Water paradox in Jakarta (Indonesia)

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Abstract. Indonesia is known as the largest archipelago in the world that is located in the equator line; particularly in a region characterized by a heavy rainfall with a generally high annual precipitation [1]. Jakarta, the capital city of Indonesia, is situated in the northern coast of Java Sea. Due to its geographical position, Jakarta benefits from a high precipitation, on average 2500 mm/year [2], but unevenly distributed timely and spatially. Moreover, Jakarta has 13 principal rivers across the city, but poor water quality. Besides, Jakarta’s artesian basin is productive, but intruded by brackish water from Java Sea. Thus, physically, Jakarta has an abundance of water. However, Jakarta deals with a severe crisis of clean water indicating a paradox: plentiful water resources yet limited clean water. The Jakarta’s inhabitants certainly need the water in their daily activities. This paradox eventually affects their water fulfillment, which attracts the attention of the actors, such as central government, provincial government, water service providers, environmental NGOs, etc.). Each actor probably responds differently, depending on his/her interests. This actors’ behavior constructs current water provision in Jakarta. Based on the issues above, this paper intends to illustrate the state of the art of water paradox in Jakarta. Besides, this paper tries to analyze how the actors respond to this paradox. To reach these objectives, we mobilizes the approach “multilevel and multi governance” because after the fall of General Suharto’s authoritarian government in 1998, Indonesia has entered to “democratic” and “good governance” era. It means that not only central government who involves in water but also other institutions including non-governmental ones. To collect the data, we mobilize primary sources from field works and secondary ones from government and non-government. There are several results of this research. Firstly, although human activities change the physical landscape of water provision in Jakarta, the nature still determines human. For example, due to the meander form of Jakarta’s rivers, water debit is naturally low.
creating difficulty during clean water production. Secondly, through the analysis of multilevel multi governance, in general we found that there are contradictive actions between the actors: tensions and conflicts, and cooperation. For example, although there is a schema of “Public Private Partnership” between the Government of Indonesia and its partners: Palyja and Aetra, the multinational companies that received water concession production, the conflict happens between them.

Keywords: water paradox, clean water problem, human activities, actor analysis, Jakarta, Indonesia

1. Introduction
Indonesia is known as the largest archipelago in the world that is located in the equator line; particularly in a region characterized by a very heavy rainfall with a generally high annual precipitation [1]. Jakarta, the capital city of Indonesia, is situated in the northern coast of Java Sea. Due to its geographical position, Jakarta benefits from a high precipitation, on average 2500 mm/year [2], but unevenly distributed timely and spatially. Moreover, Jakarta has 13 principal rivers across the city, but poor water quality. Besides, Jakarta’s artesian basin is productive, but intruded by brackish water from Java Sea. Thus, physically, Jakarta has an abundance of water. However, Jakarta deals with a severe crisis of clean water indicating a paradox: plentiful water resources yet limited clean water.

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2. Methodology
This research asserts the interaction of physical and social aspect of water provision in Jakarta. To answer this problem, I leaned on at both qualitative and quantitative methodology. I also use primary and secondary data sources. Firstly, to illustrate the state of the art of water paradox in Jakarta, a bibliographical scientific study of journal reviews and reports of diverse public and private institution, and historical archives was carried out.

Then, to understand the responses of the actors involve in water provision in Jakarta, primary data collecting from the semi-structured interviews and field surveys were conducted. Moreover, we also use secondary data and literature study to analyze actor relations.
3. Result and Discussions

3.1. Plentiful water resources yet limited clean water

3.1.1. Climatology: high precipitation, but unevenly distributed in the urban area (agglomeration)

Jakarta, the capital city of Indonesia, is located at 6° south latitude and 106° east longitude of the equatorial zone. In addition to being in between two large continents, Asia and Australia, Jakarta is also in the middle of two oceans, the Indian Ocean and the Pacific Ocean (Figure 1).

![Geographical Position of Indonesia between two large Continents and two Oceans](https://example.com/figure1)

Figure 1. Geographical Position of Indonesia between two large Continents and two Oceans (Source: ESRI ArcGis Globe)

Jakarta is situated on the northern coastal of Java. Due to its geographical position and to its tropical climate, Jakarta benefits from a high precipitation, on average 2500 mm/year [2]. The climatic characteristics of the city are the following: a tropical, wet climate, and alternate seasons (Figure 2).
Figure 2. Ombrothermic Diagram of Tanjung Priok Climatological Station [3]

Theoretically, the total of the precipitation in a region is associated with the global elements of climate such as temperature, pressure, winds directions, moisture content, etc. (Figure 3). The abundance of the precipitation in Jakarta is not only under the influence global factors which were described previously, but also under the influence of local factors of Jakarta, such as: topography (the geographical position, altitude), morphology (landscape, land use), the winds direction, etc. Those global elements, by acting together with these local elements in a region explain the variability of the precipitation in one region (Figure 4).
Figure 3. The climatic situation above Indonesia in January and July [compiled from 2, 4, and 5]
Figure 4. Monthly Precipitation in Jakarta in 2010
[2] (Source: data processing)
3.1.2. Hydrology: abundant ground water and surface water resources but in bad condition and low quality

Java Island, which extends from West to East, is crossed by a range of volcanic mountains (Figure 5). Jakarta is situated in the lower coastal plain of the North. This capital province is limited in the south by this volcanic mountain range (the highest height is 3018 meters above the sea level, that of the Mounts Pangrango and Masigit), which becomes increasingly higher southward and the slopes becomes increasingly stiff.

Figure 5. Landscape of western Java [6]

Jakarta is surrounded in the south by a mountainous range consist of Mounts Gede-Pangrango, Salak and Masigit. This mountainous range configures two groundwater basin lines: in the north, “Cekungan Air Tanah Jakarta/Artesian Basin of Jakarta” [7], and in the south, “Cekungan Air Tanah Bogor/ Artesian Basin of Bogor”¹. Because of these geographical conditions, Jakarta has many watercourses: there are thirteen rivers, which cross Jakarta. They rise in the mountain range, situated in the south Jakarta, before coming to throw itself into the sea. Consequently, these rivers flow in general from the south northward and form generally a network of parallel drainage, with a single sinuous flow (serpentine) [7].

According to the analysis of the river system carried out by the Ministry of the Public Works (“Kementrian Pekerjaan Umum”), thirteen rivers crossing Jakarta are divided into five catchment areas (Figure 6) [8]. In general, these catchment areas are in the lengthened form, and the river system are dendritic, because they look like a tree, with the concentration of the water currents become increasingly bigger in the branch and finally in the axial trunk [9].

¹Peta Cekungan Air Tanah Skala 1: 250 000, Sistem Informasi Air Tanah, Pusat Lingkungan Geologi, Badan Geologi (http://122.200.145.136/plg//fistMain.php?site=Peta%20Cekungan%20Air%20Tanah%20Skala%201:250.000, consulted in 19 January 2012).
Besides, those rivers are in bad quality due to the pollution from human activities. It can be confirmed by a study, led by “Badan Pengelolaan Lingkungan Hidup Daerah Provinsi DKI Jakarta/ BPLHD Provinsi DKI Jakarta” (Agency of Environmental Management of the Province of DKI Jakarta), about the pollution index of the rivers in Jakarta. This report shows us that more than three-quarters (84%) of 67 samples of rivers are highly polluted. There is no sample is in a good quality (Table 1 and Figure 7). Generally, the quality of the water is increasingly more polluted towards the downstream.

Table 1. Percentage of pollution index of water courses in Jakarta [10]

| Category                | Percentage of the pollution index in 2008 |
|-------------------------|------------------------------------------|
|                         | April | July | October |
| Good quality water      | 0%    | 0%   | 0%      |
| Slightly polluted water | 4%    | 9%   | 9%      |
| Polluted water          | 12%   | 9%   | 9%      |
| Highly polluted water   | 84%   | 82%  | 82%     |

The figure 8 shows us that the quality of the rivers crossing Jakarta is generally polluted. Even if there are some points of observation (samples) which are less polluted, those of the green points (in particular points 1 and 8). It is especially because these points (samples) are in the upstream of these watercourses where the land use is dominated by the open space, whereas towards the downstream settle down houses or factories which throw their domestic or manufacture or industrial waste into the river.
The serpentine physical landscape of the 13 rivers across Jakarta slows naturally down the flow so that it is difficult to use their water as raw material to be processed into clean water in the water treatment plants (WTP). In addition, the condition is exacerbated by poor river water quality due to the pollution. The cost of the purification is too expensive. Thus, two companies’ concessionaire “Palyja and Aetra” use raw water from other resources outside Jakarta.
3.2. The Responses of the Actors Involved in Water Provision in Jakarta

The previous part shows us that there is a main problem in water provision in Jakarta caused by physical condition and human activities, which is the difficulty in obtaining raw water. It leads the actors involved in this domain react differently depend on their interest. Therefore, this part will elaborate the responses of each actor to overcome this problem.

3.2.1. Dependency of Jakarta toward its Surrounding Area

The difficulty in obtaining raw water leads Jakarta to find the raw water from its neighbor provinces, West Java and Banten. 95% raw water for Jakarta is currently supplied by those provinces, where 62% is supplied by Jatiluhur Dam, which dams the Tarum River (Ci Tarum). This multipurpose dam is located in Purwakarta (West Java Province). Besides the source of raw water, it functions for electricity and irrigation. The remaining water 32% is supplied by clean water produced by WTP Serpong in Banten Province. Only 5% of the raw water supply comes from Jakarta (Figure 6). This shows that Jakarta as the capital city is very dependent on the surrounding area in terms of water provision. Despite the supply from outside the capital, the need for clean water from formal sources is still far from sufficient. The Municipal Drinking Water Company (PAM Jaya, Perusahaan Air Minum Jaya), which subcontracts the supply to two partners, "PALYJA / PT PAM Lyonnaise Jaya" for the western part of Jakarta and "Aetra" for the eastern part of Jakarta, supplies only 60% of Jakarta’s population with formal water [11]. The remaining 40% of the population is served in a wide variety of ways: bottled water, water vendors, deep wells and shallow wells [12].

The raw water from Jatiluhur Dam is flown to WTP in Jakarta through the West Tarum Canal stretching 70 km from the eastern side of Jakarta: from Curug (Karawang Regency) to Cawang (East Jakarta Municipality). This human-made watercourse crosses three major rivers: Ci Beet, Ci Karang and Kali Bekasi. To protect the quality of the water flowing, the canal was built the tunnel crossing the bottom of those rivers, known as Siphon technique [13]. The canal was built in 1968 at the time of the New Order under General Suharto’s authoritarian government. At this time, the system of government was highly centralized so that state control was very strong. Consequently, the local governments (the government of West Java Province and its municipalities and regencies such as Bekasi Municipality, Bekasi Regency, Karawang Regency, and Purwakarta Regency) agreed without any complain to the national project of West Tarum Canal. Thus, the conflict coming from the construction of the canal can be minimized. It shows that Jakarta, as the capital, had a strong bargaining position to demand its surrounding areas, as periphery, in order to contribute in Jakarta's clean water provision.
3.2.2. Urban Sprawl and Regional Autonomy (Otonomi Daerah)

The population of Jakarta grows rapidly from about 4 million in 1970 to nearly 10 million in 2010. It causes the increasing need for clean water. In addition, this population growth also encourages urban sprawl to areas around Jakarta. Consequently, population growth in the areas around Jakarta is also growing rapidly.

Moreover, the fall of the Suharto regime in 1998 has changed the politic of national development and the governance system in Indonesia. After 30 years of authoritarian government, liberty becomes euphoria throughout the country manifested in the regional autonomy. It makes local governments have more authorities to determine the direction of development in their area. In water management, they more often disagree to Jakarta. Although Jakarta is still strong enough, their priority is now divided. The local government also consider providing the supply of raw water for their people who are progressively increasing in line with the urban sprawl. It generates the tensions and even probably potential open conflict between Jakarta and its surrounding neighbours.

From demand side, Jakarta’s growing population and massive and rapid development in Jakarta has further worsened the problem of clean water. Thus, it is necessary to for Jakarta (as well as its neighbour areas) to find alternative sources of raw water to support the existing supplies from the area around Jakarta (Jatiluhur and other reservoirs), which is not enough to provide sustainable clean water. In order to overcome this problem, the central government then plans to build Karian Dam which damns Ci Ujung (one of the most important river in Banten Province), located in Lebak Regency. According to the Ministry of Public Works, the dam is currently under construction starting from 2015 and planned to complete it in 2019. The main objective of this dam is to supply raw water for urban and industrial needs in 7 municipalities/regencies, namely Tangerang Municipality, South Tangerang Municipality, Lebak Regency, Tangerang Regency and the Capital Jakarta area. The flow will be 9.1 m$^3$ per second through Karian-Serpong Conveyance System (KCS) using pipelines. Moreover, the
dam will also benefit to irrigate 22,000 hectares of agricultural land around Ci Ujung Catchment Area. Besides, Karian Dam will also be a mean of flood control in the downstream area that is a strategic area with important infrastructures such as Jakarta-Merak Toll Road (a part of trans-Java road), and some integrated industrial areas. Other benefits as the location of water destination and has the potential of hydroelectric power plant of 1.8 MW [15].

The development of Karian Dam is done in collaboration with Korea under the Built, Transfer, and Operate (BOT) scheme [16]. The development of this dam shows the duplication of policy in Suharto period and is a promising solution for clean water in Jakarta and some surrounding areas in near years. However, the question arises whether Karian Dam is a sustainable solution. On the other hand, will this duplicated policy also duplicate the current problem of the inability of West Citarum Canal to supply the capital? In addition, the construction of this dam will certainly require considerable financing (approximately 6.9 billion rupiah) and should consider how to acquire the land and how to relocate and to pay fair compensation for the people. Until now, the compensation and relocation problem is still a big problem. Thus, besides its benefits, a new dam also creates tensions and even conflicts. Moreover, spatial justice issues arise from this development project. For whom the development is addressed? It is obvious that it should be aimed for the greatest prosperity of the people. However, in fact, in the case the development of Karian Dam, it can be seen as the existence of urban bias development where it is highly focused for the greatest benefit of those who live and work in urban areas rather than rural areas such as the peasants who are already evicted and will be evicted. The development often sacrifices the interests of rural communities.

3.2.3. The Dynamic of Water Governance in Jakarta

Jakarta’s water provision is a long history since Indonesia succeeded the Dutch Indies, Batavia became Jakarta. Emblematic accomplishments were increasing (National Monument / Monas, Hotel Indonesia, Welcome Monument / Tugu Selamat Datang, Semanggi Interchange / Jembatan Semanggi, Cikini Planetarium), especially since President Soekarno, inspired by the ideas of Le Corbusier considers that the establishment of an ideal society requires the multiplication of urban development [17]. Jakarta was populated by 823,000 inhabitants in 1948 and almost 4 million in 1965. In the kampung, there are therefore various health risks. Some are particularly related to water. This is the reason for the construction of water treatment plants in Pejompongan (Pejompongan I and II) [17], by the Public Work Unit (Kesatuan Pekerjaan Umum) which has later become the Ministry of Public Works. However, they could only supply the old urban centers, and it can be assumed according to Kooy and Bakker [18] that this is a deliberate choice of the government of the time to privilege neighborhoods or spaces marked symbolically by modernity.

The fall of Sukarno in 1965 changed the economic orientation of Indonesia. The country is more open to foreign capital, especially the western capital. At the beginning of the period, however, not all sectors are open to both local and foreign investment. However, awareness of the economic value of water appears. The water consumed begins to be measured. People who have water supply begin to pay for it depending on how much they use it. As for the others, they continue to depend on other forms of supply as now. PT. PAM Jaya, a state-owned enterprise, was founded in this context in 1968. Its missions are double and poorly articulated: on one hand, it seeks profit and on the other hand it is supposed to improve the well-being of the population. Since PAM Jaya's facilities are aging, opening up to foreign capital is essential to modernize the network. In 1991, the World Bank lends US $ 92 million and pushes progressive privatization. In 1993, Thames Water Overseas Ltd (a British-German company based in London) joins a company owned by Sigit Harjojudanto, the eldest son of President Suharto, and creates a subsidiary. The French competitor, Suez, is joining Salim, the largest conglomerate in Indonesia, whose owner is Sudono Salim, who has a close relationship with President
Suharto since 1950. In June 1997, public private partnership (PPP) is signed with draconian\(^2\) clauses \([19, 20]\) for the Indonesian government.

Shortly after the signing of the contract, the monetary crisis in Indonesia provoked demonstrations that led to the fall of President Suharto. Jakarta is in full chaos, foreign experts leave the country, including the board of directors of Thames and Suez. At the same time, PAM Jaya's board of directors decided to cancel both contracts because of the following reasons: 1) there is corruption; 2) they are examples of the mismanagement of the Suharto era. New negotiations were then initiated between the two companies and the new government headed by President Habibie. All have an interest in an agreement, the distributing companies of course but also the Indonesian government that does not wish to scare foreign companies \([21]\). A new contract was signed in 2001. Two companies were created: Thames PAM Jaya (TPJ) and PAM Lyonnaise Jaya (Palyja), PAM Jaya becoming controller and policy maker on the basis of proposals made by the dealers. In addition, a regulatory body "The Regulatory Body of Water Supply/ Badan Regulator Pelayanan Air Minum (BRPAM)\(^2\)" was designed to assess the performance of PAM Jaya and its partners and to defend the interests of customers, is created. It should be noted, however, that this regulatory body was created by the Municipality of Jakarta while the two private partners signed contracts with the central government, which does not place them on an equal position. To legalize this privatization, Indonesian government promulgated a new water resource law (UU no 7/2004), replacing 1974 law that was not allowed the water privatization.

Joko Widodo, a populist, was elected as Jakarta’s governor in 2012. Two years later, he spawned the political discourse of "nationalization of water provision". This idea never worked because even the Jakarta government had enough money to take over clean water management and it considers that the public was not profited by privatization especially due to the price rocketed, but the Jakarta government was bounded by the agreements with those private companies. When the agreements especially during the crisis were signed, the bargaining position of Indonesian to foreign government both central and local ones were so weak due to the crisis.

In larger horizon, the processes of democratization in Indonesia have not only been enjoyed by large businesses, but also they have been enjoyed by civil societies such as non-governmental organizations (NGOs) who are commencing to voice the „anti-water privatization”. In 2014, they demanded the cancellation of water resources law 2004 to the constitutional court of Indonesia (Mahkamah Konstitusi), a new public institution born in democratic era after the fall of Suharto, which accepted it.

Moreover, in 2014, Basuki Tjahaja Purnama (Tjung Ban Hok, well known as Ahok) a new governor, made a “public discourse” of the acquisition of Palyja’s share by the Jakarta government. It is a kind of water nationalization, but he could not make it happen until in May 2017, he was imprisoned due to blasphemy.

With the strong support of cancellation of water resource law 2004 and the promulgation of Government Regulation 2015 of water provision (Peraturan Pemerintah No. 122/2015 tentang Penyediaan Air Minum), Jakarta government under Djroat Syaiful Hidayat administration, through its water company, PAM Jaya, continue to negotiate with the two private companies. Six years before the concessionary contract finished in 2023, in 25 September 2017, the companies, which want to continue their operation in Indonesia softens their position. Thus, they send back their right to the government of Jakarta, which, through PAM Jaya, manage directly the water provision and serve directly the consumers. However, the privates companies still work for PAM Jaya by helping it in production and pipe rehabilitation and maintenance. Moreover, PAM Jaya also agrees to continue to pay its “water charge” obligation as mentioned in previous agreements to two private companies.

Thus, the negotiation between state and two private water companies is not easy. There have been conflicts of interest between them so that the harmonious notion of public private partnership has also

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\(^2\) The clauses indicate that the government of Indonesia (PAM Jaya) must pay a fine to the concessionaires if the cooperation agreement is terminated and this for whatever reasons
not been easy to be implemented. However, there are also the possibilities to develop fair and just cooperation in order to find win-win solutions for state, private sector, and the most important, the people. The governor assures that the new agreement is dedicated to Jakarta’s inhabitants who are also water consumers. The governor would like to reduce price paid. For the private companies, a peaceful agreement is better than the conflicts that create uncertainty risks. Business is more predicted than before, and the most important, still profitable. Moreover, it will make easier to prolong a new contract with the government in 2023.

4. Conclusion and Recommendation

Water provision in Jakarta shows us the complexity of the relationship and interaction between human and nature (environment). Jakarta has abundant surface water because it is crossed by 13 rivers. However, because they are physically serpentine shape (meandered), their flow is slow. It creates the difficulties to carry out naturally the water to the Water Treatment Plants (WTP) to be processed. Moreover, it is exacerbated by the bad quality of the water, which has been polluted, causing the high cost of water purification. Those conditions show the environmental determinism that put the relationship between humans and the environment in one direction, environment control human behavior [22, 23].

However, humans have the capacities to develop science and technology to change natural environment, and to adapt and to survive in their existing environment. In case of water provision in Jakarta, we can see that humans can use science and technology (such as to build the dams, canal and conveyance to drain the raw water) to overcome the problem of natural determination. This shows the existence of "environmental possibilism", in which we cannot ignore the active role of humans on the earth surface. Besides its positive impacts, there are the negative impacts to the environment such as river pollution and to humans themselves such multi-level tensions and even conflicts.

Those tensions and conflicts involves varying actors, from international ones to local ones, from public institution to private institution and individual actors such as central government, provincial and municipality/regency governments, multinational companies and Indonesian company, and even peasant families evicted by dam construction policy. This is rooted from the notion of possibilist that the relationship between humans and environment is both active and passive [24].

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