Potential of east flood canal as provider of drinking water ecosystem services for DKI Jakarta

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Abstract. The increasing population and water pollution in DKI Jakarta by domestic waste causes raw water supply unfulfilled. The problem can be solved by utilizing one of the existing surface water in DKI Jakarta that is East Flood Canal (BKT). This research aims to analyze the quality, quantity, and continuity of East Canal Flood as water source for DKI Jakarta. The method used for water quality test is based on Indonesian National Standard (SNI) with raw water key parameters according to water class I and II Government Regulation No. 82 of 2001. BKT water quantity and continuity calculate based on the dependable flow capacity with a probability of 80% (Q80) accumulation the Cipinang River and diverted Ciliwung River. The results showed seven parameters exceeded the water quality standard class I and II Government Regulation No. 82 of 2001, ie BOD, COD, phosphate, nitrite, ammonia, total coliform, and faecal coli. The quantity and continuity of water in upstream BKT are available at minimum 1.49 m³/sec and the maximum 4.69 m³/sec when Cipinang River critical condition in August-September and the water volume in the Ciliwung River is excessive. To conclude, there is potency of BKT as ecosystem services provide drinking water for DKI Jakarta.

Keywords: domestic waste, East Flood Canal (BKT), water quality, water quantity, water continuity.

1. Introduction
Water is one of the most essential ecosystem services for every living thing. Water resources are common property resources and can be managed by the community on a continuous (continuous) basis [1]. Water management by a community depends on the quality conditions of the water source used (both surface and groundwater) [12]. Nowadays, the quality of water in various parts of the world tends to decrease. [13] reveals that up to 2025 around 2.7 billion people or 30.33% of the world's population will lack clean water, including Indonesia. A large amount of water that has been polluted lightly and severely reduces the availability of water as a natural ecosystem service [8,9].

Other water-related problems, namely the existence of seasonal variations and spatial inequality of water availability. In the rainy season, parts of Indonesia experience an abundance of water that results in flooding and damage to the environment, while in the dry season water shortages and drought are disasters in several other areas. Limitations on the amount of water that can be explored and consumed, while Indonesia's population continues to increase causing the need for raw water to increase dramatically. [11] states that Indonesia has water reserves of 3,906 billion m³/year, including the fifth largest in the world. However, this amount only 691.3 billion m³/year can be utilized effectively to date, both domestic, urban, industrial, and irrigation.

One of the regions in Indonesia that experienced this was Jakarta's Special Capital Region Province (DKI). Population populations are increasing every year and domestic waste from anthropogenic activities is the main cause of deteriorating water quality in DKI Jakarta. In addition to the increase in population, DKI Jakarta's raw water crisis is also caused by several conditions, including: imbalance between supply, quantity and needs in space and time due to spatially uneven water distribution and time,
increased pollution of water resources (surface water and groundwater), and decreased ability of an area to provide water. These conditions occur due to various environmental damages, which results in a decrease in the carrying capacity of the Watershed (DAS) in holding and storing water. Water scarcity encourages the unwise use of water sources [2]. As a result, DKI Jakarta experienced a deficit in clean water. The clean water needs of the people of DKI Jakarta up to now depend on sources outside the city of Jakarta, which is 81% of the Jatiluhur Reservoir, 14% of the Regional Drinking Water Company (PDAM) Tangerang, and 5% of the Krukut River [3].

The problem of raw water needs can be overcome by utilizing the waters in the DKI Jakarta area. The waters are based on the type of ecosystem service provisioning services, such as rivers, lakes, reservoirs, canals, etc. One potential source of surface water for DKI Jakarta is the East Flood Canal. East Flood Canal (BKT) is an infrastructure established by the DKI Jakarta Provincial Government to tackle and realize flood-free Jakarta in the east-north region of DKI Jakarta due to local rain. The average river water discharge in the BKT region over the past 5 years shows an increase of about 0.021 m³/sec [4]. BKT water utilization can apply regulatory service, which utilizes ecosystem services with water treatment processes to reduce parameter concentrations that exceed quality standards [6]. The purpose of this study is to analyze the quality, quantity, and continuity of BKT water as a raw water source for DKI Jakarta.

2. Methodology
The study was conducted three months from October 2017 to December 2017. The research conducted at Upper East Flood Canal (Cipinang River), East Jakarta. This section was chosen as main source of BKT that comes from the Ciliwung River through the Cipinang River.
Figure 1. Study area.
The qualitative method was used in this study. Water quality tested according to the Indonesian National Standard with key parameters of raw water referring to Government Regulation no. 82 of 2001 class I and II concerning Management of Water Quality and Water Pollution Control. These parameters include BOD, COD, TSS, pH, total coliform. BKT water quantity and continuity calculate based on the dependable flow capacity with a probability of 80% \( (Q_{80}) \) accumulation the Cipinang River and from diverted Ciliwung River.

### 3. Result and Discussion

#### 3.1 Water Quality in BKT

Based on laboratory tests, there were seven water quality parameters of BKT that exceeded the quality standard of Government Regulation 82 of 2001 class I and II (see table 1).

| No. | Parameters | Unit   | Sample  | Average | GR 82 year 2001 |
|-----|------------|--------|---------|---------|-----------------|
|     |            |        | \( \Delta 1 \) | \( \Delta 2 \) | \( \Delta 3 \) | \( \Delta 4 \) | Class I | Class II |
| 1   | BOD        | mg/L   | 4.40    | 4.40    | 4.60           | 4.40     | 4.45     | 2        | 3        |
| 2   | COD        | mg/L   | 75.06   | 84.07   | 84.93          | 89.23    | 83.32    | 10       | 25       |
| 3   | Phosphate  | mg/L   | 0.505   | 0.569   | 0.746          | 0.646    | 0.62     | 0.2      | 0.2      |
| 4   | Nitrite    | mg/L   | 0.294   | 0.285   | 0.247          | 0.304    | 0.28     | 0.06     | 0.06     |
| 5   | Ammonia    | mg/L   | 0.514   | 0.533   | 0.537          | 1.157    | 0.69     | 0.5      | (-)      |
| 6   | Total      | MPN/100 mL | 16,000 | 9,200   | 16,000         | 54,000   | 23,800   | 1,000    | 5,000    |
| 7   | Fecal Coli | MPN/100 mL | 9,200 | 9,200   | 16,000         | 35,000   | 17,350   | 100      | 1,000    |

High BOD parameters followed by phosphate and COD. In \( \Delta 3 \), BOD and phosphate levels are 4.60 mg/L and 0.746 mg/L. This is influenced by the diverted from the Ciliwung River, resulting in accumulation of waste that flows in the Cipinang river from various sources (domestic, industrial, and construction activities). The condition of waste originating from non-point sources has an impact on high phosphate in the upper waters of BKT. The main sources are the domestic waste in the form of population (faeces) (blackwater), food waste from households (greywater), markets and agricultural activities from the upstream part of the Cipinang River BKT. The results of the study in accordance with the findings of Merle & Poblete (2015) [7] state that waters that are positively contaminated by \( E. \ coli \) are not suitable for consumption as drinking water. In addition, the high level of BOD also correlated with the increase in COD levels in the upper BKT, ie at the point \( \Delta 2 \) to \( \Delta 4 \). The location and presence of chemical pollutants, one of which comes from the cement plant (PT. Jayamix) causes high levels of COD at that point.

Water quality parameters in the upper reaches of the BKT (Cipinang River) that exceed the quality standard outline are caused by the activities of residents around the water body. Population activity produces waste in the form of greywater and blackwater, and waste has an impact on the degradation of BKT's water quality as an ecosystem service. The point source waste source is mostly from domestic households, while non-point source waste is generated from service and trade activities around the river banks. Activities carried out by the community affect the ecological conditions around the upper reaches of the BKT. This is in accordance with the literature which states that the composition of waste diversity that contaminates a waters in the form of gray water and black water can be generated from domestic...
activities (households) and various other socio-economic activities and has an impact on water quality as ecosystem services as well as the hydrological conditions of a watershed [5,6,8,9,10].

3.2 Water Quantity and Continuity in BKT

Observation of water availability in quantity and continuity in upstream BKT is reviewed based on the mainstay discharge on the river. The result of field survey shows that the quantity of BKT water is quite abundant, but if it becomes the raw water source it is feared that it can not fulfil the water supply need continuously. The function of BKT as the flood control of eastern part of DKI Jakarta is one of the additional water quantity upstream in BKT. The addition of water quantity of BKT is done through diverted from Ciliwung River to Cipinang River (upstream of BKT). Availability of Ciliwung River and Cipinang River can be seen in table 2.

Table 2. Cipinang and Ciliwung River Availability 2014

| Rivers     | Flowrate Probability | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Oct  | Nov  | Dec  |
|------------|-----------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Cipinang   |                       | 3.74 | 3.73 | 3.08 | 3.06 | 2.52 | 2.31 | 1.76 | 1.53 | 1.47 | 2.25 | 2.28 | 2.68 |
| Q90        |                       | 3.48 | 3.57 | 2.75 | 2.71 | 1.88 | 2.1  | 1.47 | 1.14 | 1.36 | 1.94 | 2.14 | 2.14 |
| Ciliwung   |                       | 0.59 | 0.85 | 0.47 | 0.95 | 0.48 | 0.33 | 0.06 | 0.02 | 0.15 | 0.63 | 0.83 |
| Q90        |                       | 0.46 | 0.73 | 0.36 | 0.64 | 0.38 | 0.28 | 0.04 | 0.01 | 0.11 | 0.52 | 0.41 |

Table 2.3 indicates that Cipinang river water has water supply dependable flow (Q_{80}) 1.47 - 3.74 m³/sec, whereas Q_{90} ranges between 1.14 - 3.57 m³/sec. Based on the data, the volume of water in the Cipinang River (upstream BKT) is abundant. However, at a certain time such as in August-September Cipinang River discharge has decreased due to the dry season, it can affect the continuity of BKT if used as a source of raw water. In this condition, the river from Ciliwung River is reliable.

Ciliwung River which is diverted to BKT so that it becomes sustainable water resources. The flow rate from Ciliwung River is done only during the rainy season when the floodgates are opened and the water volume in the Ciliwung River is excessive. The water is flowed to BKT to increase the BKT volume so it can potentially become the raw water source of DKI Jakarta PDAM that fulfill the requirements both in terms of quantity and continuity. Based on the Cipinang River and Ciliwung River the minimum BKT availability is 1.49 m³/sec, and the maximum water availability is 4.69 m³/sec.

4. Conclusion

The quality of BKT water exceeds the quality standard are seven parameters, namely BOD (4.40-4.60 mg/L), COD (75.06-89.23 mg/L), phosphate (0.50-0.74 mg/L), nitrite (0.24-0.30 mg/L), ammonia (0.51-1.15 mg/L), total coliform (9,200-54,000 MPN/100 mL), and fecal coli (9,500-35,000 MPN/100 mL). Estimated water availability using 80% dependable flow at minimum availability is 1.49 m³/sec and the maximum water availability is 4.69 m³/sec. Based on the data, there is potency of BKT as ecosystem services provide drinking water for DKI Jakarta.

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