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Introduction

Impact of Pollution in Ir. H. Djuanda Reservoir for the Supply of Drinking Water Jakarta Metropolitan City

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Abstract: The Ir. H. Djuanda multi-purpose reservoir is intended to meet the domestic, municipal, and industry water requirements, particularly for drinking water supply in Jakarta the capital city of Indonesia, rice-field irrigation area of 240,000 ha, flood control, and also tourism, including fish farming in the reservoir. The Ir. H. Djuanda reservoir is part of the cascade reservoir in Citarum River consists of Saguling in the uppermost, Cirata in the middle, and Ir. H. Djuanda in the lower part. Bandung, the biggest city of West Java Province with population over 2.5 million inhabitants is located in the immediate entrance of Saguling reservoir.

Manufacturing activities, expanding populations, degraded watershed among others produced pollution which is discharged from point or diffuse sources into the Citarum River. The mostly polluted area by urban effluent taken place in the upper part of the catchment, particularly in the Bandung area. Urban sprawl not only increases the demands for water but also depresses the water quality. The Ir. H. Djuanda reservoir, among others is affected by deterioration of the water resources caused by the activities in the upper part of the basin and amplified by the fish farming activity within the reservoir.

Supply of drinking water to Jakarta Metropolitan city average of 400 million m3 equivalent to 80% of all drinking water need, that flowed from the Ir. H. Djuanda reservoir to Jakarta, far more than 100 km through the existing network and continued through the pipeline. In

The water quality condition in Jatiluhur reservoir has been observed since 1996, with the latest one was conducted in 2006. In 1996, based on the dissolved oxygen concentration, the effects of floating net fisheries have not been detected. The result of the study indicated that there is no significant stratification on temperature. The temperature difference between surface and the bottom of the reservoir was only 1-2°C. Based on the trophic level, in 1996, Ir. H. Djuanda reservoir was classified into meso-eutroph level



addition through the existing channels, there are also taking water directly from the river.

The main problem in the management of water resources are reservoirs of environmental issues (both of water quality and quantity) arising from the interaction between economic activity and environmental capacity are limited. The greater the number and intensity of exploitation of water resources, the impact on the degradation of environmental quality tends to increase. Quality of the aquatic environment is influenced by age of dam reservoirs, reservoir function (or a single multi-purpose dams in order), the type of reservoir, water use patterns, the main source of fertility and seasonal factors.

Each year in the water of the Ir. H. Djuanda reservoir, in the months of October, November, December and January is the season of transition or transition, among others, marked by long periods of rain with a high rainfall, limited sunshine, strong winds, large waves, changing the speed and pattern of water flow reservoir (backflow occurs) and the emergence of Mycrocystis sp. This cycle from year to year is always the same since 1978 till now. The transition has been shown to impact negatively on the cage fish farming nets floating.

Human resources capacity is important to have a proper operational works and also to have vision on managing water quality management system as a whole. Good and comprehensive, as well as customized database and information system is a supporting tool for a good decision making Collaboration and mutual coordination with other agencies is a must to have an integrated plan, promoting a sectoral planning into integrated planning, from planning into action, from monitoring into law enforcement.

Keywords: Degradation of environmental, water pollution at the reservoir, water quality management

(Seameo Biotrop, 1996). The oxygen level in the aquatic system is influenced by input, decomposition process, photosynthesis, and respiration. The input loads affect dissolved oxygen availability that requires for microorganisms to do the aerobe process of decomposition. Lack of dissolved oxygen in the water will initiate the anaerobic process of decomposition that produces toxics, such as ammonia (NH_3 -N) and hydrogen sulfide (H_2S).



Graph of Water Quality Condition at Ir. H. Djuanda Reservoir

Ir. H. Djuanda dam including hydro power plant (HPP) and irrigation infrastructures has been commenced in 1958 and in fully operational since 1967. The Ir. H. Djuanda multipurpose reservoir is intended to meet the domestic, municipal, and industry water requirements, rice-field irrigation area of 240,000 ha, flood control, tourism, and including fish farming with floating net in the reservoir. The Ir. H. Djuanda reservoir is part of the cascade reservoirs in the Citarum River consists of Saguling, Cirata, and Ir. H. Djuanda reservoirs.

Water Quality and Ambient Environment

The Citarum cascade reservoirs also act as sediment trap. The rate at which sediments are being deposited in the reservoirs is rapidly reducing storage capacity and shortening their useful life. The function of reservoir for natural purification also occurs when the quality of water released from the reservoir is better than at the inlet of the reservoir. Based on the catchment composition, almost entire inflow of Ir. H. Djuanda reservoir, 4,115 km² of catchment area belongs to Cirata. The catchment composition also characterizes the water quality conditions within the reservoir. Since most of the inflow coming from Cirata reservoir, the Jatiluhur water quality is depended on quality of inflow from Cirata and the activities within the Ir. H. Djuanda reservoir. Floating net fisheries in early 1990s has been practised in Ir. H. Djuanda reservoir and has been increasing since then. The effect of the activity was foreseen to make worse the water quality condition within the reservoir surface area has been covered by the activity). The stability of Ir. H. Djuanda reservoir surface area has been covered by the activity. The stability of Ir. H. Djuanda reservoir before existence of Saguling and Cirata reservoir was relatively stable and showed the aquatic conditions was mature. During inundation of Cirata dam, the Jatiluhur reservoir became juvenile for a while and started to develop afterwards (Seameo Biotrop, 1996).

Manufacturing activities, expanding populations, degraded watershed among others produced pollution which is discharged from point or diffuse sources into the Citarum River that affected by the activities in the upper part of the basin and amplified by the fish farming with floating net activity within the reservoir. The degraded environmental conditions are shown by the eutrophic level and toxic production that are detected at the bottom of the reservoir, and at the outlet of the Ir. H. Djuanda reservoir.

Schematic of Water Resources System

The Citarum river originates from mountainous area of Bandung region and flows northward to Java Sea through central portion of West Java Province. Bandung City, the capital of the West Java Province with inhabitants of 6,578,829 is located in the mouth of Saguling Reservoir. Topographically, the Citarum catchment upstream of is Ir. H. Djuanda characterized by a ring of high mountain ridges around a slightly undulating plain. Saguling dam is located in the upstream ridge while Cirata and Ir. H. Djuanda are in the downstream ridge.

Downstream of Ir. H. Djuanda reservoir two weirs across the Citarum divert water into the three main canals: the West Tarum Canal (WTC), the East Tarum Canal (ETC), and the North Tarum Canal (NTC). The WTC and ETC tap the Citarum at Curug weir







Efforts and Strategic Planning

Since 2000s, fish kills phenomena in Ir. H. Djuanda became routine. Almost every year tons of fishes, particularly in the floating net fisheries have died due to suffocation. The phenomena initially start with short sun shine durations and cool weather that last at least three days. With heavy wind later on, the fishes start trembling and become suffocated. Based on turbulence generation mechanism, the dominant driving force for increasing gas transfer process in the open lakes is wind (Herlina, 2005). When temperature stratification occurred, the cooling water layer at the water surface which is heavier than the warmer layer below tends to descend plunging into the lower layer which bring the oxygen from the saturated area in the upper layer and replaced by the warmer water layer from below (Murniati, 2006). Theoretically, the aforementioned condition in Ir. H. Djuanda reservoir should be in favor for oxygen transfer from the saturated layer above into the deeper lakes. But the phenomena indicate that the organic materials at the bottom of the reservoir are now in the state of overshooting. This condition also indentified by the odor of H₂S that smells when the hollow jet gates are opened. In access gallery (tunnel to power house) the smell of H_2S is also already sensed.

The effects of severe environmental conditions either to the hydro-power plants in particular or to ecosystem in general have been acknowledged and understood. Specifically to Ir. H. Djuanda reservoir, which the floating net fisheries as sources for burden of organic materials are the only inner system that can be controlled; attempts to reduce the numbers have been a priority. In general, two strategic plans to minimize the impacts are: firstly, reducing or minimizing the sources of pollutants that generate the severe environmental conditions; secondly, protecting the equipments or reducing the impacts of existing pollutions.

To reduce the sources of pollutants is a longer term of activity. Jatiluhur reservoir as part of Citarum cascade reservoirs has to be treated within the system. Hence, information disseminations should be spread in order to have similar understandings and perceptions of what is being developed and crystallized the idea how to solve the problem globally. This refers to dualism of floating net fisheries activity; the numbers are overshot and environmentally are not friendly, but in fact, economically it is still feasible.

Problems Encountered - Water Quality Deterioration

As commonly occurred in artificial lakes, the methane release is natural phenomena. The organic materials, such as trees, bushes, etc, that have been submerged into the water, gradually are composed and the anaerobic process are started in the absent of oxygen. Additional activity of floating-net fisheries (freshwater fisheries) within Ir. H. Djuanda reservoir increases the organic materials that come from fish feedings and metabolism residues. The over-feeding of fishes will increase the nutrients, such as phosphorous and nitrogen, nurture the phytoplankton availability (blooming). Consequently, the impacts of over nutrients are: (1) dissolved oxygen will be depleted, either at the surface and become worse at the bottom of reservoir, (2) disappearing of density and stability of phytoplankton, and (3) moreover blue-green algae blooming.

For the past 15 years, operation of Ir. H. Djuanda Reservoir experiencing water quality degradation due to industrial activities, rapid population growth, watershed degradation which have contribution to the amount of pollution entering the Citarum River. Furthermore, fish aquaculture cages activities in the reservoir have led to vast environmental deterioration.

With increasing sources of pollution in the river and in the reservoir, oxidation of organic matter and eutrofication took place, which causes accumulation of toxins and low oxygen content in the bottom and at the reservoir outlet.

Hollow Jet Valve (bottom outlet) in Ir. H. Djuanda Reservoir operated to regulate water in a sufficient way. It could be operated to increase the redox potential as well, which is one of the most crucial factors for aquatic ecosystem. Chemical and biological processes are highly dependent on redox potential. Manipulation of redox potential in aquatic ecosystems could often be used to create a more favorable environment with relatively low cost. Other efforts to control pollution in the river are Citarum integrated approach in determining water quality objective, monitoring and stakeholder meetings to increase participation. With the above mentioned conditions, the operation of the three reservoirs must be optimizeded to meet a variety of needs, not only in quantity but compliance to maintain good water quality.

Conclusion

Ir. H. Djuanda multipurpose dam when it was design to overcome the situation at that time produced the unique structure that characterizes the Ir. H. Djuanda reservoir. This unconventional layout of grouping all the essential appurtenances into the single structure as the morning glory tower makes it easier to control and it was designed in the time when the environmental was in favour conditions. After more than 40 years of operation, environmental conditions has degraded due to increasing demographic and population needs which impact on higher residues.

The present status of Ir. H. Djuanda reservoir showed us the impacts of severe conditions into the system. Therefore it requires to be re-designed to adjust with the existing condition and probable worst case in the future to protect both equipments and humans. The environmental condition should be considered in re-designing the system, such as strengthening the air circulation system in the tower, materials used in the system, and human safety. For longer term, the management of the river basin should be improved to have better environmental conditions.

