

# Chapter 6

## The Threats to Urban Water Security of Indonesian Cities



R. W. Triweko

**Abstract** Indonesian cities are facing complex urban water problems which are inter-related among the provision of water supply, water pollution, water related disasters, groundwater degradation, and poor solid waste management. The threats to urban water security are caused by population growth, climate change, and water conflict. Increasing population growth causes the increasing raw water demand which should be transferred from the rural areas due to heavy pollution of the water body in urban areas. Changing policy in water use from agricultural water to urban water supply causes water conflict between farmers in rural areas and water supply enterprise in urban areas, which could extend to inter-regional water conflict. In addition, over abstraction of the groundwater to fulfil water supply demand resulted degradation of groundwater table and land subsidence, which disturbance drainage system. In some coastal areas, those phenomena even increase the risk of the city to seawater flooding and intrusion. Finally, climate change which has changed the pattern of rainy season and rainfall intensity has been increasing the risk of the cities to flooding and water supply availability. To increase urban water security, each municipality should ensure the availability of water supply and sanitation system, mitigate water-related disasters, and maintain good collaboration with neighbouring regencies/cities. New paradigm of integrated urban water management should be developed to increase urban water security in Indonesian cities. The development of the Urban Water Security Index could be used to monitor and evaluate the progress of the cities in improving their urban water service.

**Keywords** Urban water security · Indonesian cities · Integrated urban water management

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## 6.1 Introduction

The Government of Indonesia in its National Strategic Development Plan 2015—2019 used water security as the goal of water resources development. Infrastructure development during that period is intended to ensure water security for supporting national security. Six objectives that will be achieved during that period are: (1) To fulfil raw water demand for domestic, municipality, and industry; (2) To fulfil the demand of irrigation water and raw water for urban areas; (3) To increase the performance of irrigation management; (4) To accelerate the utilization of water resources for electricity (hydropower); (5) To increase the prevention to water related disasters; and (6) To optimize water balance management.

The data from the Head Office of Statistic (BPS 2012) indicates that the number of urban population in Indonesia has exceeded 50% with the rate of growth 2.75%, while the national rate of population growth is 1.17% (BAPPENAS 2015). BPS (2016) estimated that the number of urban population in 2015 is 53.3% which will grow to 60,0% in 2025, and achieve 66.6% in 2035. This high rate of urbanization shows the critical condition of urban water service in Indonesia. Today, the level of water supply service by public water supply enterprise (PDAM), for example, is still under 50% of the total urban population. It means that this urbanization rate become a serious threat to urban water security. Up to now, the understanding and involvement of the decision makers to the issue of water security and especially urban water security is still very limited. Tjandraatmaja et al. (2013) developed a framework for water security assessment and capacity building and used the framework in assessing urban water security and climate change adaptation in Makassar, Indonesia. But so far, the developed framework has not been implemented nationally to measure the level of urban water security in other Indonesian cities.

Table 6.1 presented the number of regencies and cities in Indonesia. Cities are the area with a densely populated with main economic activities are public service, business, and industries. While regencies are the area in which their main economic activities are agriculture, including husbandry and horticulture. It can be said that the cities and the capital of regencies are urban areas. This table indicates that Java

**Table 6.1** Number of regencies and cities in Indonesia

No.	Island (s)	# of Regencies	# of Cities	Total
1	Sumatera	120	34	154
2	Java	85	34	119
3	Kalimantan	47	9	56
4	Nusa Tenggara	37	5	42
5	Sulawesi	70	11	81
6	Maluku	17	4	21
7	Papua	40	2	42
Grand total		416	99	515

Island is the most urbanized area, followed by Sumatera, Sulawesi, and Kalimantan. Among those cities, 11 cities have population more than 1 million, 15 cities have population between 500,000 to 1,000,000, 20 cities have population between 200,000 to 500,000, 32 cities have population between 100,000 to 200,000, and 21 cities have population less than 100,000. It means that urban water problems in Indonesia varies from the metropolitan cities, big cities, to small cities with their own characteristics of geographical condition and water resources potential, social and economic activities, that will influence their water demand and water related problems.

This study is intended to attract urban water managers and decision makers in considering the important of using urban water security as a measure in managing urban water system. Implementing a framework of urban water security will help urban water managers in developing strategies for improving urban water service based on its own characteristics, water resources potential, and urban water problems.

## **6.2 Material and Methods**

This paper is a result of literature study on urban water related problems in Indonesia. A simple analysis was done to the available secondary data related to water supply service in the eleven largest cities in Indonesia, which are assumed representing the general water supply condition in other cities. Analysis was also done from the available data of sewerage system constructed in Indonesia during the last 30 years. Comparing the results of the analysis with personal daily observation surface water pollution, solid waste management, and other information on groundwater degradation in some urban areas, resulting a comprehensive explanation on the complexity of urban water problems in Indonesian cities, in which the threats to urban water security are identified. Finally, a comprehensive program in implementing integrated urban water management in urban areas developed to improve urban water security in Indonesian cities.

## **6.3 Results and Discussion**

Indonesian cities are facing complex urban water problems which are inter-related among the provision of water supply, water pollution, water related disasters, groundwater degradation, and poor solid waste management. Managing urban water system in Indonesian cities should be integrated with municipal solid waste management as well as groundwater management, due to its inter-related impacts to urban water security.

### 6.3.1 Water Supply Service

Table 6.2 presents the number of population and house connection from public water supply enterprise (PDAM). It is amazing that the number of populations in Bekasi is higher than Medan, while the number of populations in Tangerang and Depok are higher than that of Semarang, Palembang, and Makassar which are provincial capital. Those numbers demonstrate that the three neighbouring cities of Jakarta are growing very fast to support the existence of the Capital City of Jakarta with housing for the people who work in Jakarta, which form a huge metropolitan of the Greater Jakarta with total population almost 17 million, if we also include Tangerang Selatan. Administratively, each city has their own autonomy, but in practice their urban infrastructure system, included urban water system, will interact to each other.

Assuming that each connection serves 5 people in a household, the coverage indicates the percentage of the population in the city that enjoy water supply service from PDAM. This table shows that the largest coverage is own by Medan (94.6%), which is followed by Surabaya (73.6%). The smallest coverage of water supply service by PDAM is located in Tangerang (4.8%), which is followed by Depok (13.4%), and Bekasi (29.4%), whereas the three cities is part of the Jakarta Metropolitan with very rapid housing development to support Jakarta. In average, the level of water supply service in the eleven largest cities are 43%. It can be assumed that the level of service in other smaller cities is lower than 40%.

The reason of this still low level of service is the limited capacity of the public water supply enterprise to response the increasing demand from the high rate of population growth and fast economic development of the cities. Around 50% of the urban population in Indonesia depends on shallow groundwater, because of its easy access using dug wells, boreholes, hand pumps, or electric pumps. Social and business activities such as schools, offices, hospitals, malls, and hotels usually use deep groundwater for their water supply sources. New developed housings and apartments

**Table 6.2** Public water supply service in the eleven largest cities in Indonesia

No	City	Population	# of PDAM Connection	% of Coverage*)
1	Jakarta	9,588,198	794,930	41.5
2	Surabaya	2,765,487	407,225	73.6
3	Bandung	2,394,873	146,247	30.5
4	Bekasi	2,334,871	137,474	29.4
5	Medan	2,097,610	397,065	94.6
6	Tangerang	1,798,601	17,243	4.8
7	Depok	1,738,570	46,716	13.4
8	Semarang	1,555,984	129,933	41.8
9	Palembang	1,455,284	142,651	49.0
10	Makassar	1,338,663	130,496	48.7
11	Tangerang Selatan	1,290,322	–	–

usually should find their own water supply service. In slum areas people usually get their water service from public hydrants, while in the area with high water scarcity like in North Jakarta, people should spend more money to water from the vendors. In peri-urban areas, sometime people use water springs, develop a distribution system, and manage it as community-based water supply management.

### 6.3.2 Waste Water Management System

In general, waste water management in Indonesian cities is still depended on the on-site system. Most households and public buildings rely on individual septic tanks. In some new simple housing area, they developed communal septic tanks, while in some real estate the developer installed sewerage system and advanced waste water treatment plant.

Conventional sewerage systems have been developed in some Indonesian cities since 1980s. However, only parts of the capacity are utilized, due to technical and financial problems. Table 6.3 shows the sewerage systems in Indonesia in the year 2012. In general, from the total capacity of 244,618 m<sup>3</sup>/day, it is only 114,847 m<sup>3</sup>/day or 46.9% has been used. With a total house connection of 170,178 the average waste water production for each connection is 675 L per day. The largest capacity of the sewerage system and wastewater treatment plant is located in Bandung. However,

**Table 6.3** Sewerage systems in Indonesia in 2012

City	System	Total capacity (m <sup>3</sup> /day)	Used capacity (m <sup>3</sup> /day)	% Used capacity*	House connection
Medan	UASB	10,000	5,650	56.5	12,370
Prapat	Aerated Lagoon	2,000	115	5.7	253
DKI Jakarta	Aerated Lagoon	38,880	704	1.8	1,407
Bandung	Stabilization Pond	80,835	49,769	61.6	99,538
Cirebon	Stabilization Pond	20,547	9,667	47.0	13,165
Yogyakarta	Aerated Lagoon	15,500	7,314	47.1	11,000
Surakarta	Aer-Fac-Biofilter	9,504	6,325	66.6	11,978
Bali	Aerated Lagoon	51,000	31,185	61.1	8,647
Banjarmasin	RBC	10,000	2,568	25.7	8,968
Balikpapan	Extend. Aeration	800	800	100.0	1,452
Tangerang	Oxidation Ditch	2,700	600	22.2	1,200
Batam	Oxidation Ditch	2,852	150	5.2	300
Total*		244,618	114,847	46.9	170,278

Source The World Bank and Australian Aid (2013)

\*Calculated by the author

among the smallest system, the best implementation of the sewerage system is in Balikpapan, where 100% of the capacity has been used. In contrast, only 1.8% of the available capacity in Jakarta is utilized.

Poor sanitation system and very limited capacity of the sewerage system increases water pollution in streams and rivers across the cities. Poor sanitation system in slum areas who depends on individual septic tanks which are not well constructed, results groundwater pollution, whereas the same groundwater is also used as water supply sources. Improving sanitation condition, Indonesian cities should develop innovative approach in sewerage and sanitation system. At least, new developed housing should implement a communal sewerage or small bored sewerage system combined with appropriate technology of wastewater treatment plant such as constructed wetlands or stabilization ponds.

### ***6.3.3 Groundwater Degradation***

Over abstraction of groundwater pumping, especially for industries and business activities resulted groundwater degradation in some urban areas. In coastal area of Semarang City, groundwater depletion followed by land subsidence has resulted negative impacts to drainage system which increasing the risks to sea water flooding. The problems of groundwater degradation are also experienced by the City of Jakarta, Bandung, Medan, Surabaya, etc. In Yogyakarta City, conflict heated up between local people and hotels investor due to the over-use of groundwater.

### ***6.3.4 Flooding and Inundation***

Most Indonesian cities are experiencing flooding and inundation. The City of Jakarta, Bandung, Semarang, Surabaya, and others are flooded every year. A small city of Garut in West Java Province experienced flash flood recently, in which around 26 people died, 19 people lost, and inundating public hospital and schools. Similar event was also experienced by the City of Manado several years ago.

### ***6.3.5 Urban Water Problems in Indonesia***

Figure 6.1 shows the complexity of urban water problems in Indonesian cities. The high rate of population growth in urban areas due to urbanization causes increasing water demand and land coverage. Increasing water consumption will increase wastewater production which in turn will cause pollution to the water body, due to the lack of wastewater management system. Increasing land coverage will increase direct runoff which results the problems of flooding and inundation.

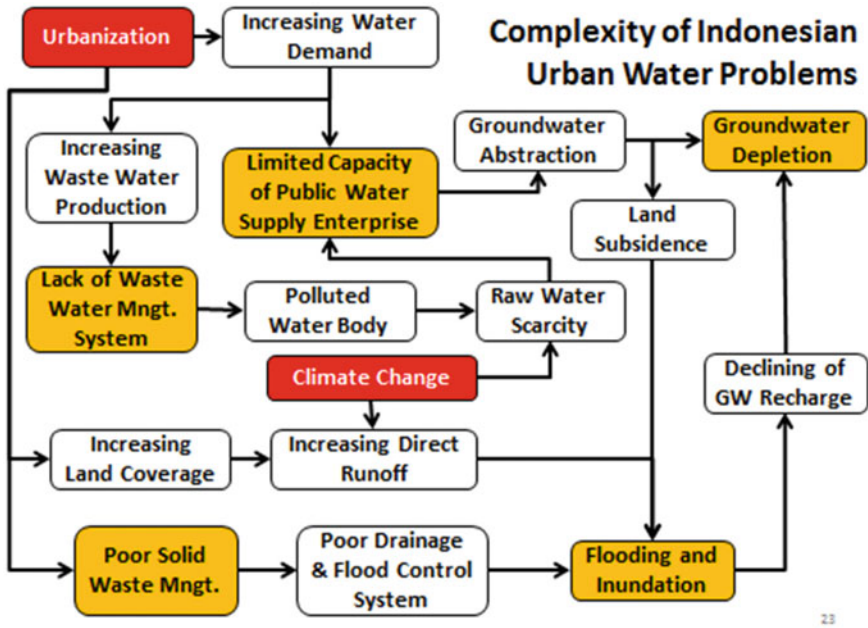


Fig. 6.1 Complexity of urban water problems in Indonesian cities

Climate change occurs in the form of increasing rainfall intensity which will greatly influence the increasing direct runoff and the shift of the season which will increase the scarcity of the water. Increasing urban population also influence solid waste management due to limited facilities, difficulties in finding final disposal site. Consequently, accumulation of garbage will accelerate drainage channel sedimentation, and dramatically reduce the capacity of the channel.

Pollution of the water body becomes a main constrain for the public water supply (PDAM) in increasing their capacity to response the increasing demand in the cities. Limited capacity of the PDAM causes most households and industries in Indonesian cities depend on the groundwater in fulfilling their water demand. Households usually use shallow groundwater for their domestic water demand, while institutions, business, and industries use deep water as a source of water supply.

Over abstraction of the groundwater, especially the deep groundwater, has resulted the decline in groundwater table, and even land subsidence, which disturbing urban drainage system and aggravate flooding and inundation problems. Beside the even worse flooding problems, saltwater intrusion also occurs in some coastal cities. Until now, all effort in developing artificial groundwater recharge has not been successful due to unbalance between the abstraction and the recharge, and might be also the decline of the aquifer capacity due to land subsidence.

### 6.3.6 *The Threats to Urban Water Security*

The concept of water security has been introduced by Global Water Partnership since 2000, who defined “Water security, at any level from the household to the global, means that every person has access to enough safe water at affordable cost to lead a clean, healthy, and productive life, while ensuring that the natural environment is protected and enhanced.” This definition underlined the fulfillment of the basic demand of water supply for clean, healthy, and productive daily life and the sustainability of the environment. UN-Water Task Force on Water Security (2013) provides more comprehensive definition on water security as follows: “Water security is defined as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.” This recent definition covers not only the affordability of water supply as the basic demand, but also the role of water in socio-economic development, minimizing water-borne pollution, controlling water related disasters, preserving ecosystems, and maintaining peace and political stability.

Improving urban water security is an important part in achieving national water security. Strategic program in improving urban water security should include the following:

1. Maintaining sustainability of water supply service for households and supporting social and economic development;
2. Ensuring protection of the environment against water borne pollution;
3. Ensuring protection against water related disasters;
4. Increasing flexibility and adaptability to climate change;
5. Maintaining political stability at the city and regional level.

Asian Development Bank (2013) identified that the key dimensions of the National Water Security consist of five components, i.e. (1) household water security, (2) urban water security, (3) environmental water security, (4) resilience to water security disasters, and (5) economic water security. Household water security covers the fulfillment of water supply and sanitation for every households in the country, either they live in urban or in rural areas. Urban water security figure out the condition of water related problems in urban areas, which include the fulfillment of water supply for domestic, municipality, and industry, the availability of effective sanitation system preventing water pollution, and controlling water related disasters.

The threats to urban water security of Indonesian cities can be classified into three categories, i.e. (1) population growth, (2) climate change, and (3) water conflict. In general, the level of population growth in urban areas are higher than the average population growth of the country. Population growth increases water demand, land use changes, and water pollution. Land use changes increases direct runoff which increases the risk to water related disasters. Water pollution becomes a hindrance to the fulfillment of the increasing water demand. Usually people used groundwater



to fulfill the demand, but over abstraction of the groundwater in the past and the declining groundwater recharge due to increasing land coverage has increased water scarcity.

Climate change phenomenon is increasingly understood, not only by experts in water resources and climatology, but also by lay people. Increasing rainfall intensity and duration, the shift of rainy and dry season, and frequent whirlwind indicates changes in climate. As a result, the risk related to water disasters increase in the form of flooding, land slide, and flashfloods. The shift of the rainy and dry season in turn will disturb water availability. Water related disasters will result a great impact to social and economic development.

Conflict of interest in water use due to increasing water demand in urban areas as a result of population growth, increasing quality of life, economic development, and industrialization needs availability of raw water. Polluted water body as a result of untreated wastewater from households, business, and industries becomes a constraint for cities in fulfilling their raw water demand. While the available groundwater resources also continuously decline. Consequently, they should find raw water sources from springs or other sources in remote rural areas which had been used for agriculture irrigation. As a result, conflict of interest in utilizing the only water sources, in turn will grow as a conflict between two water users, i.e. urban water supply enterprises and local farmers.

For Indonesian cities, increasing urban water security should be done in the following.

1. **Ensuring the availability of water supply and sanitation system** for all social and economic activities in the city, that is environmentally sustainable. To fulfill increasing water demand, new water sources should be found. The utilization of groundwater should be related to surface water. Water balance should be maintained, in terms of quantity as well as quality of water, both for groundwater and surface water. The implementation of appropriate technology in sanitation system is needed in improving water resources, both groundwater and surface water in urban areas.
2. **Mitigating water-related disaster.** Continuously growing urbanization in Indonesian cities, are increasing potential of water related disaster such as floods, droughts, landslide, and pollution. Inundation in some streets results traffic jams which in turn will disturb social and economic activities. Over abstraction of groundwater results water shortage, especially during the dry seasons. Polluted water becomes a hindrance to the effort in fulfilling water demand due to the scarcity of raw water resources. Mitigating those water related disasters, municipal government should control urban development.
3. **Maintaining good collaboration with neighboring cities and regencies** in water resources conservation, utilization, and controlling water related hazard. Water resources management in Indonesia is based on river basin territory as a management unit. Increasing water demand for agriculture, municipalities, and industries could create potential conflicts between cities and regencies in a river basin. In addition, increasing direct runoff due to urbanization could be

**Table 6.4** Implementing integrated urban water management in Indonesian cities

	Social	Environmental	Economical
Water resources conservation	<ul style="list-style-type: none"> <li>• Improving blue-green environment and more open space</li> </ul>	<ul style="list-style-type: none"> <li>• Improving water quality</li> <li>• Controlling groundwater abstraction</li> </ul>	<ul style="list-style-type: none"> <li>• Implementing water demand management</li> </ul>
Water resources utilization	<ul style="list-style-type: none"> <li>• Fulfilling basic water demand for all people</li> <li>• Developing public hydrants and sanitation facilities</li> </ul>	<ul style="list-style-type: none"> <li>• Maintaining environmental flow</li> <li>• Supporting community-based wastewater treatment</li> </ul>	<ul style="list-style-type: none"> <li>• Fulfilling water demand for industries and commerce</li> <li>• Replacing individual by public water supply system</li> </ul>
Control of water related disaster	<ul style="list-style-type: none"> <li>• Reducing number of people at risk to water related disasters</li> <li>• Restructuring of housing for people living in flood plain areas</li> </ul>	<ul style="list-style-type: none"> <li>• Preserving natural flood plain and wetlands</li> <li>• Increasing ground water recharge</li> </ul>	<ul style="list-style-type: none"> <li>• Implementing sustainable urban drainage system (SUDS) for storm water management</li> </ul>

a potential flooding for other downstream areas. Neighboring cities and regencies, therefore, should maintain good collaboration in sharing resources and improving water and environment quality.

### ***6.3.7 Integrated Urban Water Management***

In the developed countries like the USA, the concept of integrated urban water management is understood as the integration of the three main functions of urban water system which includes water supply service, waste water management, and storm water management. Based on the above discussion, however, it is understood that the scope of integrated urban water management in Indonesia is not only covers water supply service, wastewater management, and storm water management, but also included ground water management as well as solid waste management. In addition, involvement of the stakeholders is very important in the efforts to improve quality of the urban water, because the success of those efforts always need a strong support from the stakeholders. Controlling groundwater abstraction, increasing groundwater recharge, implementing new sanitation or sewerage system, implementing the concept of reduce, reuse, recycle, and recovery (4R) in municipal solid waste management are urban water related programs that need large support from the government institutions, communities, industries, business, and other non-government organizations.

In Indonesia, it is understood that water resources have social function, environmental function, and economical function that should be managed in balance. It is also understood that water resources management should cover three main activities, i.e.

Water Resources Conservation, Water Resources Utilization, and Control of Water Related Hazards. Table 6.4 demonstrates a comprehensive program to implement integrated urban water management in Indonesian cities.

## 6.4 Conclusions

From the above discussion, it can be concluded that.

1. Indonesian cities are facing complex urban water problems which are inter-related among water supply, water pollution, water related disasters, ground-water degradation, and poor solid waste management.
2. The threats to urban water security of Indonesian cities come from high rate of population growth, climate change phenomena, and potential water conflict between agriculture and urban water demand.
3. Improving urban water security, Indonesian cities should implement the concept of integrated urban water management which integrate water supply service, wastewater management, storm water management, groundwater management, and municipal solid waste management into a municipal public utility office.
4. Urban water management has a mutual influence with water resources management in the river basin level. Consequently, coordination and cooperation among cities and regencies should be developed in river basin level.

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