

## Environmental Problems and the Implications on Water Management Strategy in Jakarta, Indonesia

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### Abstract

Jakarta is the most populated capital city in South East Asia. Around 12.5 million people lived in the area of 662 km<sup>2</sup>. As the center of government administration and business activities make great pressure on Jakarta environmental condition. One of the major environmental problems in Jakarta is water management, during monsoon Jakarta area vulnerable to flooding and inundation. Moreover, water pollution and illegal water extraction become another environmental issue in Jakarta. Indonesia government and Jakarta government has pursued an effort to tackle water problems in Jakarta, various attempts were made and designs to water problems such as build up retention basins, rivers restoration, river pathways and giant seawall. However, there are still many weaknesses in the government's plans. This paper will explain the cause of the water problems in Jakarta and the government's efforts to overcome the problems. Moreover, this paper also explains the barriers that hinder government efforts to resolve water management problems in Jakarta.

**Keywords:** Environmental; Implications; Water management; Strategy

### Introduction

Most coastal cities in Indonesia are facing threats of sea level rise, abrasion, flooding and other environmental problems. Jakarta is the capital city of Indonesia and it is located in the Northwest of Java Island; this city lies in a lowland area with altitude around 7 meters above sea level. Jakarta covers an area of 662 km<sup>2</sup> and has 35 km coastline; there also 13 rivers that cross this city which discharge in Jakarta Bay. Ciliwung river is one of the largest rivers that cross Jakarta, it has 130 km length which covers of 390 km<sup>2</sup> catchment area, where the upstream areas from Mount Pangrango (to the South of Jakarta). As the centre of government administration and economic activities in Indonesia, rapid development in Jakarta generate great pressure on the environment and led to environmental degradation [1].

### Literature Review

Jakarta becomes one of the most populated cities in the world, in 2016 around 10 million people lived in this city plus around 2.5 million daily commuters from adjacent cities [2]. Population in this city rose significantly since 1975 from 4.5 million to more than 10.5 million in 2018 and it predicted that the population will reach 30 million inhabitants in 2030. The increase of population in Jakarta resulted in the increasing need for clean water and the emergence of some water issues [3].

Water problems become government top priority to be resolved in the last few decades. There are three major environmental problems which related to water management in Jakarta; river pollution, flooding and land subsidence. Jakarta experienced major floods in 2002, 2007 and 2013; these events occur during monsoon season and effect to economic loss, environmental degradation and society problems. A recent study estimated the damage cost of the annual flooding in Jakarta reach up to USD 320 million per year [4].

The objective of this paper is to investigate the anthropogenic factors and natural factors on environmental problems, specifically related to water issues in Jakarta. This paper also assesses government action to reduce flooding impact and suggest some possible water management to apply (Figure 1) [5].



Figure 1: Jakarta map.

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## Pressures on Jakarta water management

**Water resources and groundwater extraction:** Population growth and industrial sector increased water demand in Jakarta and adjacent cities (Bogor, Depok, Tangerang and Bekasi). Recent data stated that Jakarta government only supplied 60 percent of the water demand in Jakarta [6]. And to compensate the insufficient water supply, the government allowed the communities and industries to extract groundwater for their daily needs. The potential of groundwater reserves in Jakarta reach 52 million m<sup>3</sup> per year and groundwater extraction reached 21 million m<sup>3</sup> per year or around 40 percent of total reserves [7].

Uncontrolled and irresponsible groundwater exploitation in Jakarta causes an adverse impact on the environment. The groundwater level in Jakarta decrease significantly and resulted in increased pollution to groundwater and land subsidence in some area. Although Jakarta has high rainfall intensity there is lack of open space to serve as the catchment area. Rain intensity in Jakarta reach 6 billion m<sup>3</sup> per year and most of the rainwater will end as surface runoff. The government need to create more green space and basins to recharge groundwater reservoir and prevent land subsidence in Jakarta [8].

## Discussion

### Domestic waste and sewerage system

Industrial sectors responsible for the increase of water pollution in Jakarta Bay, industrial factories such as metal processing, the pharmaceutical industry, paper and pulp manufacture, tanneries and petrochemical industries discharge the industrial waste directly to water system without any treatment. Moreover, most households in Jakarta and adjacent cities, discharge their waste directly to the rivers without any treatment. Data from the World bank on water pollution in Jakarta found around 15,644 tons of nitrogen and 4000 tons of phosphorus are discharged into Jakarta rivers every year [9].

The wastewater management in Jakarta is relatively poor, the capacity of wastewater treatment owned by Jakarta government is only able to manage 3 percent of the total waste. Moreover, poor and leaky septic tank conditions of most households in Jakarta increase the risk of groundwater contamination in the lower catchment. A recent study found the similarity in temperature, pH and TDS between rivers and groundwater in Jakarta, this indicated that the rivers contaminate groundwater resources [10].

### Land subsidence, land use change and river morphology

Excessive groundwater exploitation causes land subsidence in most areas of Jakarta. The rate of land subsidence in Jakarta is around 7 centimetres per year, but in North Jakarta, the number is even higher, reach to 17 centimetres per year. Beside of groundwater exploitation, high surface load and sediment type also contribute to land subsidence occurrence. Rapid infrastructures development in the last few decades and coastal reclamation in North Jakarta lead to the occurrence of land subsidence and increase the risk of inundation during monsoon and high tides [11].

Population growth and economic growth in Jakarta are urging the opening of new land for residential and business areas. During the period 1980 to 2002, as much as 25 percent of non-urban uses in Jakarta area converted into urban and business uses. Many green spaces and agriculture land were turned into new settlements and new

business and industrial districts. The decreasing of green area in Jakarta that serves as catchment area causes the increasing of runoff into the river system. Moreover, with the limited rivers capacity and poor drainage, it causes inundation and floods in some areas in Jakarta during the rainy season (monsoon season).

Land conversion also occurs in coastal areas, coastal reclamation has been implemented in many developed countries to stimulate economic growth and facilitating the demand for occupancy for their community. The Indonesia government aim to develop their capital city into modern waterfront city as well as strive to become the new economic centre in Southeast Asia region. Since 1980's several reclamation projects have been implemented by changing mangrove forest in North Jakarta into residential and industrial districts. However, these developments have impacts on coastal communities which threatened by floods and seawater intrusion for a long time without any significant actions from Jakarta government.

Uncontrolled development along the watershed in Jakarta rivers and erosion in the upstream affect the pattern of water flows and pollution levels in several rivers in Jakarta (Figure 2). Research conducted in Jakarta rivers found rapid change in Ciliwung watershed uses from agricultural land to urban area during the period 2010 to 2014 and impact to water quality degradation and increased the flood risk in Jakarta area.

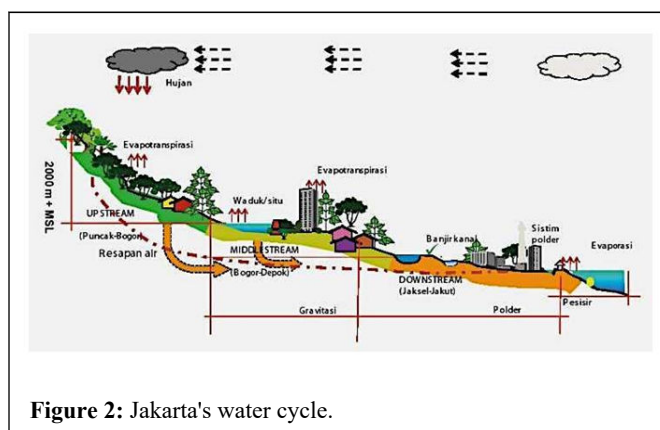


Figure 2: Jakarta's water cycle.

### River and coastal pollution

Since 1970 the level of water pollution in Jakarta rivers and bay are increased significantly, heavy metal elements from industries and households waste derived to city water system. The concentration of heavy elements such as Pb and Cd were found with a high concentration in the coastal sediment, especially in the eastern part of the Jakarta Bay. Moreover, a high concentration of Cu elements found in the western part of the bay, near the outlet of Jakarta power plant and the downstream of Cisadane river. Poor industrial and household waste management is responsible for the pollution of heavy metals in the rivers and the bay.

Water quality in Jakarta rivers are highly polluted by hazardous elements, laboratory samples from several rivers in Jakarta contain dangerous elements such as As, Cd, Cu, Hg and Pb. Although volcanic weathering might contribute to the existence of those elements, industrial waste and households waste became the main contributor of heavy metal elements in rivers and Jakarta Bay. These conditions are very dangerous for humans as well as coastal and marine ecosystems which exposed by water pollution for long period.

Household and industrial wastes carried by rivers into the bay are greatly affected the state of the marine ecosystem and marine species. The results of laboratory tests on milkfish and shellfish cultivated by coastal communities in Jakarta Bay contain harmful material radionuclide  $^{137}\text{Cs}$ . Research by Prihatiningsih et al., found that the radionuclide  $^{137}\text{Cs}$  possibly derived from a nuclear reactor in Tangerang district or steam power plant in North Jakarta. Coastal communities in Jakarta also cultivate green mussels in Jakarta Bay. However, a researcher from Bogor Agriculture Institute found that green mussels in Jakarta Bay contain Hg, which is a very dangerous element for human health. Green mussels can absorb heavy elements in high amount and more tolerant to stress than other marine species.

### Assessment of government actions

Central government together with the Jakarta government trying to overcome the annual flood disaster in Jakarta. Various attempts were made and designs to reduce floods impacts such as build up retention basins, rivers restoration, river pathways and giant seawall. However, there are still many weaknesses in the government's plans. This section will assess the advantages and disadvantages of the government's plans to reduce the impact of Jakarta flooding.

### Retention basins

The central government proposed the development of two new retention basins in Bogor district to accommodate Ciliwung river flow. Ciawi retention basin will occupy 29.2 ha and can hold as much as 6.45 million meters cubic, while Sukamahi basin will occupy 5.23 ha and can hold 1.68 million meters cubic. The aim of this retention basin development is to reduce the water volume flow in Ciliwung river and delay the water flow arrived in Jakarta. Currently, water travelling time from Bogor district to Jakarta areas is around nine hours and the development of these retention basins could extend the travelling time become 13 hours. However, the development of new retention basins stills a far way to realize.

Rapid infrastructure development in Ciliwung upstream has happened since two decades ago. Many residential developments occupied Ciliwung catchment areas and uncontrolled land conversion from agriculture areas to urban areas increase flooding risks in Jakarta areas. The government still constrained with local communities in term of land acquisitions and development funding. Moreover, the government tend to ignore the main problem which causing high volume river discharge in the Ciliwung river upstream. Land conversion still happens in the upstream and the catchment areas, the government need to regulate and stop residential development in the catchment areas to reduce surface runoff and allowed groundwater recharge to avoid land subsidence.

### River restoration

Several programs have been applied to reduce the vulnerabilities of flooding hazards in some of Jakarta areas and one of them is through river normalization and urban planning along the Jakarta watershed. The increased rate of river sedimentation because of upstream erosion and illegal settlements which occupied the floodplain has increased the flood risk during the monsoon. The government applied regular dredging to reduce sediment in the river and increase flow capacity.

Jakarta local government together with central government have to restore rivers that crossing Jakarta areas and one of the programs is restored water flow in Ciliwung river. However, since 2013 the

progress achieved less than 50% or around 16 km from 33 km. The most difficult part is when the government tried to relocate the settlements which build along the floodplain to another area. This program was widely opposed by the residents together with the NGO which used the human rights issues to argue with the government (Figure 3).



**Figure 3:** The National Capital Integrated Coastal Development (NCICD) master plan (NCICD Consortium, 2015).

### Giant seawall

Aside from river flooding, Jakarta also suffers from inundation during monsoon season. The area in North Jakarta which has low area because of the high rate of land subsidence and its location which is directly adjacent to Java sea very vulnerable to inundation risk. The Jakarta government was built a sea wall along the coast to reduce the flood risk, but the high rate of land subsidence in North Jakarta and sea level rise caused the current seawall sinking and cannot withstand the sea water.

Indonesia government proposed the National Capital Integrated Coastal Development (NCICD) or giant seawall along Jakarta Bay to protect Jakarta from the threat of sea level rise. The NCICD master plan (Figure 3) proposed the development of 17 reclamation lands and giant seawall in Jakarta Bay to protect Jakarta area as well as develop the new economic centre in North Jakarta. This project is part of the collaboration between the Indonesia government and the Dutch government. The historical proximity between both countries encourages the Dutch government to propose the NCICD master plan to the Indonesia government.

The NCICD project aims to solve all the environmental and water problems as well as increase economic and social value in Jakarta. The project adapted water system technology from the Dutch system by building several polders within Jakarta Bay and creating retention basin behind the giant seawall. The retention basin will equip with high capacity water pump to pump out water from retention basin into the Java sea. However, the development of this mega project currently postponed due to political and environmental issues.

However, the government needs to review their mega project because many problems (social, economic and environment) will arise from the construction of the giant seawall along Jakarta Bay. The development of the NCICD project will affect coastal communities

livelihood since the government plan to relocate coastal communities settlements to one of the reclamation islands and the project will demolish local fisherman fishing ground. Although the government argue that their project will increase job availability in North Jakarta, but writer argues that this project will increase social and economic inequality among Jakarta society.

## Conclusion

The development of giant seawall will impact on coastal ecosystems in Jakarta Bay. The giant seawall will block the flow of seawater and will change water salinity in Jakarta Bay. This condition will threaten mangrove ecosystem along the bay due to lack of salt water supply and in longer period will destroy mangrove ecosystem in Jakarta. The government needs to review their master plan to accommodate the existence of mangrove ecosystem because mangrove ecosystem service provides a huge benefit for communities as well as coastal and marine species.

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