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A Preliminary Study on The Performance of Eco-Trap as A Removable Gross Pollutant Tool in Removing Solid Waste on Water Surface

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Abstract: The rapid urbanisation, industralisation and population growth in the 21st century have resulted in an increasing demand for water consumption, as well as rising levels of water pollution and contamination in developing countries including Malaysia. In year 2020, a total of 29% and 5% of 672 rivers in Malaysia were classified as slightly polluted and polluted. In order to mitigate issues related to water pollution, this research intends to develop a removable trash trap that can be used as a device to remove floatable waste on water surface. The removable trash trap, also known as the Eco-trap, was designed by using plastic bottle waste, HDPE fishing net, PP rope and metal chain. A field testing was carried out in order to investigate its ability to remove floatable waste on water surface. The field testing was carried out at the Panchor River, Muar, Johor for one month. Throughout the data collection period, the Eco-trap had successfully trapped a total of 953.5kg of solid waste in which bulky waste contributed to the highest amount (620.5kg, 51%). The field testing has proven that the Eco-trap has the ability as a removable device to remove floatable waste on water surface. Nevertheless, few challenges arose from the field testing which requires further investigation to improve the Eco-trap. A more detailed research must be carried out on the fundamental aspects of the Eco-trap and the factors affecting the performance of the trap.

Keywords: *River pollution, solid waste, trash trap, removable*

1. Introduction

In Malaysia, the water quality of the rivers has always been a major concern for the government, various local authorities and even the public. Rapid urbanisation and population growth resulted in increasing demand for water consumption and in tandem with increasing issues related to water pollution. Based on the Water Quality Index (WQI), in year 2020, 29% and 5% of 672 rivers in Malaysia were classified as slightly polluted and polluted [1]. In addition, Malaysia is also ranked 8th among the 192 selected coastal countries with high amounts of mismanaged plastic waste. Around 0.36 million out of 0.90 million of mismanaged plastic waste had become plastic marine debris [2]. According to Tan [3], the Klang River in Malaysia was listed as one of the 50 most polluted rivers in the world. The plastic bottles, packaging and containes floated on the surface of the Klang River or were trapped in the roots of the mangrove trees by the riverbank. This is a serious problem because polluted

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water will have adverse effects on all the living things including human health [4, 5], animals [6] and ecosystems [7]. Apart from that, the accumulation of solid waste in the river can also lead to the malfunction of dams, which play an important role in water bodies [8, 9].

In general, the sources of river water pollution can be divided into two categories which are point source and non-point source pollution. Point source pollution includes localised sources such as industrial and residential effluent while non-point source pollution comprise diffuse sources such as agricultural land and forests [4]. When the source of pollution is different, the components of the polluted river water also varies. Therefore, various studies had been carried out to analyze the components and pollutants in the polluted river [10, 11]. Based on the conditions of the river, specific methods will be implemented for treatment purpose. Among the methods that can be used to treat polluted river water include: i) physical treatment [12]; ii) biological treatment [13]; and iii) chemical treatment [14].

On top of the various treatment for polluted water, Gross Pollutant Traps (GPTs) have been identified as one of the effective devices that can be used as a pre-treatment method to improve stormwater quality by reducing the concentration of pollutants [15, 16] and removing gross pollutants from entering the river system [17, 18]. Currently, there exist a variety of GPTs in the market, including patented and registered designs suitable for use in urban catchments such as floating debris trap, trash rack, gully basket and continuous deflective separation (CDS). Even though there is a vast introduction of new GPTs designs over the past decade due to stormwater pollution concerns, the existing designed GPTs devices are mostly large in size, high cost of installations, difficult and expensive cleaning procedures [19]. In addition, due to its location site, size and cost, the GPTs can only be installed by the government or industries that have obtained approvals from the Department of Drainage and Irrigations [20].

Seeing that one of the most effective strategies for removing gross pollutants involve a combination of structural treatment methods and non-structural measures [16], by using the concept of a GPT, it is important to develop a removable trash trap so that this tool can used to ease the river cleaning process by anybody who are interested to do a clean-up in rivers and drainage outlets. In addition, a removable trash trap can also be used to inculcate awareness and waste management programmes to the public. Therefore, this research is interested to establish a conceptual approach in improving the stormwater quality by using a removable trash trap as a gross pollutant removal device. Based on the existing GPTs, a trash trap was developed and tested on site to investigate whether this removable tool is able to remove floatable waste on water surface to ease the river cleaning process without using any machinery equipment.

2. Materials and Method

A removable trash trap that is called an Eco-trap is developed and tested on its ability to trap solid waste on water surface. The eco-trap is developed by using the following materials: i) fishing net – a High Density Polyethylene (HDPE) material of gill net with 1cm openings (3.5 meters wide and 7 meters long); ii) plastic bottle waste – 1.5L plastic bottle of carbonated drinks such as 100 Plus, Coca-Cola and Pepsi; iii) metal chain – 4kg and 4 meters long; and iv) rope – Polypropylene (PP) rope.

In developing the Eco-trap, a fishing net is used as a filter to trap the solid waste on the water surface. The same type and size of plastic bottle waste is attached to the net to form a consistent buoy line. The plastic bottles will act as floaters and a barrier to trap the floatable waste brought by water flow. Then, a metal chain is attached at the bottom of the net. The metal chain will act as a weight to hold and keep the net from being flipped over by a strong water current. The balance between the buoy line and weight will hold the net perpendicularly towards the direction of water flow and capture the waste brought by the water flow. Lastly, by using the concept of a drawstring bag, the ropes are attached along the side of the net. The ropes will be tied at the riverbank to keep the trap in position. Once the trap is filled with waste, the ropes tied at the riverbank will be pulled and the trap will be closed with the floatable waste trapped inside the net. The sketched diagram of the eco-trap is illustrated in Figure 1 below.

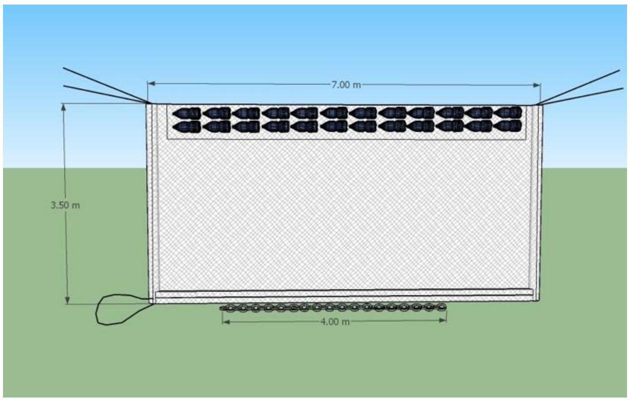

Figure 1: Diagram of the Eco-Trap

Data Collection

The research area is located at Panchor river, Muar, Johor which is one of the branches of Muar River. From observation, it can be said that the research area is surrounded by housing area and restaurants. Besides, there are many trees such as coconut trees planted along the side of the river. The data collection was carried out for a month at the end of October 2020.

The Eco-trap is installed and released into the Panchor River in which the four ends of the rope are tied tightly to the iron rods at the riverbank. The trap will then be left alone to allow it to trap the floatable waste that flow into it (refer to Figure 2). Once the net is full of waste, the rope at the riverbank will be pulled causing the net to close and all the floatable waste will be retained inside the net. Finally, by using manpower, the Eco-trap is lifted by pulling all the ropes simultaneously.

Figure 2: The Eco-trap Installed at the Panchor River, Muar, Johor.

Once the Eco-trap has been lifted, the waste trapped were taken out and the net was cleaned and dried. With the assistance of the SWM Environment, the collected waste was sorted based on their category, weighed and disposed in a proper manner. SWM Environment is one of Malaysia's largest concessionaires that provides integrated waste management and public cleansing service in the southern region of Peninsular Malaysia.

3. Results and Discussions

Throughout the data collection period, a total of four times of waste collection had been carried out. For every collection, all waste collected were sorted and weighted according to its category before being properly disposed. The types and amount of waste collected during the data collection period is summarized in Table 1.

Table 1: Types and amount of waste collected at the Panchor River, Muar, Johor

Types of waste	Amount of waste (kg)				
	Week 1	Week 2	Week 3	Week 4	Total (kg)
Steel cans	12	19.5	24.5	5	61
Plastic	32	67	56	62	217
Aluminum cans	2	15	6	1.5	24.5
Bulky waste	83	128	98	311.5	620.5
Total	**129**	**229.5**	**184.5**	**380**	**923**

From the field testing, a total of 923kg of floatable waste were collected throughout the data collection period (refer to Figure 3). Majority of the waste collected comprise of bulky waste (620.5kg, 67.2%). The bulky waste collected in this research included shoes, coconut fruits, its branches and fronds, and pieces of furniture that were large and heavy such as drawers. This is followed by plastic (217kg, 23.5%), steel cans (61kg, 6.6%) and aluminium cans (24.5kg, 2.7%). The plastic waste accumulated include PET bottles, polystyrene containers and plastic bags. The steel cans collected throughout data collection period included food cans and insecticide containers, while the aluminium cans collected included soda and food cans.

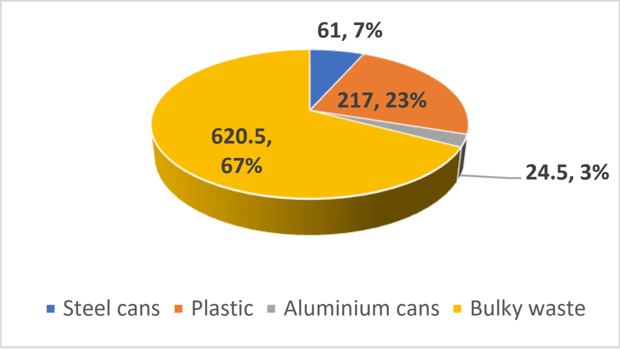

Figure 3: Types of Waste Collected (kg) at the Panchor River, Muar, Johor.

From the data collection, it can be summarized that bulky waste is one of the largest contributors of pollutants in the Panchor River that will led to the sea. This is not a common scenario in Malaysia. According to Aruna [21] and Tan [22], in Malaysia, bulky waste such as discarded mattresses, tree branches, kitchen utensils and motorcycle helmets were commonly found to be trapped at the log boom that is designed to collect or contain floating garbage installed in a river. The similar scenario can be seen abroad. A documentary on watergoat trash trap in the United States revealed that there among the bulky waste being trapped in the watergoat include shoes [23].

Over the years in Malaysia, various parties such as the government, institutional sectors, private sector, Non-Governmental Organisations (NGOs) have put in effort to educate and increase the awareness level of the community on waste separation at source and recycling. Due to these efforts, the recycling rate and volume in Malaysia had shown positive increment from year to year [24] [25]. Therefore, it is a bit disappointing to discover that there are some people, despite of their awareness level and knowledge on waste separation practices, they still choose convenience and the easy way out by dumping everything into the rivers, even though they know it very well that their actions will cause pollution to the rivers. This is line with a study conducted by Nordin and Adman[26] in year 2019 on the behaviour of the householders towards waste separation practices. Their studies revealed that even though the respondents had moderate knowledge and awareness level on waste separation, but they did not put this into practice in their daily activities.

Challenges and Limitations of Eco-trap

Overall, it can be said that the Eco-trap has proven its ability to trap floatable pollutants in water surface and can be used as a removable tool to ease the river cleaning process. Nevertheless, during the field testing, few challenges had occurred that hampered its ability as removable gross pollutant tool. One of the biggest challenges is unpredictable weather conditions. During rainy days, the water current becomes strong and accelerates the water flow of a river. This caused the rope to become torn and detached from the riverbank which led the net to float freely on the river surface. When the trap floats freely on the river surface, the floatable waste just passes along the net following the water flow without being trapped inside the net. Another challenge that arose because of the rainy weather is the bulky waste. During the rainy days, the bulky waste became twice as many and large in size. The accumulated bulky waste in the trap not only ruined the trap, but also caused the trap to be too heavy to be lifted using just manpower.

In addition, the research team faced the problem of retaining the waste inside the net during the lifting process. The trap was not able to be fully enclosed and retained the floatable waste inside the net when it was being lifted. After several attempt of trials and errors, this problem was resolved by applying the concept of cast-net fishing to the Eco-trap. In general, the cast-net fishing concept is similar to the drawstring bag concept, in which the ropes are aligned alongside the net; and cause the net to shrink like a drawstring bag when the ropes are pulled, and the net is lifted from the river.

Even though the field testing indicated there is a possibility the Eco-trap can be used as a pre-treatment tool to remove solid waste on water surface, nevertheless, few limitations of the Eco-trap have been identified during the data collection process. One of the biggest limitations is that the field testing was only carried out to determine the ability of the Eco-trap to fully capture the waste without re-entering back into the river. The maximum load of the waste that can be trapped inside the net was not tested. Thus, the maximum capacity of the trap to its job before the trap is damaged or cannot be handled manually with manpower remains unknown. Apart from that, the factors affecting the efficiency of the Eco-trap, e.g., base flow of the river, storm condition, and materials used to develop the trap are not identified in the field testing. The absence of these factors caused the optimum performance of the trap could not be determined.

Since there is a possibility that a removable trash trap could be developed and used as a pre-treatment for river and drainage outlets pollutions, further studies should be conducted to improve the current Eco-trap based on the limitations identified. This is to ensure that the trap can give its full performance and efficiency as a removable tool in removing the floatable waste on water surface

4. Conclusion

From the field testing that was carried out, it can be concluded that the Eco-trap has the ability to become a pre-treatment tool in removing floatable waste on water surface. Nevertheless, there are many challenges and weaknesses discovered during the data collection process. These problems must be addressed and researched further to ensure that the Eco-trap can be used as a removable tool to ease the river and drainage outlets cleaning process that can be used by the public. Finally, the awareness level and waste management practices of the local citizens at the study area should be concerned and improved.

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