The effect of anthropogenic activities to the decrease of water quality

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Abstract. The raw water in Jakarta is supplied from Jatiluhur Dam, which is distributed pass through West Tarum Canal with an open canal about 70 km long. This water quality does not meet the standard set by the government and heavily polluted by anthropogenic activities along its river. This research uses a quantitative research approach with the mix-method. This research did an in-depth interview with inhabitants along the riverbank about their daily activity. The water along the riverbank is polluted by anthropogenic activities, such as: first: domestic activities (washing, cooking, and bathing), second: littering into the river, and third: discharging waste water from households into the river. This present research measures water quality for parameters pH, temperature, Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Total Dissolved Solid (TDS), Total Suspended Solid (TSS), and Fecal coliform. In this social segment, it is shown that pH, DO, TDS and Fecal coliform in the downstream part are worse than in the upstream.

1. Introduction

In Sustainable Development Goals (SDG)’s goals, water is as the 6th goal, namely: "Ensure availability and sustainable management of water and sanitation for all”[1]. It shows that clean water is one of human basic needs, and it is processed from raw water to clean water by using any treatment. To reach the standard of living, water is a necessary for humans [2]. The 1945 Constitution of the Republic Indonesia also described that every natural resource is used to meet citizens needs i.e water. Jakarta as the largest city in South East Asia with 9.7 million inhabitant [3], has just about 58 percents of needs that can be fulfilled. Government of Jakarta’s treat and distribute water to inhabitants are supported by two private companies (PT Lyonnaise Jaya (Palyja) and PT Aetra Air Jakarta). The raw water from Jatiluhur Dam has flown through West Tarum Canal since 1997, which uses open canal of ±70 km. It divided into three drinking water units, namely: Buaran, Pulogadung and Pejompongan area.

Concentration of BOD in the intake drinking water unit is between 14-26 mg/l while the standard by the government is 2 mg/ l. The COD is between 17-61 mg/l while the standard is 10 mg/l. Solid is between 109-122 mg/l with the standard is 1,000 mg/l. Total coliform is measured 34,000-4,800,000/ml with the standard of 100 mg/l[4]. Water quality is strongly influenced by anthropogenic activities pollutants that enter to the body of water as the result of human activities, such as domestic activities (households), urban activities, as well as industrial activities [5]. As the consequence of those, the raw water should fulfill the first’s class water quality based on the Government Regulation No. 82/2001 regarding Water Quality Management and Water Pollution Prevention.
The existence of population growth is followed with the number of settlements and the growth of the industry, particularly along watersheds that dump waste into surface waters, causing a decline in the quality of surface water [6,7]. The uses of riverbanks as the area to conduct a bath, wash, and draw the waste water to the river give an impact in the quality of raw water in Jakarta’s drinking water unit [8]. Human activities exploit water and soil resources that reduce water quality [9]. In other, the citizens in the riverbank, who have lived more than 20 years along the river, could become the effect of the decreasing water quality. This present research aims to analyze the anthropogenic activities along the riverbank, i.e. domestic activities (washing, cooking, and bathing), littering into the river, and waste water from households discharged into the river. This thesis contributes to find the proper strategy for water quality cleaning from upstream to downstream. This is different from the current literature, that pays attention to the intake of Water Treatment Process (WTP), not the condition of raw water[4,10,11].

Formulation of the problem in this research is the quality of the raw water of Jakarta’s drinking water unit being contaminated due to anthropogenic activities along the riverbank, whereas raw water to be used should meet the applicable standards. The research question posed is how do the anthropogenic activities in the river affect water quality of the river? This research aims to analyze anthropogenic activities on the riverbank which affect river water quality deterioration. The academic benefit from this research is to analyze the status of river water quality and identify which anthropogenic activities could worsen the water quality of the river. As a practical benefit, this research is expected to provide information and feedback on the raw water pollution of Jakarta’s Drinking Water Company. By this research, the government shall do urban planning in that city. To keep the water quality along the riverbank, the government shall build a good environment for citizens, motivate them to give responsibility of a collective effort to do bathing-washing in their own toilet not in the river’s body, clean river regularly, manage solid waste, and other efforts. The contribution of all the communities makes the raw water adequate to be used.

2. Method
This research fits within the framework of water sustainability which has concern in three main aspects: economic, social, environmental. It focuses its analyses on raw water problems affected by anthropogenic activities in the riverbank as an urban area. This research uses a quantitative approach, whereas the method is used the combined qualitative and quantitative method. Interviewees and topics were identified through sampling between September 2015–January 2016. This research was conducted by using primary and secondary data. Primary data are the data obtained by researchers using interviews, observations of anthropogenic activities, and the water quality in the segments of citizens. Human activities were performed at the segment B. Tb. 7-11 (about 7 km from Dam), and it was selected because this area is near upstream and about 5 km along this riverbank shows anthropogenic activities. Most questions were open-ended to provide flexibility to express their experience and opinion about issue. Interview lasted about 20 minutes, the majority were recorded, transcribed, and coded. To examine the effect from inhabitants, the water quality in upstream and downstream is measured, using parameters: temperature, pH, COD, DO, TSS, TDS, and Fecal coliform. Secondary data are from the governance and drinking water company. The anthropogenic activities from interviews will described descriptively.

3. Result and discussion
3.1 Description area
Jatiluhur Dam as the source of raw water for the drinking water treatment unit is about 81% from Citarum River, in West Java. This area has several purposes, such as to support agriculture, fisheries, public water supply, industry, hydroelectric power, recreation and others.
The increasing population in West Tarum Canal affects the river conditions. The river should be bordered by inspection space, but now it becomes a residential settlement for urban people along the riverbank. It makes the river contaminated and makes the river become narrower. Based on the interview with citizens, it is discovered that they have already lived there more than 20 years. About 54% citizens had low income, namely 0-Rp. 2,000,000, so it makes them use the riverbank for their daily activities, which is shown on Table 1.

| No | Activities      | Kind of waste                          |
|----|-----------------|----------------------------------------|
| 1  | Residential     | 1. Black water from bathroom           |
|    |                 | 2. Solid waste                         |
|    |                 | 3. Waste from defection in the riverbank|
| 2  | Industrial      | 1. Polluted air from burning            |
|    |                 | 2. Waste Water                         |
| 3  | Small shop      | 1. Black water from cleaning the dishes|
|    |                 | 2. Organic solid waste                 |
| 4  | Mosque          | 1. Black water from toilet             |
|    |                 | 2. Water from ‘wudhu’                  |
| 5  | Public Bathroom | 1. Black water from bathroom           |
|    |                 | 2. Waste from defection in the riverbank|
| 6  | Littering into river | 1. Leachate from solid waste        |
|    |                 | 2. Solid waste in the river            |
| 7  | Construction well| 1. Construction Waste                  |
|    |                 | 2. Sediment in the river               |

Figure 2 shown the flow of raw water from Jatiluhur Dam to intake of Drinking water unit. “Bangunan Tarum Barat (B.Tb.) mentioned the distance from Cibeet Dam.
3.2 Anthropogenic activities

Water that has decreased in quality is affected by anthropogenic activities along the river bank, such as defecation in the riverbank, water dispose of domestic waste water into the river, taking out the trash and others. Firstly, the anthropogenic activities are bathing, washing, and latrine activities in the river. In the interviewing, 37% have no toilet and 63% of the interviewer have toilet in their own house, although 55% of them prefer to do bathing, washing, and defecation in the river than in their own toilet. Along the riverbank, each house has toilet in the body of the river. However, the researched by Parlindo (2012) stated the usage of the riverbank for domestic needs affects the river have bad smell and become blackened.

Secondly, the activities discharge domestic wastewater into the river body such as grey water from bathing, washing and feces. By observing, the researchers found that many houses disposed domestic waste water into the river. About 54% of houses have no septic tank and throw waste water directly into West Tarum Canal. About 17% of houses have septic tank only for defecation but throw waste water directly into West Tarum Canal. The waste water directly flows into water bodies through PVC pipes, culverts and ditches. Based on the results of the observations on the segment of society, most people in the riverside neighborhood dispose domestic waste water from households directly into the river. It is mostly done in the morning (6:00 to 9:00 a.m.) and afternoon (13:50 to 17:30 p.m.), because those are the peak hours.

The third is littering into the river. All houses produce any rubbish or garbage or solid waste, and the handling is just making a hole in the ground, sacks, plastic containers, and others. Most of the inhabitants collect and then burn the garbage. The bins are put near the river, and it is possible to be carried over by water when it rains. From the interview, it is found that each house produce about 3.2 kg/day. Based on the interview, about 69% of the people never throw solid waste into river, but 31% do, such as diapers, organic waste, and others. The interviewers also collect the solid waste in the riverbank about 1-2 days before burn it. However, it is possible to come into the river’s body because of runways. It is also supported by the inclined surface sloping riverbank, so that the waste can easily be carried into water bodies. The source of spreading pollutants gets into the water as runoff or runoff of surface soil or agricultural settlements. In addition, the existing trees along the riverbank also contribute in additional organic waste that is carried away by the water, because the leaves are falling directly into water bodies.

In addition, there are also other anthropogenic activities that allegedly support the degradation of water quality of the river, such as the construction of overpasses near to Buaran Area (intake of the Drinking Water Unit provided by AETRA). In the other words, many people who have small-scale livestock such as goats, chickens, and ducks placed at the riverbank, can also increase pollutants in the river.

3.3 Water quality

To examine the effects of anthropogenic activities contributing to the decline in water quality, water quality testing was done on the downstream and upstream of society segments. For upstream point in B. Tb. 7 with coordinates 6023'38.2"S and 107020'22.4"E, while the downstream point as B. Tb. 11 with coordinates 6021'53.9"S and 107019'12.3"E. It obtained the test results for the parameter: temperature, pH, COD, DO, TSS, TDS, and Fecal coliform in those sampling points shown in Table 2. Anthropogenic activities on the segments of society B. Tb. 7-11 show the effects in the decrease of water quality, although the result is not significant. Visually, it can be said that the waters become smelly. The temperature is still appropriate with the standard. The temperature could be affected by the height of the above mean sea level (AMSL), radiance of the sun, stream of the river, and depth of the river.

Parameter pH declared the Hydrogen ion concentration is an important quality parameter in water. The low pH affects the mobility of toxic heavy metal compounds and the high value of pH disturb the balance of a biological life. The measurement results in this present research show that the water meets the standard, namely: 7-8. It stated that the condition of the water is still normal.
Table 2. Water quality in citizens segment

| No | Parameter       | Unit            | Up  | Down |
|----|----------------|-----------------|-----|------|
| 1  | Temperature    | °C              | 29  | 29   |
| 2  | pH             |                 | 7.21| 7.17 |
| 3  | COD            | mg/l            | 11.3| 9.72 |
| 4  | DO             | mg/l            | 8.71| 6.47 |
| 5  | TDS            | mg/l            | 272 | 271  |
| 6  | TSS            | mg/l            | 83  | 51.5 |
| 7  | *Fecal coliform* | Colony/100mL   | 360 | 930  |

Chemical Oxygen Demand (COD) has indicated the amount of Oxygen required to oxidize organic materials in the water. In the upstream, it is above of the standard set by the government, but in the downstream it meets the standard. This concentration of COD showed chemical compounds arising from industrial activities. The concentration of COD shows affected by contaminants coming into water bodies, because of the number of residents who live along the West Tarum Canal.

Dissolved Oxygen (DO) is useful for aquatech. The high DO shows the quality of water as well, but it is opposite with the concentration of COD and BOD. The number of COD and BOD explains the number of Oxygen needed to decompose organic and inorganic compounds. The existence of Oxygen in water shows that the quality of water is good. In the upstream and downstream it meets the standard (≥6 mg/l), but the quality decreases. It can be caused by the influx of domestic waste water. The concentration of DO in water should be increased, because the DO is needed by microorganisms to decompose pollutants in the water body.

Total Dissolved Solid (TDS) is a physical parameter of raw quality and size of the solute (both organic and inorganic substances), which is generally considered not as a major pollutant. The concentration of TDS in water must be controlled, because if the high TDS concentrations can reduce the clarity of the water, contributing to a decrease in photosynthesis, compounds react with heavy metal, and cause an increase in water temperature. The TDS content of ions and minerals contained in the water can accumulate in the body and cause kidney disorders. TDS value is used as an indicator of the aesthetic characteristics of the water and as an indicator of the number of very small particles. In the upstream and downstream, the concentration of TDS is almost similar, not significant, but both are still below the quality standard.

Total Suspended Solid (TSS) measurement based on the dry weight of the particles are trapped by the filter, usually with a specific pore size. Generally, the filter used has a pore size of 0.45 lm. The suspended solids may include organic and inorganic materials. The existence of the suspended solids will block the penetration of the light that enter the waters so that the relationship between TSS and brightness will indicate that the relationship is inversely proportional. Based on the measurements of parameters of TSS in the segment of society, it shows that it is larger in the upstream than in the downstream, but both had passed the quality standard. The factor affecting the suspended solids is rainfall and water runoff is relatively small in the downstream.

The number of *Fecal coliform* is an indicator of water quality changes due to human and animal fecal contamination. The number of *Fecal coliform* is expected to meet the quality standard, since most people use water along the riverbank. The number of *Fecal coliform* is affected by poor sanitation toilets, waste water charging into the river, the inclusion of human and animal feces, and other factors. The data of *Fecal coliform* in the upstream and downstream on the quality standard (100 colonies/100 mL for first class function). The increasing number of *Fecal coliform* caused by those people who still do domestic activities in the river. The existence of coliform in water shows the pollution inside water, so inhabitants should not be able to directly use the river water without pre-treatment.
The decline is seen in the quality parameters of pH, DO, TDS, and Fecal coliform. It shown that the water should not be used for purposes designated as first class’s function based on Government Regulation No. 82/2001 regarding Water Quality Management and Water Pollution Prevention.

3.4 Proper strategy

The anthropogenic activities on the riverbank is examined in this study, and those consist of domestic activities (washing, cooking, and bathing), littering into the river, and discharging waste water from households into the river. This present research extends this literature by providing information about raw water quality of this river by determining proper strategies to avoid water contamination from anthropogenic activities based on the reality. Proper strategies are keeping the upstream area, keeping along the riverbank such as release anthropogenic activities, treating domestic and industrial waste before discharging into the river body, having integrated solid waste management, keeping the river physical wide, and regular monitoring about the anthropogenic activities.

4. Conclusion

The conclusion is that the water in the West Tarum Canal has been contaminated, due to anthropogenic activities along the riverbank, namely domestic activities (washing, cooking, and bathing), littering into the river, and discharging waste water from households into the river. Some suggestions by this research are that it is necessary to learn and observe the influence of industry on water quality in the canal because the industry is located directly and indirectly on the riverbank.

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