Protecting Water Resources by Sustainable Household Solid Waste Management in Jakarta, Indonesia

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Abstract. Solid waste has been recognized as a crucial environmental problem in many urban areas in Indonesia, particularly in Jakarta. In fact, an underperforming solid waste management (SWM) is also expected to result in an increased risk of water pollution. This research aimed at exploring past and current efforts of territorial water protection in Jakarta, Indonesia, which had been attempted by changing society’s behavior in managing solid waste at household level. To do so, this study applied literature reviews and interviews to investigate solid waste management of riverbank communities. According to a report on Environmental Statistics, there were 1.81% of households in the country’s capital in 2014 who managed their solid wastes by primarily throwing them into waterbodies. Apparently, un-transported solid wastes, which were those left lying on roadsides or empty lands, per day in the South Jakarta Region reached 8%. Those untreated wastes were expected to later end up in sewers, rivers, or the sea. In Srengseng Sawah, Jakarta, SWM has been conducted by non-governmental organizations, who received retributions from the people to transport household solid wastes. To overcome potential solid waste pollution in rivers, it is necessary to change community behavior to apply a more sustainable SWM in managing their household solid waste. This is strongly influenced by the availability of solid waste infrastructure and community awareness.

Keywords: community behavior; water pollution; solid waste management; sustainability

1. Introduction
Inappropriate waste management methods, e.g. burning, stockpiling, and disposing solid waste into waterbodies, have been recognized to result in environmental pollutions [1]. In general, the number of populations living in an area and their income levels are two critical factors in the increases of waste generation [2]. Waste management is not a problem for the government solely. Instead, it also requires an active involvement of communities through an increased awareness and behavioral changes [3]. Due to high population densities, waste pollution has been consistently posited as a critical problem in urban areas in developing countries. It occurs mainly due to the lack of information regarding waste production, limited funds for conducting proper waste management, and inadequate technologies for processing generated waste [4]. Besides, public awareness in countries as such still lacks proactive participations in the management of household waste [5].

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In fact, the lack of public awareness in managing waste is expected to affect behavior in disposing solid waste. For example, people living in riverbanks often dump their household waste into the river. It will undoubtedly result in a declining water quality. It will then harm human health due to, for example, a proliferation of disease vectors [6]. Hence, sustainable waste management with an active involvement of communities is a solution to protect rivers in Indonesia [7]. Any efforts to protect the environment must hence be devotedly supported by the governments, academics and the public [8].

In general, there is a variety of community behaviors in managing household waste. About 38.87% of the people dispose solid waste into available dump containers, while 21.83% dispose solid waste into their own yard. Besides, 18.34% of local people dispose solid waste on roadsides, while 6.99% of them dispose solid waste on empty lands. Then, about 13.79% dump their solid waste into rivers [9]. In fact, the behavior of people disposing solid waste into waterbodies and the lack of waste infrastructure in riverbanks are critical to prevent accumulated waste in rivers. In 2012-2013, un-transported solid waste in Jakarta has consistently increased by 5-15% annually. The un-transported waste will then end up in various waterbodies, including rivers, lakes, and the sea [10].

According to Law no. 18/2008, waste management in Indonesia shall begin at household levels by applying the 3R principle (Reduce, Reuse, Recycle). Waste management through the 3R principles are a practical choice to conduct a sustainable waste management; however, less people have actively implemented these principles. By applying the 3R principles, communities are expected to properly manage waste generated in their own households. It is then expected to result in a reduced pollution in the environment by reducing waste generation and those dumped into landfills [11].

2. Materials and method
This study aimed at describing river quality and community behavior in managing household waste. This research was conducted in the village of Srengseng Sawah, South Jakarta, Indonesia. The village was being passed by several waterbodies, including the Ciliwung and Kali Baru Barat. This study applied a mixed method conducted through literature reviews, observations, and interviews. Literature reviews were taken to collect secondary data on the quality of Ciliwung River (monitoring point 1) as well as Kali Baru Barat (monitoring point 1), and data on existing waste management. Then, observations and interviews were taken to discover the pattern of garbage transportation in Srengseng Sawah. Respondents consisted of two heads of community unit and four heads of neighbourhood unit.

3. Reviews of river water quality and waste management behavior
Water pollution is a crucial problem in developing countries, including Indonesia. Human activity and behavior are essential aspects underlying the occurrence of river pollution [12]. Polluted rivers are the result of lacked public awareness to preserve rivers and lacked government roles in river management. Sustainable river management requires active participation and coordination between stakeholders, including community living in the area [13]. In fact, dumping solid waste into the river is an undesired behavior causing water pollution [14]. An effective way to solve the waste problem is by shifting people’s behavior to reduce, reuse, and recycle waste generated in their own households [15]. Human activities and their behavior shall be in a balance with awareness, knowledge, and active participation. It is the balance that is expected to result in a good quality of river water [16].

3.1. Water Quality
The village of Srengseng Sawah is bordered by several rivers, including the Ciliwung and Kali Baru Barat. The Ciliwung River at monitoring point 1 is in a mild pollutant status, while Kali Baru Barat in segment 1 is in a mild pollution status [17]. Table 1 present the levels of Total Suspended Solid (TSS), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) at these two observed locations in 2017.
Table 1. Water quality of Ciliwung River and Kali Baru Barat at monitoring point 1 (2017)

| Water Parameter | Water Quality Standard (mg/L) | Measured Water Quality of Kali Baru Barat (mg/L) | Measured Water Quality of Ciliwung River (mg/L) |
|-----------------|------------------------------|-----------------------------------------------|-----------------------------------------------|
| TSS             | 100                          | 77                                            | 142                                           |
| BOD             | 10                           | 6.04                                          | 4.7                                           |
| COD             | 20                           | 48.90                                         | 32.5                                          |

Table 1 indicates TSS and COD levels in Ciliwung River to exceed water quality standards. The high COD level indicates pollutants from non-domestic sector. The high TSS level inhibits sunlight from entering the water, which will hamper any photosynthesis processes. Inhibited photosynthesis is then expected to decrease oxygen content in the water. Table 1 also indicates that COD level in Kali Baru Barat River to exceed desired quality standard of class B river water. It classifies monitoring point 1 of the Kali Baru Barat to have a relatively high organic pollutant. In fact, the upstream direction of the monitoring point 1 is in a residential area, by which the organic pollutions are assumed to exist due to the disposal of household waste directly into the waterbody. This study explains the disposal of household waste, both liquid and solid waste, into rivers will reduce river water quality (figure 1). Besides, it causes other problems such as flooding and a proliferation of various diseases [18].

Figure 1. Waste Composition in Jakarta

3.2. Waste Management Behavior
According to Indonesia’s Environmental Statistics in 2014, about 1.08% of people in Jakarta managed their household waste by dumping the waste directly into waterbodies [19]. Based on data from Statistics Indonesia [19], the amount of generated waste originating from the South Jakarta region in 2017 reached 1,516.82 tons/day. Of the total waste, only 1,401.77 tons/day were transported to landfills. In other words, about 8% of the generated waste were left un-transported. On the other hand, the composition of waste generated in Jakarta in the past five years was dominated by organic waste (53.75%) [20]. The un-transported solid waste was assumed to get dumped into rivers, polluting the waterbodies. Therefore, it is necessary to pursue a more sustainable household waste management by applying the reduce, reuse, and recycle (3R) behavior.
Looking at the results of interviews with the heads of community unit and heads of neighborhood unit, waste management in Srengseng Sawah was apparently conducted by the neighborhood unit. Result research highlighted that the pattern of household waste collection in Srengseng Sawah included indirect individual actions, by which garbage were taken from house to house using a garbage cart. The waste was then transported to a Temporary Garbage Shelter to later be transported to a Final Processing Site (Tempat Pembuangan Akhir – TPA). The household waste transportation was conducted by non-governmental organizations which received retributions of about IDR 30,000-60,000 per household. The waste transportation was irregularly scheduled 1-2 times a week. In fact, the irregular schedule had caused a buildup of waste in residential areas. Besides, the pattern of transporting waste at riverbank settlements was still limited to collecting and no proper 3R-based waste management. On the other hand, solid waste transportation services were considered lacking due to the unavailability of solid waste infrastructures (e.g. polling stations) and irregular waste transportation schedules. It then increased the potentials of community to dump waste into the river at times.

Therefore, an effort is required to make significant changes to household waste management. Wang et al. [21] has suggested that the existence of an organized garbage disposal site can improve people’s behavior in disposing solid waste with a community compliance rate of 80%. Besides, the results discover a properly chosen location and a properly designed condition of garbage bins provided for the community to encourage appropriate behavior of waste management [21,22]. Results of other studies have also revealed income aspect to have a strong relationship with community willingness to sort waste before being transported [23].

In agreement with Wang et al. [21], waste management facility is one of the important factors in waste management process. In the application of 3R principles, waste management facilities can be distinguished based on the type of waste that has been sorted. In general, trash bins divided into three types, there are trash bins for organic, inorganic, and hazardous waste. A proper waste management facilities will facilitate the subsequent waste management process. Other determining factors have also included better knowledge of a proper waste management to trigger a better attitude in sustainable waste management. The better attitude is expected to increase desires to implement sustainable waste management behavior. Based on these results, efforts on river protection can be initiated by intervening current community knowledge to improve existing waste management through reduce, reuse, and recycle and to prevent adverse effects of continuing to dump solid waste into the river [24].

4. Conclusion
An improper management of household waste has been recognized to indirectly cause water pollution in rivers. In that case, community behavior is an important aspect in maintaining river sustainability by not dumping solid waste into the river. Improved public knowledge on a sustainable household waste management through reduce, reuse, and recycle is hence required to actualize behavioral changes. Besides, the provision of solid waste infrastructure and an optimized waste transportation are also required to support behavioral changes within community to sustainably managing solid waste.

5. References
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