descriptive analysis is conducted in order to describe in detail the existing condition and potential water sources in Bandung city. Estimation of the water resources consist of surface water, spring water and ground water. Domestic water demand is calculated based on the projected number of population and its water consumption.

## 3. Result and Discussion

### 3.1 Surface water

The main river flows in the Bandung Basin is the Citarum River and its tributaries. The area of Citarum River is 1,675 km<sup>2</sup> with a discharge of 42 liters/s/km<sup>2</sup>. The Citarum River consists of several tributaries such as Cikapundung River, Cimahi River, Cibeureum River, Citarik River, Cisangkuy River. The rivers in the Bandung Basin have a very large discharges fluctuations. In the dry season it has limited supply of water and high sediment and garbage disposed by residents. Whereas in the rainy season the river will be flooded by high number of water discharged into the river. In general the quality of surface water in Bandung city is bad due to domestic waste, sedimentation and industry's effluent. Surface water is the main raw water sources with total discharge used of  $\pm$  3,280 liters/sec.

**Table 1.** Data of Rivers and Tributaries in Bandung City [5]

No	Rivers	Total Length(Km)	Average Width		Average Debit	
			Upstream (m)	Downstream (m)	Maks (m <sup>3</sup> )	Min (m <sup>3</sup> )
1	Cikapundung	15,50	6,00	12,00	250,00	12,00
2	Cipaganti	4,40	3,00	5,00	25,00	0,75
3	Cikapundung Kolot	10,00	4,00	8,00	75,00	4,50
4	Cibunut	2,20	2,00	8,00	12,00	0,80
5	Cihapit	2,50	3,00	6,00	15,00	0,50
6	Cikudapateuh	3,00	1,50	1,00	20,00	0,50
7	Cibeunying	3,50	6,00	8,00	64,00	0,60
8	Cipalasari	4,00	3,00	5,00	20,00	0,15

No	Rivers	Total Length(Km)	Average Width		Average Debit	
			Upstream (m)	Downstream (m)	Maks (m <sup>3</sup> )	Min (m <sup>3</sup> )
9	Ciateul / Ciguriang	2,00	2,00	4,00	20,00	0,25
10	Cihampelas	2,50	2,00	5,00	8,00	0,40
11	Cipamokolan	18,00	5,00	15,00	40,00	25,00
12	Cileuweung	2,50	4,00	5,00	36,00	0,75
13	Cikiley	5,00	3,00	8,00	27,00	0,30
14	Cicabe	2,00	1,00	3,00		
15	Cisaranten/Cipagalo/ Cingised	5,00	3,00	7,00	30,00	1,50
16	Cidurian	20,00	6,00	12,00	83,00	1,25
17	Ciharalang	2,50	1,50	4,00	12,00	0,40
18	Cimuncang	2,50	1,50	4,00	16,00	0,50
19	Ciparangpung	10,00	3,00	5,00	20,00	0,20
20	Cicadas	18,00	3,00	8,00	17,00	0,60
21	Cinambo	7,30	2,00	20,00	15,00	0,50
22	Cipamulihan / Cihampelas	8,50	2,00	7,00	15,00	0,70
23	Cilameta	6,00	2,00	5,00	10,00	0,60
24	Ciwaru	7,50	2,00	4,00	8,00	0,80
25	Cisurupan	3,00	2,00	3,00	5,00	0,20
26	Cisaranten	2,50	2,00	9,00	23,00	0,35
27	Cipanjalu	5,00	4,00	8,00	27,00	0,15
28	Cijalupang	5,00	4,00	15,00	24,00	0,20
29	Cipariuk / Cibiru	6,00	2,00	4,00	20,00	0,40
30	Ciwastra	3,50	3,00	6,00	18,00	0,40
31	Citepus	6,50	2,00	15,00	50,00	0,10
32	Ciroyom	3,00	4,00	6,00	25,00	0,10
33	Cipedes	2,50	1,50	1,50	2,00	0,50
34	Cikakak	5,50	2,00	11,00	38,00	0,15
35	Cikalintu	4,00	3,00	4,50	30,00	0,15
36	Cigebog Girang	1,50	2,00	4,00	20,00	0,15
37	Ciraden	2,80	2,00	4,00	5,00	0,30
38	Cibedug	5,00	5,00	8,00	15,00	0,10
39	Curug Dog-dog	2,50	5,00	8,00	25,00	0,15
40	Cibaduyut	2,25	4,00	6,00	20,00	0,15
41	Cikahiayangan	1,60	3,50	4,00	15,00	0,10
42	Cibuntu	4,00	3,00	4,50	30,00	0,15
43	Cianting	4,00	3,00	4,50	5,00	0,70
44	Cigondewah	3,00	2,00	3,00	35,00	0,20
45	Cibeureum	12,00	6,00	8,00	38,00	0,75
46	Cinanjur	3,00	2,00	4,00	4,00	0,20

### 3.2 Springwater

Springwater sources are found on the northern, eastern and southern part of Bandung Basin. The appearance of Springwater is caused by fault structures and found generally around the volcano.

**Table 2.** Springwater Sources [5]

No	Springwater Sources	Resources Capacity (Liter/ Second)
1	Ciwangi 1, Ciwangi 2, Legok Baygon, Ciasahan, Cigentur 1, Cigentur 2, Ciliang, Cilaki, Ciwangun, panyairan, Cisolada 1, Cisolada II, Cicariuk, Citalaga, Cirateun, Cibadak, Cikendi)	36,48 - 111
2	Cisurupan	1,00 – 5,00
3	Pasir Impun	1,00 – 5,00
4	Citiis	70
5	Cikeruh	115
6	Ciseupan	95

### 3.3 Groundwater

Bandung city and its surrounding area is situated in Bandung basin. The basin extends from Tangkuban Perahu in the north up to Pangalengan in the south, and Batujajar in the west to Cicalengka to the east. Administratively, this basin is located in four administrative areas, namely Bandung Regency, Cimahi City, Sumedang Regency and Bandung City. The flow of groundwater that enters the Bandung Basin is  $71 \times 10^6 \text{ m}^3$  per year, equivalent to 2,251 L/s. The number is quite high. However, excessive groundwater extraction has caused land subsidence in Bandung city [8].

### 3.4 Domestic water demand

Water demand is affected by the population number and its activities. The need for water in principle depends on the size of the population and its level of well-being, which will determine the level of water requirements per person.

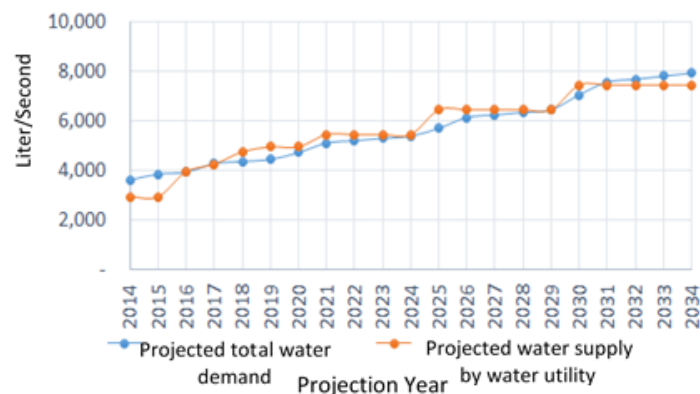
Calculated fluctuations in water demand for the drinking water system of Bandung city is indicated in table 3.

**Table 3.** Fluctuation of Drinking Water demand of Bandung City in 2014 – 2034 [5]

No	Year	Average water demand (L/Second)	Maximum water demand (L/Second)	Peak water demand (L/Second)
1	2014	4,342	5,210	7,598
2	2015	4,618	5,541	8,081
3	2016	4,713	5,655	8,247
4	2017	5,128	6,154	8,975
5	2018	5,230	6,276	9,152
6	2019	5,331	6,398	9,330
7	2020	5,659	6,791	9,904
8	2021	6,125	7,350	10,719
9	2022	6,238	7,485	10,916
10	2023	6,350	7,620	11,112
11	2024	6,462	7,755	11,309
12	2025	6,838	8,205	11,966
13	2026	7,364	8,836	12,886
14	2027	7,487	8,985	13,103
15	2028	7,611	9,133	13,319
16	2029	7,735	9,282	13,536
17	2030	8,463	10,155	14,810
18	2031	9,074	10,888	15,879
19	2032	9,216	11,060	16,129
20	2033	9,361	11,234	16,383

No	Year	Average water demand (L/Second)	Maximum water demand (L/Second)	Peak water demand (L/Second)
21	2034	9,509	11,411	16,640

Projection of total water demand and water supply by water utility of Bandung city can be seen on figure 2.



**Figure 2.** Bandung City Projected Water Demand and Water Supply

Based on the water demand projection, Bandung city water demand will exceed its supply in 2034. Water resources management in Bandung city is oriented mostly on the supply side. The water utility depends only on unutilized surface water sources with costly investment. The water utility has not maximize its production capacity. It still has idle capacity which can be optimize. The water utility has not utilize other sources of water available such as rainwater and recycled water. The city will not be able to meet the water demand projected if it does not manage both of its water supply and demand. An effective strategy is required to improve the availability of water in order to meet the demand. Water management is a complex issue [9]. Paradigm shift from conventional supply management to demand management is required [10].

An effective way to mitigate the water crisis is to manage the water demand, by understanding water use in various sectors, developing water reduction tools and strategies, and reuse or recycle water for various purposes. Another example of water demand management that can be implemented is education on water sensitivity. Community awareness education is an important components of water demand management, as well as the participation of various stakeholders in policy decisions and development. Water governance is an important factor in water security. It can be achieved through engagement of government stakeholders in all level [4].

Water demand management involves the application of policies or investments by water utilities to achieve efficient water use by all members of the community. Improvement of water regulation to increase water scarcity resilience is required [3]. Bandung water utility already implemented water tariff as its water demand management. Optimal water tariff will affect users' water consumption [11]. However this action is not enough to achieved sustainable water resources. Variety of demand management approaches should be promoted.

#### 4. Conclusion

In 2034, Bandung city will not be able to meet the water demand if only rely on the existing water supply. Water resources management in Bandung city is oriented mostly on the supply side. Bandung water utility only implemented water tariff as its water demand management. Major paradigm shift from conventional supply management to the demand management is required in order to overcome the water problem in Bandung city. In addition, government commitment plays a very important role in the successful implementation of supply and demand management strategies.

## 5. Acknowledgement

This paper was prepared with financial support from the Faculty of Engineering, Universitas Pasundan.

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