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Identification of important efforts in urban river water quality management (case study of Cikapundung River, Bandung, Indonesia)

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Abstract. Rivers located in urban areas in Indonesia, frequently suffer by severe pollution caused by the waste of people activities who directly disposed into the river without prior processing. Therefore it is necessary to study the improvement efforts that can be conducted in order to recover the condition of the river, especially considering the water quality problem. This study was prepared to identify the important efforts to manage the urban river water quality. The study was initiated by learning how the Kitakyushu City, Japan improved the quality of its river. The next step is to conduct a focus group discussion of stakeholders in Bandung City as a case study of this urban river improvement. The Cikapundung River is selected as the location of the study, in connection with the Citarum River as its main river. In-depth interviews were also conducted to explore in detail the efforts that can be applied in big cities in Indonesia in managing the quality of river water. Based on this study, there are 3 main efforts that can be conducted, i.e. the facility development of domestic sewage treatment by the government, strict law enforcement and continuous education for the community.

1. Introduction

Increasing the number of residents in urban impact on the increase of waste generated to the environment, including to water bodies such as rivers. This is especially true in big cities in Indonesia that have poor river management. This fast growth and urbanization have also stressed and polluted the rivers; however the government actions are mainly concentrated on managing water scarcity, floods, and pollution [1]. Citarum River is one of a river with high levels of pollution. Cikapundung River is one of the tributaries of the Citarum River which passes through the city of Bandung. The city has a high density of 14,832 people / km2 [2]. The increasing number of the population stimulates the development of housing on the banks of the Cikapundung River without adequate sanitation facilities [3]. The river represents the condition of other river in urban area, such as Citepus River in Bandung City [4] and almost all river in Jakarta City [5].

Pollution that occurred in the Cikapundung River has occurred in recent years due to uncontrollable disposal of domestic and nondomestic activities into the river. Some non-domestic activities located around the banks of the Cikapundung River include shops, restaurants, medical clinics, home industries, etc. The pollution index obtained from the monitoring result of the Bandung Environment Agency shows that rivers in Bandung City have severe pollutants, including Cikapundung River.

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Several actions have been made by the government to improve this condition, but have not achieved good results, especially when viewed from the water quality.

Kitakyushu City is one of the cities in Japan that has improved the quality of its environment. In the 1960s, the city experienced heavy pollution due to intensive industrialization. In addition to river pollution, damage also occurs in air and ground components. With its excellent rehabilitation efforts, Kitakyushu City has succeeded in restoring the environment to a clean and healthy environment. This rehabilitation effort lasts approximately 20-30 years. The duration is relatively short when considering the level of high pollution occurring at the commencement of the rehabilitation activities. Experience possessed by Kitakyushu City can be one of learning for big cities in Indonesia to make improvements to environmental conditions, including the aquatic environment.

This study aims to identify the efforts that can be done in Indonesia in order to manage the quality of the river using the experience that has been done in Kitakyushu City. However, it should be noted that not all efforts that have been implemented in other cities abroad can be directly applied in big cities in Indonesia. Therefore, there should be more in-depth research to get the right effort applied in Indonesia.

2. Research Methods

The location of this research is Cikapundung River which is passing through the Bandung area. Figure 1 shows the Cikapundung River location.

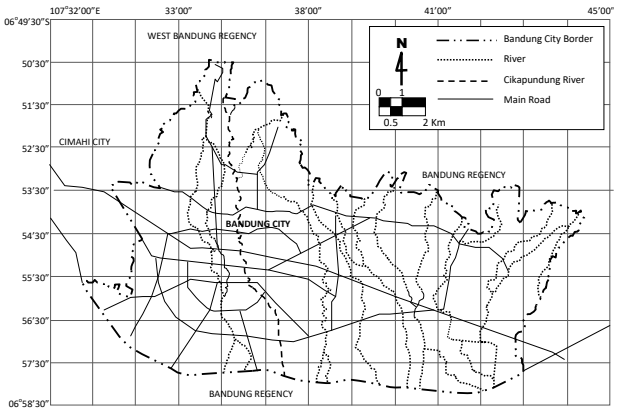

Figure 1. Cikapundung watershed [6].

Extracting information from Kitakyushu City in dealing with water body pollution problem became the first step in this research. Information collecting activities are conducted by visiting local government, educational facilities, and the community. Information on river management in Kitakyushu City is then submitted to stakeholders in Bandung by conducting a Focus Group Discussion (FGD). In this FGD activity, the participants were asked for their opinions on possible actions to recover the quality of the Cikapundung River.

After that, the in-depth interviews were conducted with respondents from government, private and community. Efforts that stakeholders recommend are then formulated in an integrated diagram. The results of these activities are used to identify strongly any efforts that can be applied in Bandung to improve the quality of Cikapundung River.

3. Result and Discussion

FGD activities resulted in several portraits of views from stakeholders in looking at the quality management aspects of the Cikapundung River. The participants represent 3 sectors of stakeholders, government, academic/ university, and community. Since the most influencing sector is from the

government, the portion of this sector is dominant. There are 6 government institutions participate in the FGD.

In the FGD, the participants were informed on how the Kitakyushu City cleaned the environment. River rehabilitation efforts in Kitakyushu City include education, infrastructure support of wastewater treatment, land use management, routine water monitoring, water purification and storage technology, and strict law enforcement. The city provides many museums and learning centers for the community, especially early age citizens, to understand the importance of healthy rivers and environment. The public activities involving the river were also regularly conducted, i.e. kayaking, swimming competition, etc.

A poll of stakeholders on factors affecting river water quality shows that public awareness is the most influential key. Another factor is law enforcement and population pressure. The rapid growth of population has a negative effect on water resources [7]. Figure 2 shows the percentage of importance of factors in influencing the quality of river water based on the opinions of stakeholders.

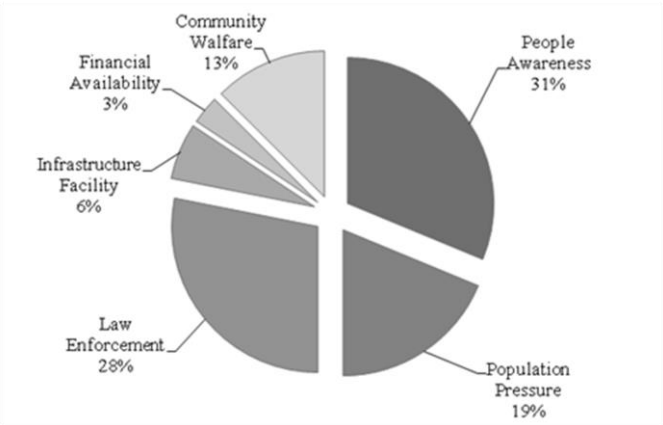

Figure 2. Influencing factors in river water quality.

Efforts to increase awareness can be done through various things, both in the form of formal and non-formal education. The stakeholders consider that this education is the most important effort needed in order to improve the condition of the river. In addition to education, strict law implementation must also be enforced. These two aspects are followed by the infrastructure support to treat the wastewater prior to discharge into the river body. The result of stakeholder assessment on the importance of several river rehabilitation efforts can be seen in Figure 3.

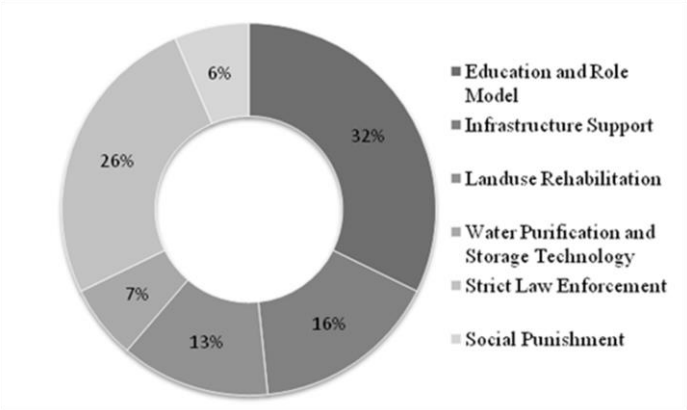

Figure 3. Assessment on Aspects Importance in the recovery of river quality.

Deep interview results concerning the programs planned and undertaken by several stakeholders are as follows:

- National Level Government programs: river research from upstream to downstream, development of a pilot project to process livestock waste into the river body, the WWTP Cisirung redesign, optimize of Bojongsoang domestic WWTP, restoration of Upper Citarum River by returning it according to the initial master plan
- Province Level Government programs: monitoring and supervision of water quality, focusing on managing Upper Citarum River, develop the eco-village village eco-friendly, conducting river patrol looking for sources of pollution, recycling water assessment in industry
- City Level Government programs: mapping in order to make the pollution position system, solid waste management, relocating illegal housing located near the Cikapundung River, revitalization of rivers, enforcement of spatial law, providing education to the community in terms of health and hygiene, including for the river
- NGOs programs: creating 'Creative Tourism' in Cihampelas community, close to Cikapundung River, conducting activities that involve the community around the river banks Cikapundung
- Academic Researcher and Faculty Members of University programs: research on the river water quality improvement, management and information system; providing education for students and communities

Many efforts may have been conducted by various institutions. However, the result on river management is still insignificant [8]. In the stakeholders sharing, networking and information scale, all activities should be integrated to have stronger impacts. Public involvement is supposed to be integrated in the water resources management, including rivers. Hence the various disciplines of research need to be put together on a scale of river watershed with the stakeholders in the network. Meetings between government, academia, researchers and users of data in local, national and international should be conducted regularly. Each stakeholder not only works partially for each level and sector, but also must be integrated with each other. In addition, it is also important for stakeholders who have the field of science and technology in cooperation with stakeholders engaged in social economic community [9]. The concept in the figure can be adopted to manage the rivers in Cikapundung River.

Integration of social science is important in approaching the citizen [10]. This collaboration is necessary to raise public awareness and educate local communities. These efforts should be initiated by mapping the knowledge and living conditions of people, especially those living in the river areas. Data collection and observation and social survey need to be conducted and interpreted seriously so that the education is applied in accordance with the needs. Utilization of river water quality modelling is also a popular tool in river management [11]. In addition, local communities should also be involved in river management efforts so that the program can be sustainable without continuous supervision and assistance from the government.

Cooperation among stakeholders should be done in river watershed scale. This is important because Cikapundung River also receives waste from upstream livestock waste that is outside the administrative area of Bandung City. Cikapundung River flies to the north of Bandung, namely in West Bandung regency, across the city of Bandung, and empties into the River Citarum located in Bandung regency. The need for cattle waste processing in the northern part of Bandung regency can be fulfilled by involving wastewater plant designers with appropriate technology needs. To maintain this multi-stakeholder cooperation, routine meetings are also needed in order to evaluate the programs that have been undertaken and to formulate program improvement plans. Financial needs can be allocated to this cooperative group by taking into account the administrative rules of each region.

There are 3 large groups of river management efforts based on FGDs and in-depth interviews, namely environmental education, law enforcement, and infrastructure development. Figure 4 shows a diagram of activities for river management.

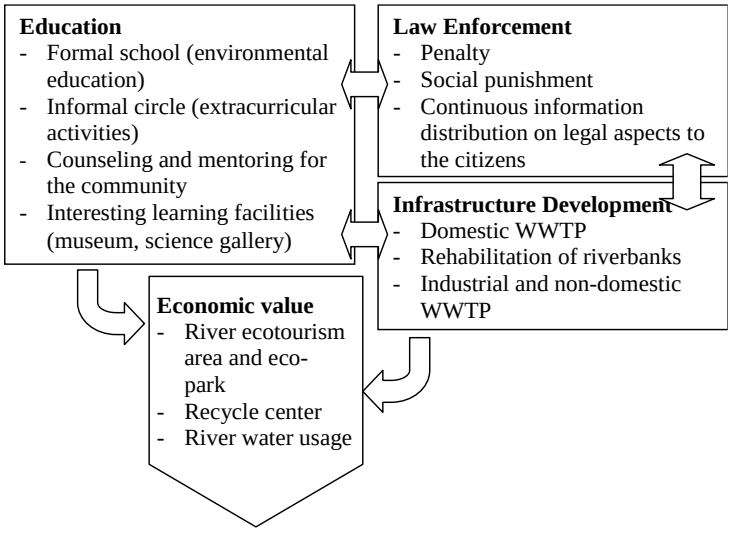

Figure 4. Diagram of river management activities.

A well prepared curriculum need to be formulated for the environmental education subject in order to be able to shape the behavior of the citizen in treating the environment. One of the most utilized methods in learning the behavior is theory of planned behaviour [12]. Informal education on the environment preservation also important and can be influenced by the surroundings' habits, including parents' to their children [13]. Behavior can be supervised by law enforcement. In several developing countries, environmental law appears inappropriately applied. Many pollution cases were not solved by the law. Lack of financial, court system support and changing social and political climate may exempt the law implementation [14].

Activities of river management should also give impact on the direct increase of community welfare. Many people tend to reluctantly pay attention to any new regulation and movement, including in river rehabilitation framework, when it comes without any impact on the economic improvement. Development of eco-park and eco-tourism can attract the economical circle in the river area. Other environmental circular economy can also be applied such as recycle center operation and utilization of river water. It presents production and consumption improvement models and an indicator of inefficiency of resource usage [15]. Not only recycle the wastes, the circular economy is an economic model involving process of designing and managing the process and output through planning, resourcing, procurement, production and reprocessing to maximize the function of ecosystem for human welfare [16].

4. Conclusion

In the management of water resources, the public involvement should be integrated. The various disciplines of research need to be put together on a scale of river watershed with the stakeholders in the network. Meetings between government, academia, researchers and users of data in local, national and international should be conducted regularly. These forums also need to hold festivals or other activities that involve the community.

There are 3 main efforts to manage the river water, i.e. strong education method to increase the people awareness for the early stage of their interactive life, strict law enforcement, and massive development of sanitation infrastructures. The efforts must be in parallel with citizens' economical strengthening efforts.

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