

A Megacity's Hydrological Risk: An analysis of water security issues in Jakarta City, Indonesia

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Abstract

Water is the most important and arguably the most crucial resource on the planet. As it is the necessity for life, the need to improve sustainability and reduce the scarcity of water around the globe, while ensuring equal access and quality is imperative for the survival of millions of individuals. Overpopulation, overconsumption, and globalization continues to increase the demand for the resource. Efforts to achieve global water sustainability and security will fail if appropriate sustainable management methods and practices are not addressed and implemented. This paper examines water security in the megacity of Jakarta, Indonesia. Research outcomes indicate that water security in Jakarta City is impacted by inadequate infrastructure, unequal use by a growing population, and inadequate governance structures. It is important to identify water security issues to achieve sustainable, safe, and affordable access for all current and future users. To address the water security issues in Jakarta, it is being recommended that effective and good governance strategies be implemented within Jakarta's social, political, and economic structures with the investment of adequate infrastructure and management systems, the improvement of integrated water resource management (IWRM), the adoption, alignment and enactment of the New Agenda and National Action Plan principles, in addition to the improvement of education, public awareness, and collaboration of all stakeholders. These recommendations are both essential and vital if Jakarta wishes to meet growing water security demands.

Key Words

Water security, informal settlements, wastewater, Indonesia, Jakarta, climate change, inequality, adaptation, vulnerability, flooding, groundwater, precipitation, contamination.

Introduction

More than 80 per cent of the world's municipalities are located along rivers and coasts and more than 50 per cent of the world's population live within these municipalities, including Jakarta (IPCC, 2012). Located south of Malaysia, west of Papua New Guinea and north, above Australia, is the country of Indonesia ([Figure 1](#)) that is one of the most diverse, yet complex countries surrounded by issues of water security (United Nations University, 2015). The country of Indonesia, officially known as the Republic of Indonesia, is an archipelago made up of roughly 17,000 islands out of which 6,000 are inhabited (National Disaster Management Agency, 2015). Indonesia has a population of approximately 258.7 million, with roughly 148 million people (more than 60 percent) living in extremely vulnerable areas (World Bank, 2018). The megacity of

Jakarta is home to approximately 10,770, 485 million people and there are concerns surrounding the increased demands for water and land due to a growing population, increased economic development, industrialization, intensive agriculture, and climate change (Kumar et al., 2017). The demand is accelerating from year to year and future predictions and uncertainties are continuing to rise (World Bank, 2018).



Figure 1. Map of Indonesia (Nations Online, 2019)

The world will not be able to meet the increasing demands and development challenges of the 21st century without improving how countries manage their water resources and mitigate against rising risks, including Jakarta (World Bank, 2014). Human development, livable cities, climate change adaptation, food security, and sustainable energy consumption cannot occur sustainably without the revision and implementation of water management. Unfortunately, population growth, economic development, pollution, and mismanagement practices have pushed water resources, in almost all parts of the world, including Jakarta, to their limits. The effects of climate change have driven the concern for water demand, and the potential for risk and scarcity to an all-time high, most concerned with the changing flow patterns of increased flood and drought frequency. The level of security and action planned is often decided by governments, resource and utility managers, community planners and ideally, the participation of the users. Unfortunately, this however, is not always the case, with cooperative efforts not being met (Swatuk 2020 & Hoekstra et al, 2018). Providing water security comes at both a financial, environmental and social cost, however these costs are essential if cities like Jakarta, are to have their water security needs met and function sustainably.

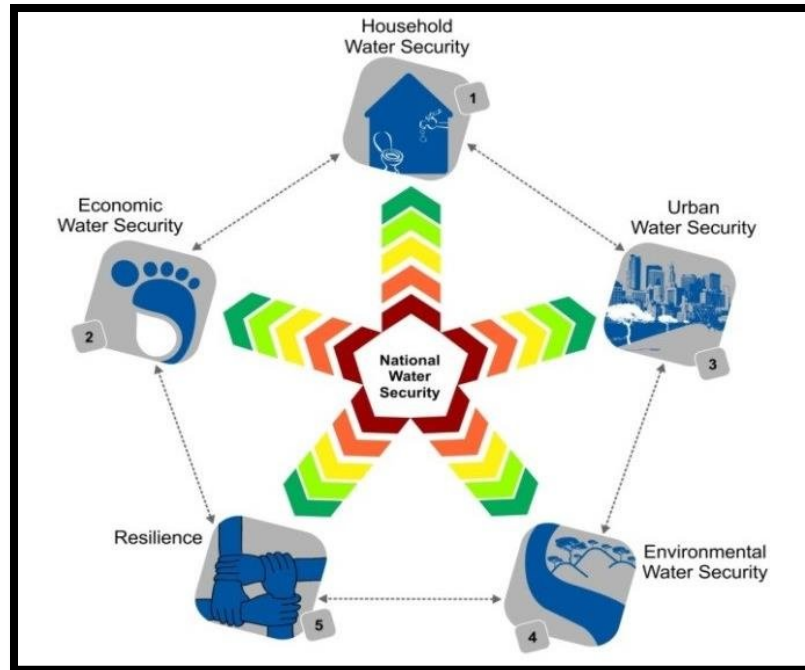


Figure 2. National Water Security (Asian Development Bank, 2016)

The UN-Water Status Report on the Application of Integrated Approaches to Water Resources Management (2012) states that by 2025 water stress will be experienced by two-thirds of all nations globally, including Indonesia. Water security has three dimensions: environmental sustainability, social equity, and economic efficiency that must be achieved together with appropriate stakeholders (Wuysang et al., 2018). National water security shown in [Figure 2](#) includes various stakeholders and users including: household, economic, urban, and the environment coupled with resiliency. To ensure water security for all users who need the resource for survival, policies, plans and approaches must be based upon strengthening capacity to increase resilience to vulnerability and risk. Jakarta struggles to maintain social equity regarding water use and availability because it does not provide clean water and sanitation to all households, particularly in low income areas. In areas without piped water, groundwater is extracted, and this leads to land subsidence (sinking) and the pollution of rivers and waterways that deteriorates the environment (Kumar et al., 2017).

Although Jakarta is water abundant, water security continues to be increasingly impacted by inadequate infrastructure, unequal use by a growing population, and inadequate governance structures. In support of this argument, the paper proceeds as follows: the next section will include a background of Jakarta's demographics, water resources and land use change over time that has had an impact upon Jakarta water accessibility and availability. Following this, the main challenges to achieving water security will be analyzed and sustainable solutions will be provided to alleviate Jakarta's water woes to assist in achieving water security for a growing population.

Background of Jakarta, Indonesia

The capital city of Indonesia is Jakarta and it is located on the island of Java. It is the economic and cultural hub of the country and the largest city in Indonesia and in Southeast Asia (Luo et al., 2019). Administratively, Jakarta is equal in size to a province and its official name is the Special Capital City District of Jakarta or DKI Jakarta (Luo et al., 2019). The area has a population of 10,770,485 million and it is divided into 5 municipalities, 44 sub districts, and 267 villages (World Bank, 2018 & Statistik Indonesia, 2019). Jakarta's five districts depicted in [Figure 3](#) are known as Jakarta Central, North, East, West, and South respectively (Statistik Indonesia, 2019). Jakarta is flanked by the Java sea and located at the gateway of the Ciliwung River on Jakarta Bay, shown in Figure 1 (Luo et al., 2019). Thirteen rivers run through the areas and the largest of them all is the Ciliwung River that play a crucial role in water security for the Jakarta area (Maru et al., 2015).

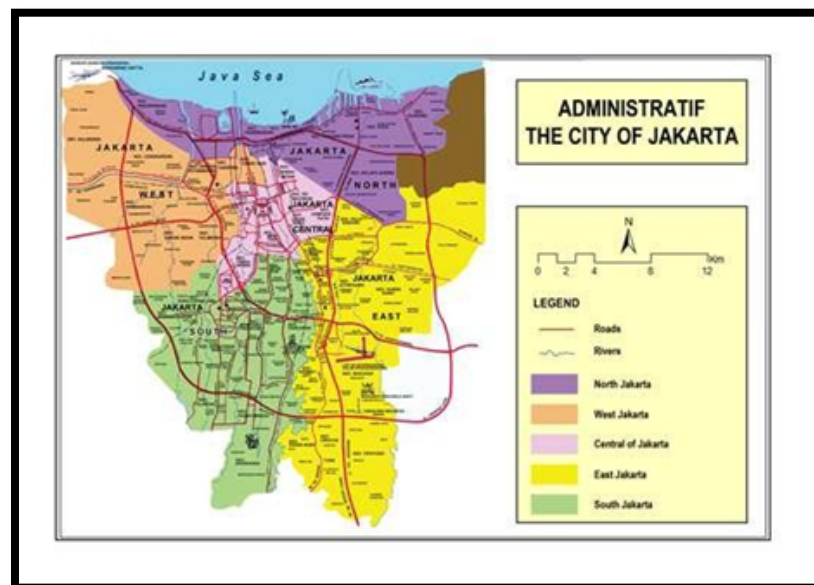


Figure 3. Jakarta's Five Districts (Maru et al., 2015)

NATURAL PHYSICAL CHARACTERISTICS OF JAKARTA, INDONESIA

The combination of high hazard-exposure and high vulnerability can be found in Jakarta due to its location along the ring of fire and physical characteristics (Hoekstra et al., 2018). Indonesia has a complex archipelago with several active and extinct volcanoes, continental blocks subduction complexes and both young and old basins (Asian Development Bank, 2016). This unique landscape makes the country prone to natural hazards and disasters including flooding, landslides, subsidence, earthquakes, and volcano eruptions (Hoekstra et al., 2018). Jakarta is prone to flooding from sea level rise and extreme weather events and it is made worse because of its low elevation that ranges between -2 to 50 meters, with the average elevation is 8 meters above sea level (Luo et al., 2019). This elevation is rapidly reducing because within the last 30 years Jakarta has sunk by 4m, twice the average for other coastal megacities, due to the over-extraction of groundwater by both domestic and industrial users (World Economic Forum, 2018). Climate change will also impact Indonesia and scientists predict an average of 7.5-

centimeter sea-level rise per decade in Indonesian shores within the next century due to global warming (IPCC, 2012). This rate of subsidence coupled with sea level rise will create various issues for the megacity and by 2050, it is estimated that 95% of Jakarta will be underwater at this current rate of sinking (World Economic Forum, 2018). These issues and an increasing population and urbanization in Jakarta has put stress upon water resources.

DEMOGRAPHIC CHANGE OVER TIME

During the past few centuries and more specifically within recent decades there has been a dramatic shift of people living in small rural communities migrating to urban areas (United Nations, 2018). It is estimated that 4 billion people live in urban areas around the world, accounting for more than half (55%) of the global population (United Nations, 2018). **Figure 4** depicts the steady increase of Indonesia's urban population from 1960 to 2017 (UN World Population Prospects, 2020). Indonesia has a growth rate of 4.1 % per year that is faster than any other Asian country (World Bank, 2016). It is predicted that by 2025, 68% of Indonesia's population will live in urban cities (World Bank, 2016). Currently, the population of Jakarta is 10,770,485 million and is expected to increase to 15,923,577 million by 2050 (Statistik Indonesia, 2019). This will require further urbanization for both households and services in an already ballooning city with high levels of congestion (Statistik Indonesia, 2019). Population density has increased from 7,400 people per square kilometer in 2000 to 9,400 people in 2010 (World Bank, 2016). Currently, there are 2,735, 100 households in Jakarta and the average household size is 3.8 people (Statistik Indonesia, 2019). The average size of households varies within Jakarta and is increased in low-income areas where the landscape is populated with informal settlements (Kooy et al., 2018).

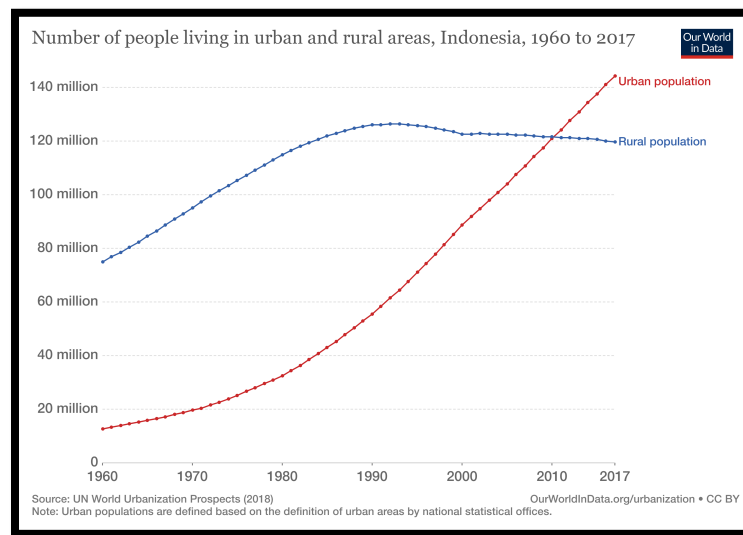


Figure 4. Indonesia's Urban and Rural Population (Ritchie & Roser, 2020)

Many of the low-income areas in Jakarta's five districts are in the form of slums and informal settlements. Slums in Jakarta are referred to as kampungs that refers to an informal or formal settlement that lacks infrastructure, services and has pockets of poverty that are a result of housing policies, land management systems, and unaffordable housing (Alzamil, 2018). In Jakarta, there are 607,778 people that live below the poverty line, accounting for 3.55 % of the population (Statistik Indonesia, 2019). As **Figure 5** depicts, kampungs are typically located on

government owned land located along railways, waterways, rivers, and reservoirs (Baker, 2012). North Jakarta has a high density of low-income communities with a lot of informal settlements along waterways (Kooy et al., 2018). Low-income households are pushed to high risk areas within kampungs due to the lack of available land because of urbanization or high land cost.

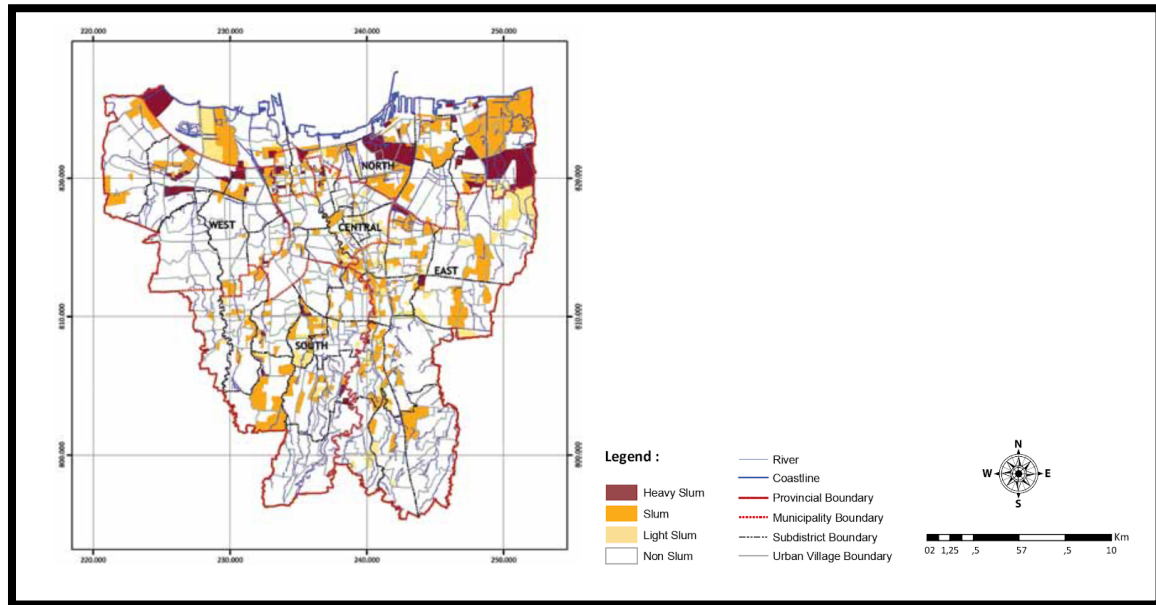


Figure 5. Kampung Locations in Jakarta Map (Baker, 2012)

Like other Southeast Asian cities, urban planning and development in Indonesia was influenced by colonialism (Setiawan, 2015). Dutch rule in Indonesia impacted urban development through European-style influence and concentrated on the infrastructure needed for exporting commodities instead of the development of urban institutions (Setiawan, 2015). Infrastructure and amenities had been built by the private sector for the benefits and use of European settlers and excluded the rest of the population (Setiawan, 2015). Apartheid spatial organization along with ethnic segregation policies were used to attract European migrants by providing superior location and centralized utilities for settlers while also remaining them of their European homelands (Setiawan, 2015). This activity forced native people to live in kampungs with little access to sanitation facilities and other modern utilities (Setiawan, 2015).

In 1949, when Indonesia achieved independence there was rapid growth and then large-scale colonial urban design that took place at the entrance of the Ciliwung River (Firman, 2009). This quick urbanization altered the forest land use from cultivated land to impenetrable urban regions that have significantly changed the terrain (Firman, 2009). Following this in the 1990s, more than 3,700 deep wells were drilled during the industrial boom due to the high-quality, low-cost groundwater source availability (Shatkin, 2019). The large-scale land changes have exacerbated social divide within Jakarta, through unequal access to housing, land, and urban amenities and low-income populations forced to live in high-risk flood areas (Padawangi & Douglass, 2015). The rapid urban expansion illustrated in [Figure 6](#) resulted in 25% of agricultural land converted into commercial and industrial uses to meet the growing urban demand (Alzamil, 2018).

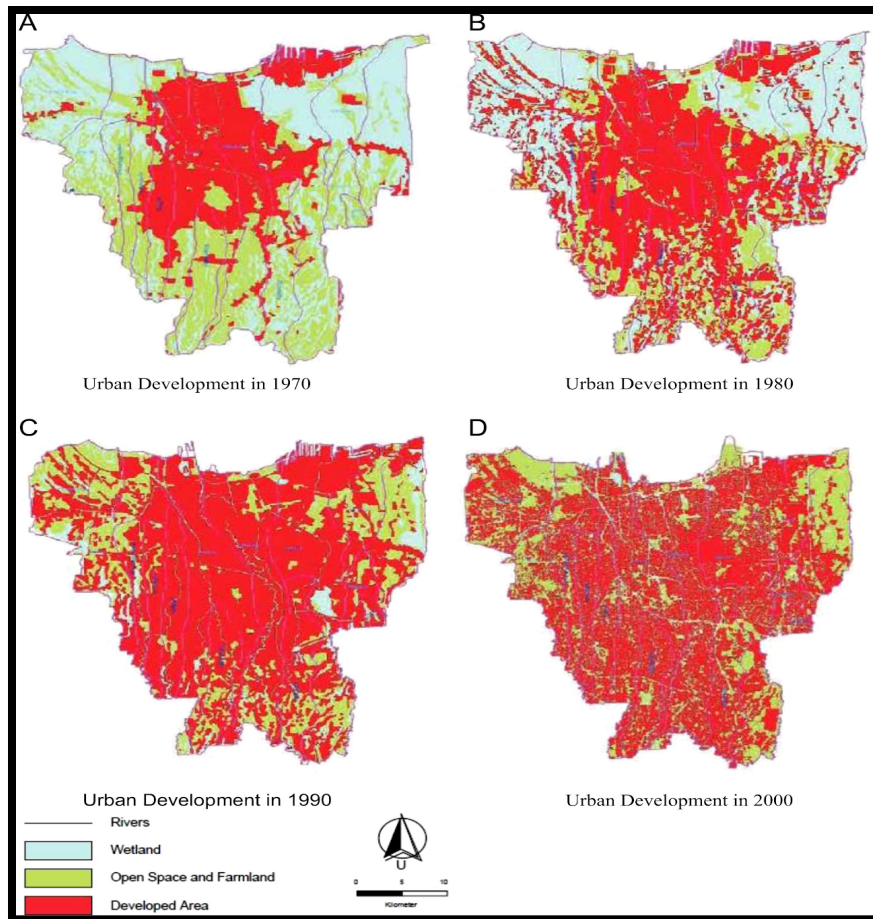


Figure 6. Urban Development in Jakarta from 1970-2000 (Alzamil, 2018).

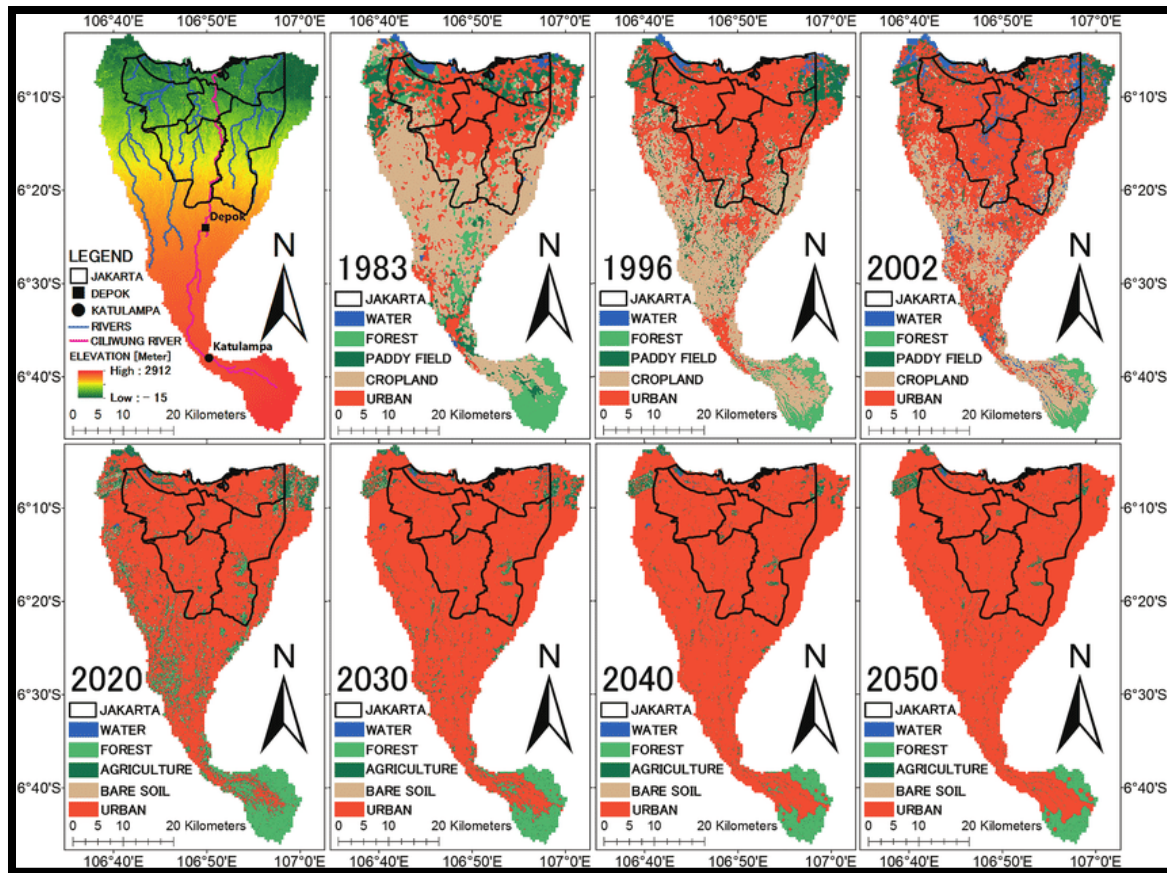


Figure 7. Jakarta land use projections from 1983 to 2050 (Moe et al., 2017)

Moe et al., (2017) used historical land use, slope, urban growth, transportation, exclusion, and hill shade to create land use change predictions from 1983 to 2050, shown in Figure 7. Using this projection Moe et al., (2017) has determined that “Jakarta and its surrounding areas, especially the upstream region, would be fully urbanized by 2040” (p. 102). Land use change will continue in an around Jakarta as the population increases. It is important to mitigate the impacts of urbanization through government interventions to increase water and forest area.

Jakarta's Water Resources

The capital city of Jakarta is in the Ciliwung-Cisadane River basin (Hatmoko et al., 2020). The Citarum River and the Jatiluhur Reservoir provide Jakarta's water supply as well as groundwater, but it is a less reliable source for domestic needs due to its limited availability and use by the private sector (Luo et al., 2019). The main source of piped water is the Citarum River, but it only reaches 60 % of the residents and depending where they live water is only available during certain hours of the day (Luo et al., 2019). There are 13 heavily polluted rivers near which 3,700 wells are located that residents use to extract ground water due to a lack of access to piped water or because the piped water is polluted and inconsistent (Luo et al., 2019). Clean water use in Jakarta is “413 million m³ a year, but the supply from the District Water Utility reservoirs is limited to 200 million m³” (Kumar, 2017, p. 1), which shows that the remaining 213 million m³ of

clean water required is reliant on underground water reservoirs (Kumar, 2017). This dependence on underground water reservoirs is an unsustainable way to provide water security for the growing population in Jakarta.

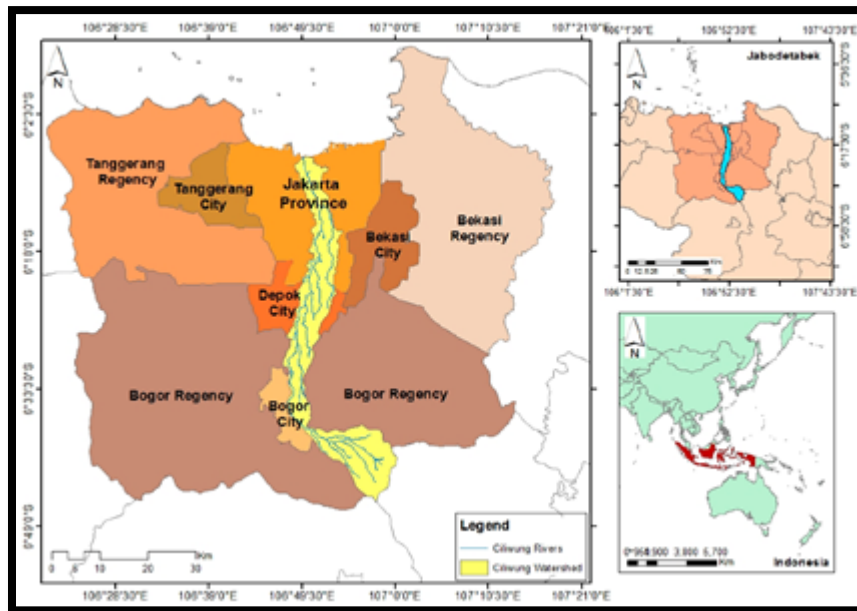


Figure 8. Location of the Ciliwung River Basin (Kumar et al., 2017).

CILIWUNG RIVER

The Ciliwung River basin has a watershed area of 420 km² as illustrated in [Figure 8](#) and is 117 km long beginning upstream at Bogor Province Tugu Punack and flowing northward from Depok and Jakarta City ending at Jakarta Bay (Kumar et al., 2017). There is 75 km of the Ciliwung River that flows inside Jakarta City with an elevation of 5 to 350 m above mean sea level (Kumar et al., 2017). The vegetation around the Ciliwung River has rapidly changed to built-up areas within the last 30 years, leading to the degradation of ecosystems, land fertility, and water quality. These negative effects have been exacerbated by drought and flood events during dry and wet seasons (Kumar et al., 2017).

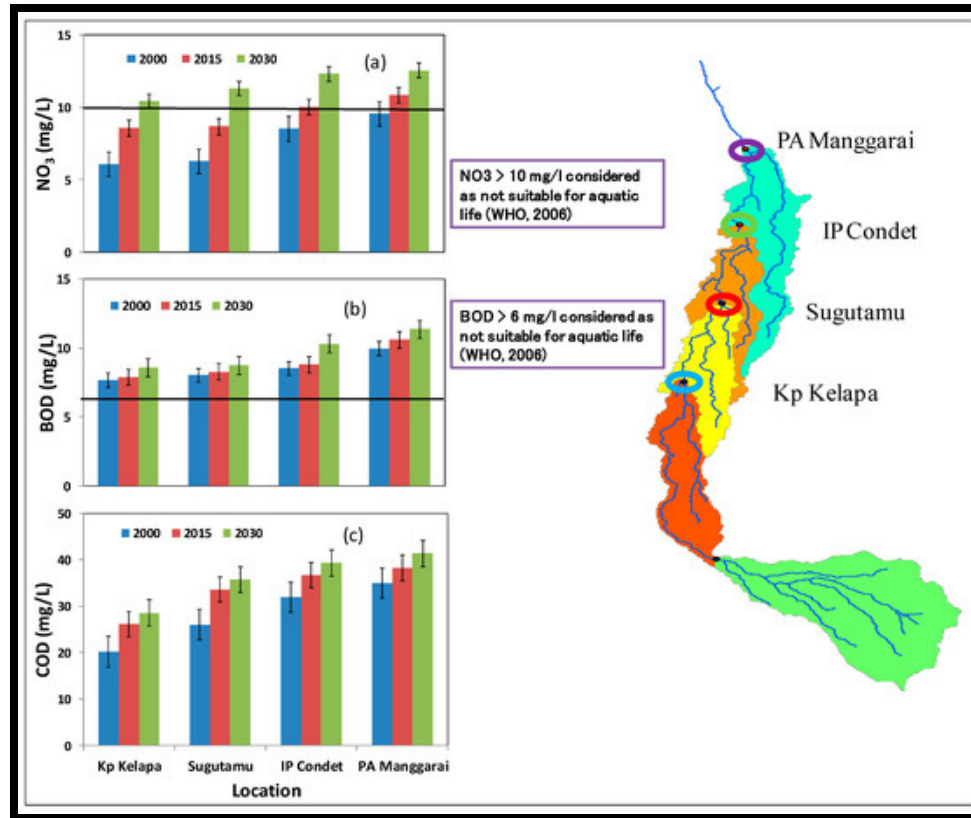


Figure 9. The simulation results of the annual average values of (a) NO₃, (b) BOD and (c) chemical oxygen demand (COD) for four different locations in 2000, 2015 and 2030 (Kumar et al., 2017).

Although it provides about 30 per cent of Jakarta water needs, the Ciliwung River has high amount of pollution from households and industries. The organic pollution (as measured by Biological Oxygen Demand) and chemicals (as measured by Chemical Oxygen Demand) in the water increases as it moves downstream (Kumar et al., 2017). There is an estimated 33.8 ton an hour of Biological Oxygen Demand and 73.8 ton an hour of Chemical Oxygen demand that enters the Chiliwung River (Kumar et al., 2017). In a study done by Kumar et al. (2017) (Figure 9), it was found that water quality deteriorated from upstream to downstream due to sewerage. Climate change and variability will increase these negative impacts due, in part, to extreme weather events (Kumar et al., 2017). As the Jakarta area is downstream, the impacts of the pollution are higher due to the addition of sewage outputs (Kumar et al., 2017).

PRECIPITATION

Figure 10 illustrates the minimum and maximum values of the average monthly rainfall patterns in Jakarta for 2015 and as hypothesized for 2030. The figure visibly shows a changing pattern with more precipitation during a shorter period and less precipitation during typically dry days (Kumar et al., 2017). Jakarta's Kemayoran Station recorded 2,152.10 mm of precipitation and 151 rainy days in 2018 which is quite high leading to ample amount of water available (Statistik Indonesia, 2019).

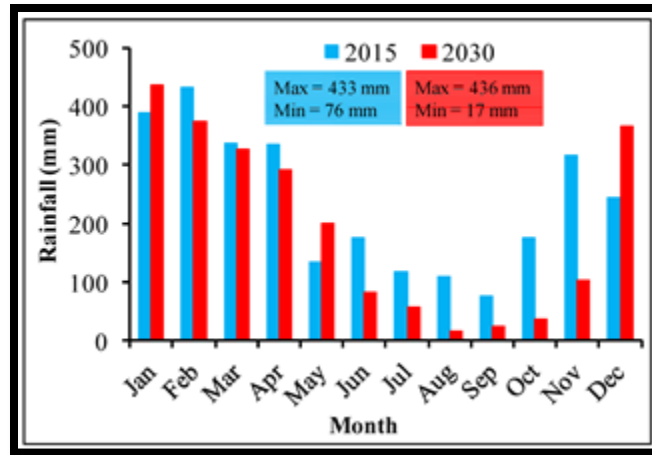


Figure 10. Average Monthly Rainfall Patterns in Jakarta, 2015 and 2030 (Kumar et al., 2017)

Indonesia is considered to be abundant with water, “with 3,22 trillion cubic metres of water resource potential, which is equal to 16.800 cubic metres of water supply per capital per year” (Republic of Indonesia, p. 55, 2016). The average monthly discharge from 2015-2030 at different stations along the Ciliwung River illustrated in Figure 11 indicates high flow rates and a forecasted increased flow in May and December in 2030 (Kumar et al., 2017).

Due to climate change, Indonesia has experienced an increase in annual rainfall by 12% over the last 30 years and shorter and more intense rainy seasons that has led to increased flooding (IPCC, 2012). Four-year droughts are now occurring every three years, and scientists predict the temperature will increase by 0.2-0.3 °C per decade that will have a direct impact on drought events (IPCC, 2012). This already water abundant city will need to manage severe weather events that will bring both heavy rainfall and more intense dry seasons, so creating the risks of hazard events.

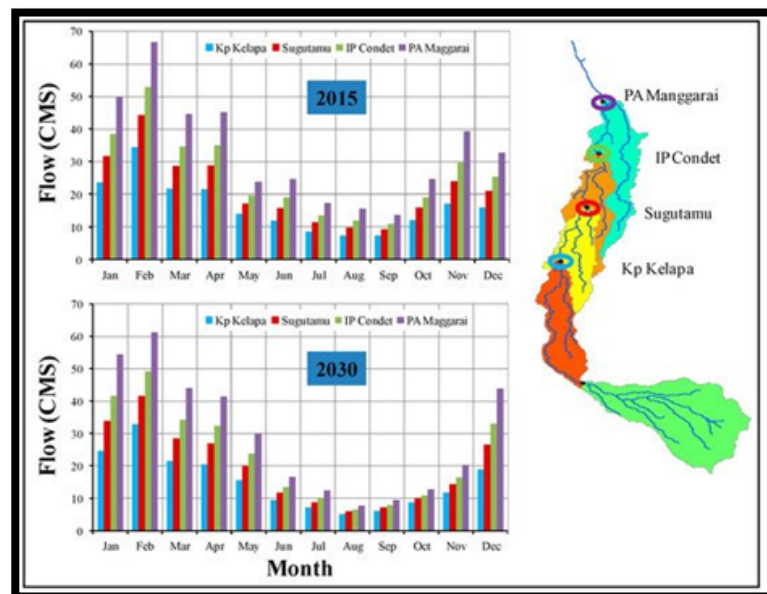


Figure 11. Average Monthly Discharge from 2015-2030 (Kumar et al., 2017)

Water User Profile

The five municipalities of Jakarta have large population, households, and industrial activities that require water use. Indonesian agriculture is largely rainfed and requires 3,500 billion m³ per year and 17% of agricultural activities use irrigation (Asian Development Bank, 2016). Irrigation methods primarily draw water from rivers (87%) with 12 % from reservoirs and 1% from ground water (Asian Development Bank, 2016).

Kumar et al. (2017), simulated the water demand for Jakarta City based on population growth estimates for the year 2030 and found that 1.34 billion m³ water will be demanded in 2030, 2.5 times the demand from 2000 shown in [Figure 12](#). Socio-economic irregularity is evident in Jakarta by a gap between water supply and demand. Piped water is common in wealthy residential areas but not in slums and poorer communities (Luo et al., 2019). Poor communities have experienced water shortages for years due to the inaccessibility of piped water and the dependence on polluted lakes, wells, river water and bottled water to meet their water needs (Luo et al., 2019). Sustainable development in Jakarta cannot be achieved without addressing the gaps between the demand and supply of water.

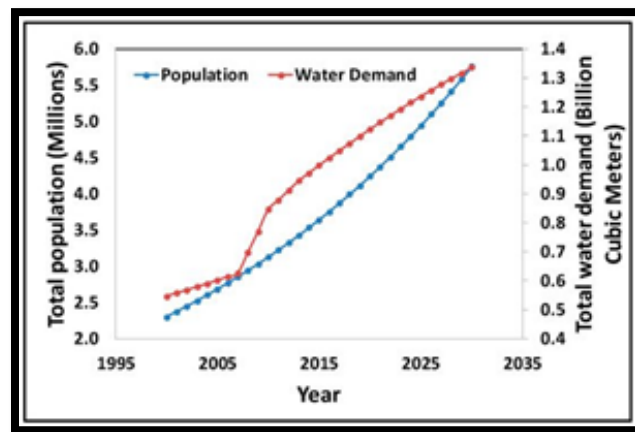


Figure 12. Total Water Demand in Jakarta City: 1995-2030 (Kumar et al. 2017)

Economic activity within Jakarta also demands high rates of water. Industrial activities are not concentrated in one zone but rather they exist in different parts of the City and are referred to as industrial estates for the manufacturing sub-sector (Asian Development Bank, 2016). The industrial estates in Jakarta account for the activities of 518 firms whose total demand for water is between 19,602 m³ per day to 72,963 m³ per day (Asian Development Bank, 2016). As detailed in this section there are multiple water users in Jakarta using the resource for personal and economic gains.

WATER QUALITY

The Asian Development Bank (2016), confirms that there has been a steady decline in water quality within the past decade across Indonesia and states that while “some reports may indicate stabilization or even small improvements, it is expected to be applicable to specific locations or substances” (pg. 23). The main contributors of water pollution across the country include agriculture, fish farming, mining, industry, and domestic wastewater (Asian Development Bank, 2016). In urban areas merely 1 % of wastewater is collected and treated

safely and only 4 % of sewerage where large amounts of fecal coli, nutrients, and high amounts of COD are found in surface water (Asian Development Bank, 2016).

The governance of water as illustrated in **Figure 13**, represents the responsibility of The Ministry of Environment and Forest and The Ministry of Health in monitoring drinking water quality and regulation of water standards for water supply agencies (Asian Development Bank, 2016). The multi-level structures of Jakarta's governance systems have become more prominent recently as a result of the country's decentralisation policies (Ward et al., 2013). The Ministry of Public Works is responsible for river systems, while Public Works offices at the provincial level are responsible for the main drainage systems and most of the local drainage works (Ward et al., 2013). The targets for water quality are established by the government and the local governments have the power to set their own targets for industrial discharge that goes into their jurisdiction's water resource (Asian Development Bank, 2016). Indonesia has abundant water resources and its availability surpasses the demand; the issues regarding water security is the result of faulty or lack of infrastructure and poor management (Asian Development Bank, 2016).

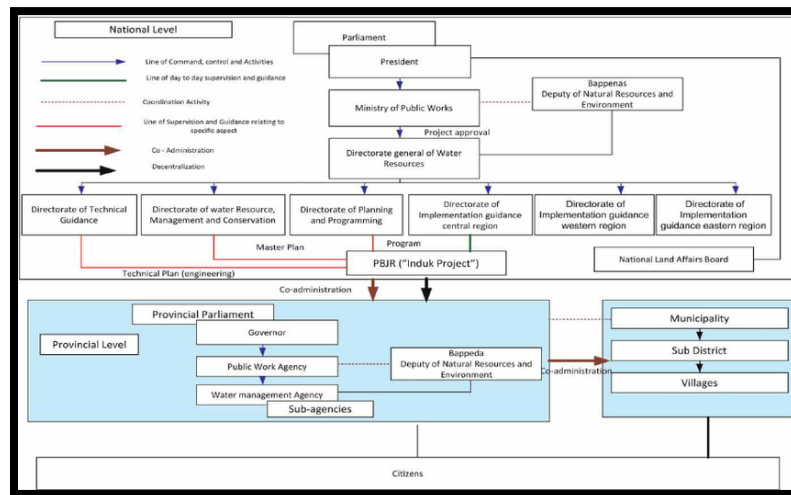


Figure 13. Administrative bodies of the water sector (Simanjuntak et al., 2012)

Jakarta ground water is polluted and a study by Fitria et al. (2018), shown in **Figure 14**, found that 80 % of the water sampled was contaminated by E. Coli and the correlations between water quality were demographic factors such as population and density (Fitria et al., 2018).

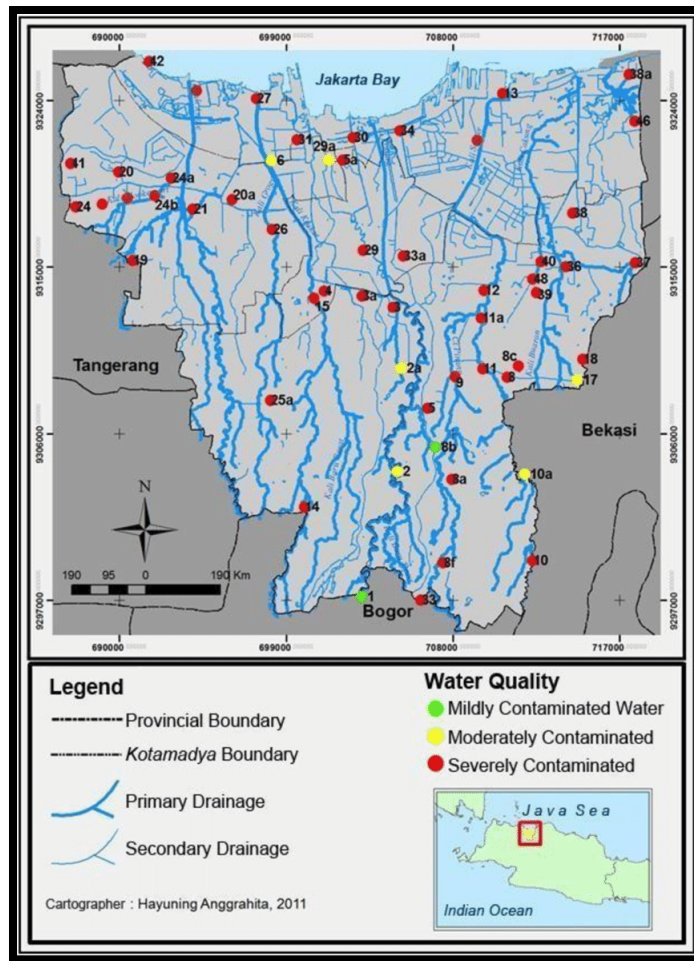


Figure 14. Water Quality in Jakarta (Fitria et al., 2018)

COST OF WATER

There are two systems within the country to charge for water resource use, the first is a service fee for water resource management (SFWRM) and the second is a fee charged for water processed for drinking by water utility (PDAM) (Asian Development Bank, 2016). The SFWRM is applied when efforts are made to conserve water resources and “facilitate utilization of water through the development of infrastructure, such as dams and canals, by which the dammed water can be delivered continuously to the water users” (Asian Development Bank, p.71, 2016). Customers are charged a fee when the PDAM converts the raw water into drinking water by PDAM (Asian Development Bank, 2016).

Water utility company PAM JAYA’s water tariffs are calculated based on dwelling size and water use in three volume categories: 0-10 m³, 11-20 m³, and 20 m³ (PAM JAYA, 2020). A very low-level house is charged, Rp.1.050, Rp. 1.05 and Rp. 1.575 and an above middle-class house is charged Rp. 6.825, Rp. 8.150, and Rp. 9800 (PAM JAYA, 2020). As mentioned earlier, middle to high class income households do not primarily use piped water and this reduces the monetary gains that may be used for infrastructure development and repair (PAM JAYA, 2020).

GOVERNANCE STRUCTURES

Within the context of water security in Jakarta, the need to address governance structures and the role of primary water actors is crucial in order to deconstruct and understand the power dynamics and official authority stakeholders involved with decision making. Understanding the role of governance structures in Jakarta allows for critical understanding of existing policies, current regulations in terms of water use and quality, in addition to accountabilities.

Unfortunately, governance structures within the country of Indonesia, and more specifically within the municipality of Jakarta remain complex and inadequate for the needs and concerns of the growing population (Ward et al., 2013). Managing a growing population and regulating fast-paced human activities within a limited spatial concentration such as Jakarta requires a very dynamic and concrete approach with considerable investment required for proper management facilities, inclusive policy reforms and appropriate regulations (Asian Development Bank, 2016).

Figure 13 depicts the charted graph which represents the governing structures and administrative bodies water management in Indonesia. **Figure 15** depicts the charted graph which represents the government structures and changing paradigms of water management in Indonesia. As illustrated, as changing governing paradigms occur, associated implications follow.

Table 1. Changing paradigms in water resources management in Indonesia.				
Elements	Old (1971–1998) and new (1998–present) paradigms and their implications in water resources management			
	Old Paradigms	Implication	New Paradigms	Implication
Governance regime	Autocracy	Strong leadership character	Democracy	Participative leadership
Administrative rule	Centralization	Concentration on national administration	Decentralization	Domination by district and provincial administrations
Decision-making process	Top down	All decisions made based on administrator interests	Bottom up	All decisions made based on stakeholders aspiration
Budgetary system	Government allocation	Financial sources from debts offering by international institutions funding and government budget	Water users sharing participation	Financial sources from water users and water polluters pay principles and government budget
Role of water in regional development	Supporting factor	Risks to environmental imbalance	Limiting factor	Priority on water balance consideration
Management responsibility	Regional authority	Regionally economic development interests	River basin and regional authority	Sustainable development interests
Role of government in construction	Provider	Risks of corruption due to power authority	Enabler	Capacity building needs for strengthening government administration
Project setting up orientation	Partial approach	Regionally (or personally) economic development interests basis	Integrated approach	Environmental sustainability interests basis
Project interest	Supremacy instruction	To increase personal popularity	People aspiration	To solve water-related problems
Project preparation	Based on short term planning	Approved based on personal/local interests	Based on master plan	Approved based on comprehensive study

Figure 15. Water Resource Management in Jakarta (Fulazzaky, 2014)

Currently, the governing structures regarding water management remain multifaceted and complex. As one of the fastest growing nations of Asia, the most vital issue within Indonesia today includes coping with the fast-growing demand for freshwater services in both rural and urban areas, and governing towards progressive development (Nastiti, 2017). The objectives of providing adequate water governance and quality water supply lie beyond physical access and include efforts to protect people's health and avoid the excessive and unnecessary costs which can follow. Poor water supplies have long been associated with water-related diseases, chemical exposure, and indirect health impacts resulting from poor sanitation facilities (Nastiti, 2017). These conditions are largely due to poor governance structures which have not prioritized or funded such vital systems. Challenges also remain within insufficient coordination among governing agencies due to the country's complex nature and numerous governing bodies which govern the thousands of islands within the country. In addition, there remains limited adoption and funding at the sub-national level due to differing local priorities and political cycles (United

Nations Economic and Social Commission for Asia and the Pacific, 2020). Although recent governing mandates have committed to the improvement of drinking water and sanitation facilities, as well as targets to strengthen and develop stronger governance divisions, past years exemplified poor recognition and insufficient capacities, making the progression of development within Indonesia and issues regarding national water security both slow and unprogressive (Ministry of National Development Planning, 2020). In addition, many violent conflicts and forms of corruption have rose within both urban and peri-urban areas due to increasing poverty concerns and issues related to water security, holding governing bodies accountable for their lack of management (Nastiti, 2017). Fortunately, population growth, economic development, extensive pollution, and poor water, sanitation, and mismanagement practices have pushed water resources in Jakarta to their limits, with urgent action and viable accountability being now mandatory. Recognition for a systemic structural design, involving revised policy regulations, comprehensive implementation strategies, and multi-stakeholder considerations with government support will serve to enhance past years of neglect and help revitalize and rehabilitate the country's vital structures and services (United Nations Economic and Social Commission for Asia and the Pacific, 2020).

Challenges & Main Issues

The City of Jakarta faces several challenges regarding water security, including too much water and too little water. Although the area is water-abundant, Jakarta has several challenges that obstruct the ability to achieve urban water security. The groundwater resources are heavily over-exploited, and the quality of freshwater resources is severely deteriorated (Firman, 2009). Furthermore, Jakarta has insufficient services and infrastructure to supply water, there is surface water pollution, and land use deregulation that has created inequalities which has had an impact on water availability and use (Padawangi & Douglass, 2015). In 2010, Jakarta met the MDG target of improving water access in the City, however this achievement was dependent upon access to groundwater and not piped water sources (Kooy et al., 2018). The following section will outline the main challenges in achieving water security. Focus is placed on three factors: inadequate infrastructure, unequal use of water by different groups, and poor government structures.

INADEQUATE INFRASTRUCTURE

Climate change is not the only factor that will have an impact upon Indonesia's water security. Land subsidence is a large issue for coastal cities and Jakarta is no exception (Hoekstra et al., 2018). The over-abstraction of groundwater in coastal cities, as well as in Jakarta, causes flood hazards and saline intrusion that reduces water quality (Abidin et al., 2011). During the past few decades there has been significant urbanization (Figure 5). Dramatic alterations to the built environment have contributed to the water security issues – threats and vulnerabilities – to which the population is exposed. For example, as the demand for water in Jakarta increases, this tendency has not been dealt with by expanding surface water supplies (Luo et al., 2019). Those that are unable to access surface water often extract groundwater, and this is impacting land subsidence and increasing flood risk (Luo et al., 2019).

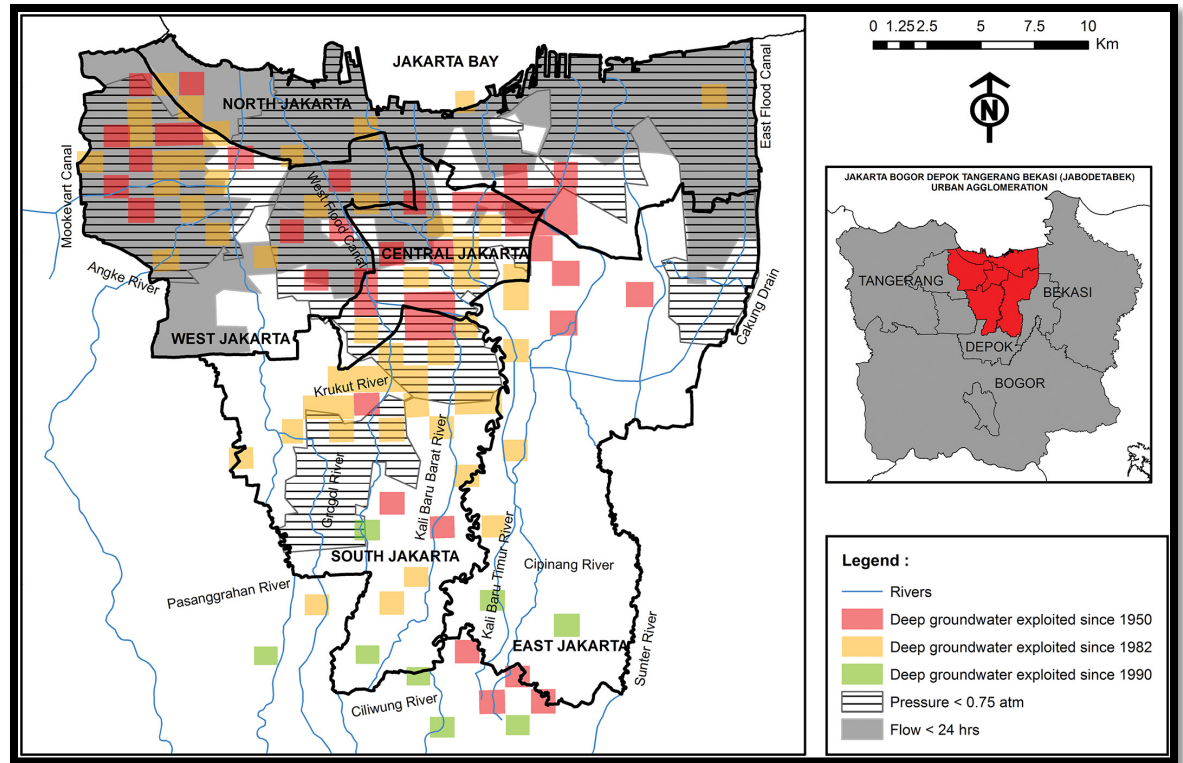


Figure 16. Piped water service quality and deep groundwater exploitation in DKI Jakarta (Furlong & Kooy, 2017).

In 1997, Jakarta Municipal Waterworks (PAM Jaya) was privatized in 1997 and the Jakarta Water Supply Network was split into two concession areas, Jakarta East, and Jakarta West (Furlong & Kooy, 2017). The piped water provided by both networks use water that is extracted from reservoirs located south of the city (Furlong & Kooy, 2017). However, groundwater is relied upon for water supply by more than 60% of the inhabitants of Jakarta and deep aquifers are used by industry, businesses, and expensive neighbourhoods (Furlong & Kooy, 2017). As high-income users do not use the piped network, it impedes “the cross subsidization upon which service extension to the lower-income areas of the city is based” (Furlong & Kooy, p. 888, 2017). As a result, the Urban waterscape is fragmented by the disconnect of activities that do not include network infrastructure (Furlong & Kooy, 2017).

As shown in [Figure 16](#), not all areas in Jakarta have access to piped water (white areas on map), and if piped water is accessible it is not available all the time and/or has inadequate pressure (Furlong & Kooy, 2017). The standard of 0.75 atmospheric units (atm) of pressure for water is only achieved by half of the City’s water connections (Furlong & Kooy, 2017). Piped water infrastructure is absent in North, East, West, and South Jakarta, but concentrated in Central Jakarta (Furlong & Kooy, 2017). Bakker & Kooy (2008), conducted a GIS-mapping study to analyse land use and water network distribution and found that key economic zones (Industrial Estates, commercial districts, and residential zones for the elite) had high concentration of water supply networks. As indicated in [Figure 17](#), Northern Jakarta has a large concentration of poor neighbourhoods and slums that have little to no water pressure because eligibility for an on-premise piped water connection you must hold a citizenship card and proof of

payment/receipt of land and building tax. This regulation makes it difficult for those living in slums or on illegal land for which land and building tax is not owned or paid for (Kooy et al., 2018). **Figure 17** illustrates that Jakarta also has a high prevalence of unregistered land concentrated in varying areas along waterways and in North East Jakarta where the colonial and oldest part of town has poorly maintained infrastructure (Baker, 2012).

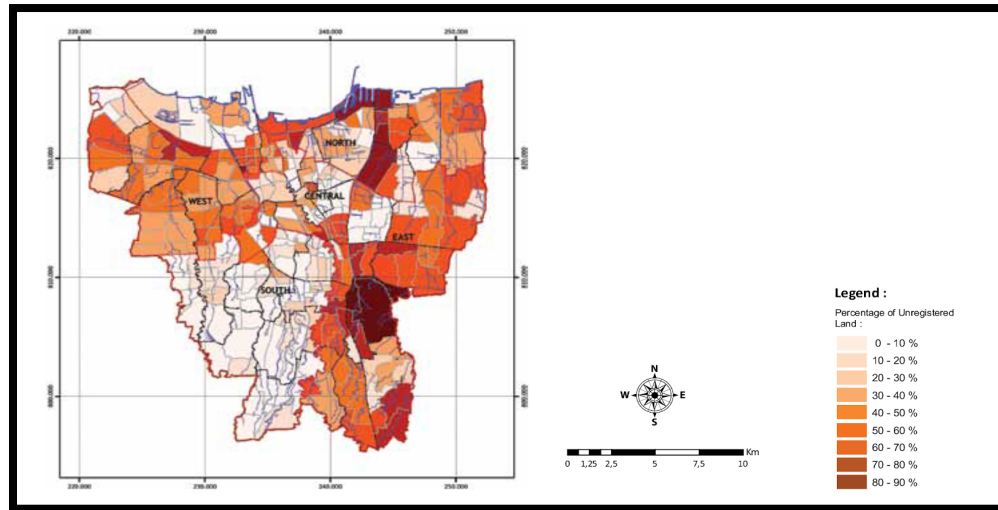


Figure 17. Land Registration in Jakarta (Baker, 2012)

Along with households there is also urban development due to the high amounts of industrial activity in the Jakarta area. Industrial activity is spread out throughout Jakarta's five municipalities forcing households to live in areas with high pollution and competing water resource use.

INADEQUATE WASTEWATER TREATMENT & SEWERAGE MANAGEMENT

The availability of wastewater or sanitation infrastructure is one of the basic human needs with the main purpose of separating human waste from the living environment to prevent diseases (Setiawati et al, 2013). According to The World Health Organization (WHO), bad sanitation conditions causes 85-90% diarrhea in developing countries and causes 1.6 million deaths annually among children under the age of 5 (WHO, 2020). In developing countries, the simplicity and low cost of construction of basic sanitation lavatory (simple holes) without operation and maintenance, contributes to the spread of disease through the ground water contamination (Setiawati et al, 2013). Jakarta has similar sanitation issues as other cities in developing countries and the correlation issues are concentrated within wastewater problems, in addition to poor governance and inadequate management and infrastructure (Setiawati et al, 2013).

Asian megacities experience severe pollution issues from a lack of wastewater treatment from agricultural, domestic, and industrial sources and Jakarta is no exception (Luo et al., 2019). Jakarta's sewerage covers only 1.9 % of the population and the majority depend upon on-site sanitation that drains into surface water due to inadequate infrastructure (Luo et al., 2019). Wastewater treatment in Jakarta is divided into on-site sanitation and off-site sewerage

management systems (Luo et al., 2019). Rapid urbanization and industrialization have also influenced the already poor infrastructure.

Drainage concerns regarding Jakarta's water management is a crucial element to Jakarta's water and sanitation profile (Luo et al., 2019). The drainage system in Indonesia remains increasingly problematic for several reasons: a) most of its cities are developed incrementally instead of through long-term planning; thus it is difficult to design an integrated drainage system in the existing situation; b) drainage system planning is still based on conditions during normal climate, while extreme rain due to climate anomaly has often occurred, and c) water runoff has increased due to land use change (Luo et al., 2019). Improving Jakarta's drainage system will enhance water quality and the collection of wastewaters for sanitation purposes and disposal within the city.

INADEQUATE MANAGEMENT SYSTEMS & POOR GOVERNANCE STRUCTURES

Unfortunately, the responsibility for the functioning of Jakarta's drainage system is based on a three-tier government system. The multi-level structure has become more prominent recently as a result of the country's decentralisation policies (Ward et al., 2013). Because of this, flood management and drainage within Jakarta is politically and administratively fragmented. In previous years, there were no particular agencies or institutions which were assigned to oversee and account for risk and vulnerability assessments, to manage climate change data, or to disseminate climate-related information to the public, and therefore water and sanitation efforts regarding drainage management remained poor and inadequate (Ward et al., 2013).

Another issue that impacts the ability for Jakarta to provide water infrastructure is the amount of money the country allocates and spends in support of it. Although Indonesia's economy grew by 5.8% during the late 2000s there was only a 3% growth in spending on infrastructure (World Bank, 2016). In contrast to a growing population in China, their government spends 10 % of its GDP on water infrastructure (World Bank, 2016). In order to maintain and improve water infrastructure money is needed and must be allocated correctly alongside adequate management. This includes better alignment and priority focus for both investment and effective management regarding poor governance structures.

Key Opportunities for Water Security & Sustainability

WATER LAW

To address water security concerns within Jakarta, the government of Indonesia has made special considerations since the enactment of Law No. 7/2004 on water resources (Fulazzaky et al., 2014). Guided by this law, the decision makers, managers and operators regarding the water sector must strive to implement effective strategies, programs and activities to support water management. The law and policies governing water resources within the city are the legal provision for managing water resources in the river basin perspective but have not yet been synchronized effectively (Fulazzaky et al., 2014). In Indonesia, the implementation of IWRM requires a participatory approach (Fulazzaky et al., 2014). The most important milestone in implementing the IWRM principles and processes is the enactment of Law No. 7/2004 on water resources, although several other laws and regulations are in place in Indonesia to deal with water related issues, such as the Disaster Management Law of 24/2007 and the Spatial Planning Law of 26/2007.

Programme management in terms of climate change adaptation has been very limited, resulting in a lack of agency and institutional capacity to manage climate-change data and activities (Indonesia National Action Plan, 2018). As a result, the lack of capacity to provide the impetus needed to develop a programmatic approach, even though the need for integrative programme management is recognised by local and regional government bodies, serves to illustrate its need for adequate and improved governance structures, as well as effective policy revisions for water management practices within the country.

INTEGRATED WATER RESOURCE MANAGEMENT IN JAKARTA

Within the city of Jakarta, many attempts for integrated solutions have been made in support of urban water security. One such attempt is the implementation of IWRM. In theory, IWRM is designed to help policy makers deal with water's complexity within and beyond Jakarta in order to maximize the economic and social welfare in an equitable manner, without compromising the sustainability of the water system (Fulazzaky, 2014). Unfortunately, the implementation of IWRM in Jakarta remains inadequate due to several factors, including funding and budgetary constraints, technical and managerial challenges, in addition to the lack of effective and cooperative governance, despite having the SDG's promulgated in September 2015 arranging that all states agreeance to have functioning IWRM practices in place by 2030 (Fulazzaky, 2014). Although efforts have been made, with the government of Indonesia adopting new strategies for water resource management through the enactment of Law No. 7/2004 on water resources, the implementation of IWRM in Jakarta still remains inadequate due to a continuance of low funding and budgetary constraints, technical and managerial challenges, in addition to the lack of effective and cooperative governance (Fulazzaky, 2014).

Through critical analysis, the role of sustainable governance comes into play with this, with the need to understand whose water is at risk, who is vulnerable, what are the major threats that individuals within the city face and what is being done to mitigate for transformative sustainable consumption and change? Additionally, the approaches to Jakarta's distribution, in deconstructing how water is being used and for whom, is extremely important as the need to recognize the power dynamics which water inherently holds and flows in Jakarta can help address the opportunities for intervention and key opportunities for achieving urban water security within the city (Kooy et al., 2018). The challenge for the present and future development of water security within Jakarta remains conflicted within education, access, governance, and management concerns (Indonesia, 2018). Many violent conflicts have taken place between different ethnic groups and between governments as a result of heightened vulnerabilities and uncertainties regarding food and water security (UN Asia-Pacific Disaster Report, 2019). This further speaks to the issues between the state and civil society/citizens, and the lack of accountability and poor performance measures of governing officials. As a result, these conditions have put the country of Indonesia and its population at risks of exposure to extreme scarcities, concerns for accessibility and decreasing water quality (Indonesia, 2018).

Climate change is also expected to exacerbate Indonesia's current issues, including the prevalence of natural disasters in addition to the depletion of natural resources in the coming years (UN Asia-Pacific Disaster Report, 2019). The uncertainty regarding the security of the growing population, in terms of both food and water must be reviewed in an effort to understand the current landscape of water management approaches and methodologies in Indonesia at both a national level and community level, in addition to understanding the

capacity of local officials' ability to implement and improve adequate water management programs. Total water demands to support Indonesia's growing population and economic growth for irrigation, domestic, municipal, and industrial uses are currently at an all-time high, with the variations in climate from the year to year affecting water availability (Fulazzaky, 2014). As a result, current water use in Indonesia is already highly constrained by unbalanced conditions of demands and the potential availability, particularly during the dry season (Afifah et al, 2018 & Mursidi et al, 2017). Because of this, the negative impacts of increasing water pollution and quality is also having negative impacts on human health within the city (WHO, 2020).

THE SUSTAINABLE DEVELOPMENT GOALS IN INDONESIA (2015-2030)

In a forward-looking review, current government actions within Indonesia have now recognized and acknowledged the need for viable transformative change. The adoption of the Sustainable Development Goals (SDG's) presented on a global forum in September 2015 has provided the country with additional guidelines and targets necessary to achieve successful progression. The country of Indonesia has committed to the implementation of the Sustainable Development Goals, including initiatives for the improvement of drinking water and sanitation facilities, as well as targets to strengthen and develop stronger governance divisions (Ministry of National Development Planning, 2020). Indonesia's Presidential regulation and decree No. 59/2017, the SDG Roadmap, as well as the National Action Plan concerning the implementation of the SDG's works in partnership with the Ministry of National Development Planning which stresses policy revisions and regulations necessary for systemic change (Ministry of National Development Planning, 2020). The government has also integrated 118 of the 169 global SDG targets into the National Medium-Term Development Plan (RPJMN) (United Nations Economic and Social Commission for Asia and the Pacific, 2020). However, given the complex nature and past of governance within the country, there remains concerns regarding the viable actions and accountabilities made by governing bodies for current and future considerations (Ministry of National Development Planning, 2020). Although baselines and targets have been set with measurable indicators, challenges still remain regarding the actual method of measurement for certain indicators, insufficient coordination among governing agencies, as well as the limited adoption at the sub-national level due to differing local priorities and political cycles (United Nations Economic and Social Commission for Asia and the Pacific, 2020).

To date, Indonesia's development plans have been designed through complex, holistic approaches, with frameworks extending to Thematic, Holistic, Integrated, and Spatial (THIS) (Ministry of National Development Planning, 2020). This is largely due to the country's complex nature and numerous governing bodies which govern the thousands of islands within the country. With this, the actions and implementation of the Sustainable Development Goals within Indonesia, specifically regarding water security, has required the recognition for a systemic structural design, involving revised policy regulations, comprehensive implementation strategies, and multi-stakeholder considerations (United Nations Economic and Social Commission for Asia and the Pacific, 2020). Some governing initiatives which have become highlighted within the policy directions of Indonesia include, enhancing good governance for the provisions of safe drinking water, enhancing innovation and the capacity of technology for operating capacities of Indonesia's water systems, accelerating infrastructure development regarding both rural, urban, and peri-urban settings, as well as integrating the conservation and collection of raw water sources in efforts to optimize the utilization of raw water sources and

efficient uses of technology for water security enhancement (Ministry of National Development Planning, 2020).

Prioritizing these guiding policy directions for both current and future governing considerations (2025-2030) can enable effective regulations, institutional accountabilities, and sufficient financial funding to be available and utilized in the most necessary ways (United Nations Economic and Social Commission for Asia and the Pacific, 2020). These active initiatives within recent policy considerations have provided Indonesia's existing governing bodies with directions forward regarding the rehabilitation of the country's vital structures and services, however more viable and measurable action will be needed if social, political, environmental, and economic considerations, including water security in the country are to improve. These active guidelines must be continuously backed up with measurable data, acknowledged accountability, and real progressive change.

THE NEW AGENDA & NATIONAL PLAN

The New Agenda on Urban Governance Framework allows for urban populations who reside in unconsolidated urban areas like Jakarta to access urban services such as basic water and sanitation. In addition, Indonesia's proposal for the New Urban Agenda of Habitat III (2016-2036) has developed as a framework of the long-term national development goals (2005-2025) to achieve the vision of Indonesia as an independent, advanced, prosperous and equitable country (Indonesia National Plan, 2016). National development goals of the Republic of Indonesia have been clearly stated in the Preamble of the 1945 Constitution, which are to protect the nation and promote the general welfare of the people. The National Development Plan is carried out in stages: the long-term, medium-term, and annually (Indonesia National Plan, 2016). Efforts to achieve the national goals are implemented through systematic stages and planned processes, through sustainable integration. Within this plan, many goals, targets, and objectives are specified, including long-term visions for Jakarta's development. Some of these visions and/or guiding principles include: Independent, being able to realize an equal position with other nations and to rely on own abilities and strengths, Advanced, achieved prosperous and high quality human resources within a stable political system and well developed institutional and legal framework, Equitable, no restriction or discrimination of any kind, either between individuals, gender, or between regions, Prosperous, the fulfillment of the needs of Indonesian society so that to enable the country to give a meaningful roles among other nations (Indonesia's National Plan, 2016). Embedded within these visions includes the rights and equitable management and access to quality water. Although these actions plans are not necessarily legally binding agreements, they are however a step in the right direction for the awareness and recognition of change needed for the sustainability and security of the country.

INDONESIA'S GREEN FRAMEWORK

A challenge towards creating sustainable development within an urban megacity like Jakarta is the need for sustainable application regarding infrastructure and technological innovation. In alignment with the National Action Plan, the enactment of Indonesia's Green Framework was created, initiated by the Green Cities Program of the National Plan (Indonesia National Plan, 2016). The initiative towards a more green and sustainable nation serves to enable policy makers, governing officials and community planners to take highlighted focus regarding sustainable design planning for future resiliency against increasing water demands in Jakarta (Indonesia National Plan, 2016). The utilization of a Green Framework can also be a critical

guideline regarding spatial planning and design in Jakarta with the increasing population influx and implementation of sustainable water infrastructure. The Green Framework, under its provisions should exemplify the macro and meso impacts of ecological and social impacts, especially within local action plans regarding water security.

MANAGING RAPID URBANIZATION

According to Indonesia's National Report (2016), there are three supporting factors for an increase in urbanization: i) natural population growth; ii) rural-urban migration; and iii) administrative reclassification. Indonesia manages its urbanization through a) population control; b) expansion of urban areas; and c) migration and population mobility control, with the city and capital of Jakarta being no exception. Managing urbanization through population control is an effort of managing natural population growth by reducing birth and mortality rate, as well as improving reproductive health, which has occurred through family planning initiatives within Indonesia since 1957 (Indonesia's National Report, 2016). In 1969, the initiative was formalized into a government body titled *Coordinating Body for Family Planning* (Badan Koordinasi Keluarga Berencana (BKKBN) with expanded task to integrate family planning with increasing family's welfare (Indonesia's National Report, 2016). Stagnant population growth that occurred within the past two decades was largely associated with democratization and decentralization in Indonesia, with continued rates rising each year to this day. Because of this, the National Family Planning (KB) program was evolved into voluntary base, with heavy involvement from the central government in which the President is fully responsible and actively involved in all activities ranging from promotion and ensuring top-down implementation of central policy is utilized.

To ensure the management of population and urbanization remains ongoing, Law No.10/1992 on Population Growth and Family Welfare Development was enacted to accommodate decentralization and balance population mobility with the environmental capacity of both Indonesia, and its capita city, Jakarta (Indonesia's National Report, 2016). The ongoing implementation of family planning could help stabilize Jakarta's population concentrations, or rather provide essential welfare development for families who may need support. In addition, managing urbanization through the improvement and expansion of urban areas, like Jakarta, can help address the negative impacts of rapid urbanization, particularly in the formation of slum settlements, impoverished communities, encroaching fertile land, and limiting protected zones, which can only serve to exasperate existing risk and vulnerabilities. Expansion of urban areas can include adding more areas and/or increasing the area carrying capacity. This of course would have to be paired with adequate supporting infrastructure for the capacity of the city to be stable. Essentially, investment and prioritization within social development, long term planning, and sustainable monitoring can contribute to achieving water security at the individual and household level.

INVESTMENT IN INFRASTRUCTURE & MANAGEMENT SYSTEMS

During the past few decades there have been significant urbanization and man-made changes that have altered the City's land-use which has contributed to the water security issues that the population has been exposed to. As the demand for water in Jakarta is gradually increasing, this tendency has not been dealt with by expanding surface water supplies (Luo et al., 2019). As a result, the investment in improved and adequate infrastructure within Jakarta will serve to

enhance existing infrastructure challenges related to water quality and access within the city, including providing adequate piping and water management systems to meet growing city demands (Figure 18). As previously discussed, governing officials need to recognize that investment of adequate and up-to-date infrastructure will serve to eliminate future costs. This includes water, sewage, and management systems, which are often non-existent in many impoverished communities or rather shared amongst industry settlements (Baker et al, 2012). As a result, poor infrastructure, insufficient health, and sanitation concerns, in addition to heightened management concerns for resource demands pose uncertainty for individuals, all which add to increasing risk, vulnerability and poor development (World Bank, 2014).

Therefore, in addressing inadequate infrastructure within the city of Jakarta, the investment and upgrade of appropriate infrastructure and management systems for the growing population by governing officials can in turn, be a crucial source for global cooperation, development, and security. A solution for this, in correlation with possible budget constraints or political barriers can be the utilization and emergence within already established or existing infrastructure. Additionally, investment within design and smart city infrastructure can also help secure Jakarta's current water security demands and minimize costs and maintenance. In order to meet the growing demands for both current and future considerations, governing officials, policy planners and experts need to collaborate and prioritize investment for improved city infrastructure if sustainable transformative change is to occur.

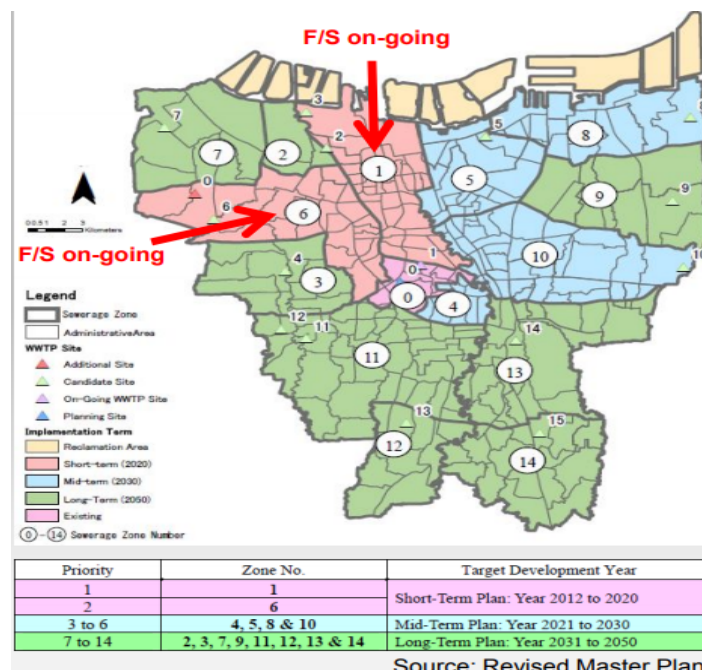


Figure 18. Sewage Development Plan in Jakarta (Master Plan, 2012-2020)

GOOD GOVERNANCE

For governance structures to improve, states and country borders need to agree and invest in jointly water resource management structures if they are to share both the rightful costs and associated benefits. The investment within adequate infrastructure and management systems can in turn, be a crucial source for global cooperation, trust and security. This idea of water

diplomacy can serve to enhance conflict resolution which bounds the needs and conflicting views of different countries and sectors together. In turn, the emergence of water diplomacy and the focus towards jointly managed water systems can become a leveraging tool for security, prosperity, and the protection of the environment all in one.

In recognizing the need for change, effective solutions towards sustainable water management is key to ensuring peace, long term stability and security. The current global water crisis is mainly an issue of poor or inadequate governance structures or the denial of the water crisis and the mismanaged investment for current and future water considerations. As a result, good governance strategies are essential for preventing water related conflicts at every level and ensuring all individuals and stakeholders involved have equal access to quality water and management facilities (water and sanitation), for current and future projections.

IMPROVING INTEGRATED WATER RESOURCE MANAGEMENT (IWRM)

In an effort towards addressing the challenges Jakarta currently faces and the opportunities for change, a reasonable solution remains with the need to improve the capacity of IWRM strategies related to enabling the environment, institutional frameworks and management instruments which are crucial for contributing to the future directions and sustainability of water governance for Jakarta. As a management framework, integrated water resources management (IWRM) is now the dominant paradigm for water management in many developing countries, including Indonesia (Swatuk, 2020). The IWRM paradigm is an effective framework which urges the government to involve stakeholders in each level of water management, in an effort to engage stakeholders to restore and maintain the natural water flow regime of the rivers as a key part of building a sustainable water management initiative within the city (Fulazzaky, 2014).

To address the inadequate waste and water management infrastructure, unequal, unmonitored, and over consumptive use by the growing population, in addition to ineffective governance structures, a key intervention for change can include improving the role of IWRM and governance within Jakarta. As mentioned previously, the government of Indonesia has made special efforts on IWRM since the enactment of Law No. 7/2004 on water resources, however as effective IWRM strategies account for the inclusion, cooperation and involvement of key stakeholders (i.e. policy makers, city planners, managers and engineer operators) these approaches have yet to be synchronized effectively (Fulazzaky, 2014). The Law No. 7/2004 meets the most important elements of two aspects of IWRM (i.e., enabling environment and institutional roles), however not to the level of effectiveness needed in order to improve the city's water security (Swatuk, 2020 & Fulazzaky, 2014). At the governing level, each ministry involved has a mandate with responsibility for promoting social, economic, environmental and cultural well-being of communities in the present and for the future, however in the case of Jakarta, these values are not often exercised in a collective way, and therefore, building the capacity for good governance would be an effective leverage point for which governing bodies can collectively agree and manage Jakarta's consumption, quality and distribution in an appropriate manner. When governance strategies incorporate inclusive participation amongst stakeholders and citizens, while working with the physical limits of water, water security can be reassured for millions of citizens, a possibility which can be implemented within the city of Jakarta under the right considerations and collective cooperation.

INTEGRATED WATER RESOURCE MANAGEMENT (IWRM) APPROACH

The rationale for the IWRM approach as a potential framework and methodology has been accepted by many countries as the way forward for efficient, equitable and sustainable development and management of the limited water resources and for coping with conflicting demands. The implementation of (a)n IWRM approach within the city of Jakarta, for example, can include the following: (1) IWRM at the level of river basins; (2) the decentralization of water management; (3) participative management and planning, involving all stakeholders and the public; (4) application of the polluter-pays principle and the engagement with Jakarta's water agencies; (5) local public municipalities responsibility for water supply and sanitation utilities; (6) monitored use and maintenance of the various methods used for managing water utilities, either managed by a public authority or by a delegated private company; and (7) transparency in the operation of services and information to the users (Fulazzaky, 2014). With these acting guidelines in place, governing members, city planners, experts, and individual users can collaboratively work in transparency to overcome water security challenges in a more efficient, equitable and sustainable way in coping with heightened demands. Through these guiding principles, in partnership with the established Sustainable Development Goals, governing officials, experts and city planners, can collaboratively work in transparency to overcome water security challenges in a more sustainable and collaborative way.

EDUCATION, PUBLIC PARTICIPATION AND COLLABORATION

In the case of Jakarta, public education, awareness, and community participation can be crucial for effective transformative change to occur. Law No. 12 Year 2011 on the Establishment of Law and Regulation, states that individuals within Indonesia have the rights to provide input, verbally or written, in the process of formulating law and regulation (Republic of Indonesia, 2016). Enabling participation in policy making and planning is vital for individual water security and well-being. This includes the public awareness and education needed for individuals and industry towards environmental degradation and the population of main water sources. Paired with this, governing officials must enact various policy reforms and regulations regarding the proper disposal of waste in recognition of current poor waste management facilities (Indonesia National Report for Habitat, 2016). When stakeholders, policy makers and governing officials work together towards better education, public awareness and community participation, efforts of coordination regarding inter-ministerial cooperation can build up existing city structures and enhance sustainable adaptation and mitigation solutions for long term water security (Padawangi & Douglass, 2015). Republic of Indonesia, (2016). The goal of participatory involvement is to help identify any gaps on the local-community level and implement mechanisms that encourage both governing officials and city planners to address direct concerns and complex challenges of water faced by the city's inhabitants. An example of this can be represented in changing community behaviours through training and education workshops by local officials and NGO's, with a focus in support of water resource conservation and the provisions and benefits of safe drinking water and conserving raw water resources to optimize water collection by locals and municipal governments (Ministry of National Development Planning, 2020).

FUTURE SUSTAINABILITY OF JAKARTA: A FORWARD-LOOKING VIEW

To confront the main challenges and issues regarding water security in Jakarta, in a forward-looking review, efforts to achieve global water sustainability and security will fail if appropriate sustainable management methods and practices are not addressed and implemented. As a result, the current landscape of water management approaches and methodologies in Indonesia at both a national level and community level needs to be revised in an effort to enhance the capacity of local officials and the ability to implement and improve adequate water management programs for long term sustainability. Climate change is expected to exacerbate Indonesia's current issues, with water security being no exception. As a result, long term sustainability must be reflected on in an effort to offer sustainable and appropriate solutions for Jakarta's context, with opportunities for intervention reviewed and proposed. The heavy reliance on groundwater to serve industrial and domestic needs for Java's large urban areas cannot continue indefinitely. Although the Government of Indonesia has made considerable attempts towards sustainable change, more is needed if the city of Jakarta wishes to have its water security demands met in partnership with the complex dynamics regarding its growing population.

Conclusion

The challenge for the present and future development of water security within Jakarta remains conflicted within education, access, governance, and management concerns. In terms of management, the country of Indonesia remains to be a conflicted context regarding water, as seasonal challenges provide both an abundance and disparity of water in variable qualities, not yet properly stored or managed effectively. As a result, these conditions have put the country of Indonesia and its population at risks of exposure to extreme scarcities, concerns for accessibility and decreasing water quality, all which have been addressed and critically reviewed within this paper.

Ultimately, efforts to achieve global water sustainability and security will fail if appropriate sustainable management methods and practices are not addressed and implemented. Jakarta's water system will fail and continue to be uncertain if sustainable approaches and management strategies are not put into place. Expressed within our proposed thesis statement, *water security in Jakarta City is impacted by inadequate infrastructure, unequal and unmonitored use by industry, by a growing population, and poor governance structures* is evident. Our recommendations included the review of existing government and management structures and the opportunities for intervention and transformative change. To address the water security issues in Jakarta, effective and good governance strategies must be implemented within Jakarta's social, political, and economic structures with the investment of adequate infrastructure and management systems. Additionally, the improvement of integrated water resource management (IWRM), the adoption, alignment and enactment of the New Agenda and National Action Plan principles, the collection and recorded measurable targets and data provided by SDG initiatives, in addition to improvement of education, public awareness, and collaboration of all stakeholders must be conducted. With these strategic and active guidelines in place, pair with the accountable actions measures through international regulation, governing bodies and the growing population of Indonesia can become catalysts for viable change and action to occur in the interest of water security for all. When governance strategies further incorporate inclusive participation amongst stakeholders and citizens, while working with the

physical limits of water, water security can be reassured for millions of citizens, a possibility which can be implemented within the city of Jakarta under the right considerations and collective cooperation.

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