

**Physical and Ecological Impacts of Improper Solid Waste Disposal Activities: A Study on a Selected Area of the Mahaweli River**

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**Physical and Ecological impacts of Improper Solid Waste Disposal Activities: A Study on A Selected Area of the Mahaweli River**

M.R.F. Sajida<sup>1</sup> and M.I.M. Kaleel<sup>2</sup>

**ABSTRACT**

*Water is essential for life, yet it is one of the most poorly managed resources globally. Improper solid waste disposal and river water pollution are growing environmental issues in Sri Lanka. The study was conducted based on quantitative and qualitative analysis and aimed to identify the physical and ecological impacts resulting from improper solid waste disposal in the Mahaweli River basin, which stretches from Peradeniya to the Polgolla Dam in the Kandy district. Primary data collection methods, such as direct observation, questionnaires, discussions, and interviews, as well as secondary data sources like divisional secretariat reports, websites, research reports, municipal council records, and books, were employed.*

*The Solvin Method was used for sampling in 22 villages along the riverbanks, with 100 questionnaires distributed randomly. Data analysis was conducted using software like ArcGIS 10.8, Google Earth Pro, OpenStreetMap, and Microsoft Excel 2019. Areas where solid waste was deposited in the river were digitized and photographed. The study identified several critical issues in the area, including flood, drain blockages, challenges in dam implementation, health impacts, variations in water quality, damage to biodiversity, soil degradation, natural beauty deterioration, and plastic pollution.*

*To address these issues, the study proposes management measures to prevent and reduce improper solid waste disposal, techniques for removing solid waste accumulation in the river, and alternative recommendations and guidelines to reduce solid waste in the study area.*

**Keywords:** Mahaweli River, solid waste. Polgolla Dam.

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## Introduction

Although there are many resources in the world, water resources are one of the main ones. A river can be described as a watershed region that stretches from the top of a mountain to the sea (Zahir et al. > 2014). Water is one of the resources that is most improperly managed worldwide, even though it is considered necessary for life (Nadansan, 2002). The globe has seen major change because of human progress and activities; however, despite this, the natural world has suffered greatly from human activity and advancement. This is also a result of the different kinds of waste that are released these days (Sathak, 2019).

In Asian nations, river water contamination is an obvious environmental concern (Abeygunawardhana, 2011). The main factors causing river water pollution and changes in water quality include urbanization, population growth, waste production, physical resource scarcity, a lack of infrastructure needed to carry out final energy activities, and problems in solid waste management.

Solid waste generation and river water pollution are growing environmental problems in Sri Lanka (Mahees et al., 2011). Sri Lanka and other developing countries discharge a lot of solid waste. Without any kind of middleman, solid trash is disposed of in open areas, wetlands, roadside streams, and water bodies. The second-level environmental concerns in Sri Lanka are related to solid waste and its management in urban areas, with improper solid waste management being the main cause of these problems (Ministry of Environment and Natural Resources 1999, UNEP 2001).

The island of Sri Lanka is a country rich in water resources. There are 103 river basins in the country. The Mahaweli River is the longest in Sri Lanka. The waters of the Mahaweli River are mainly polluted by soil erosion, chemical and agricultural pollutants, industrial pollution, and solid waste. Solid waste is one of the major causes of water pollution in Mahaweli. Most of the solid waste is dumped or processed in riverbeds and open spaces (Mahees et al., 2011). It is noteworthy that improper disposal of solid wastes in the Mahaweli River has caused the river to suffer various environmental health problems, and social and economic problems have also arisen.

Based on that, several problems have arisen due to the accumulation of solid waste in the Mahaweli River flowing through the Kandy district in the Central Province of Sri Lanka for many years. This study has assessed the environmental and physical impacts caused by solid waste by defining only the Mahaweli River flowing through the Kandy district and the river flowing from Polgolla Dam to Peradeniya.

What are the environmental and physical impacts in the study area, and from what sources are solid wastes being discharged? What are the reasons for that? What are the suggestions to limit the practice of improper solid waste disposal? It has also been investigated. Since this topic has not been explored in the study area before, this review was also done to fill this gap.

## **Problem of Study**

Due to an increase in population, urbanisation, and a lack of good management practices in the study area, household and industrial wastes indirectly end up in the Mahaweli River basins. As a result, people face physical and environmental impacts, and the following issues were considered in this study.

- Depletion of the riverbed due to the accumulation of solid waste in the river causes flooding.
- Damage to the dam due to the accumulation of solid waste in the dam
- Impact on biodiversity
- Exposure to public health hazards due to improper solid waste management.

## **Aim and Objectives of the study**

### **Primary Objective**

- Identification of physical and ecological impacts in the study area due to improper solid waste disposal activities.

### **Secondary Objective**

- Map the solid waste disposal sites along the river using GIS technology.
- Recommending strategies for resolving and reducing the impacts of disposal impacts in the research area.

## **Methodology**

This study used a *mixed-methods* approach, which combines both quantitative and qualitative data. The study adopted a *descriptive* and *analytical* design, using both primary and secondary data sources. The primary data were collected through Questionnaires, interviews, observations and discussions while the secondary data were obtained from published and unpublished sources, such as books, journals, reports, maps, and satellite images.

The selection of samples was made in proximity to 22 village divisions using the Solvin method, and 100 survey questionnaires were distributed. The collected data were then analysed using tools such as ArcGIS 10.8, Google Earth Pro, Open Street Map, and MS Excel 2019.

## The Study Area

The study area is in the Kandy district, Central Provinces, extending from Polgolla Dam to Peradeniya Bridge, inclusive of the Mahaweli River Basin, for a distance of 13.29 km. The location and extent of the study area are between  $7^{\circ} 19' 19''$  N and  $80^{\circ} 38' 41''$  E and Peradeniya Bridge  $7^{\circ} 15' 51''$  N and  $80^{\circ} 35' 37''$  E. This study area includes 4 Regional Divisions (Pathathumbara, Gangavadakoralai, Yattinuvara, and Harisbathuva), and 293 GN Divisions. About 22 Gramasevaka Divisions are found in the proximal areas along the river. The study area has a total population of 495,188 and the annual rainfall is 1,840 mm. The temperature of the area is  $20-22^{\circ}$  C throughout the year and as such it has a mild and salubrious climate. Services, handicrafts, and agriculture on a small scale are the economic activities of the area.

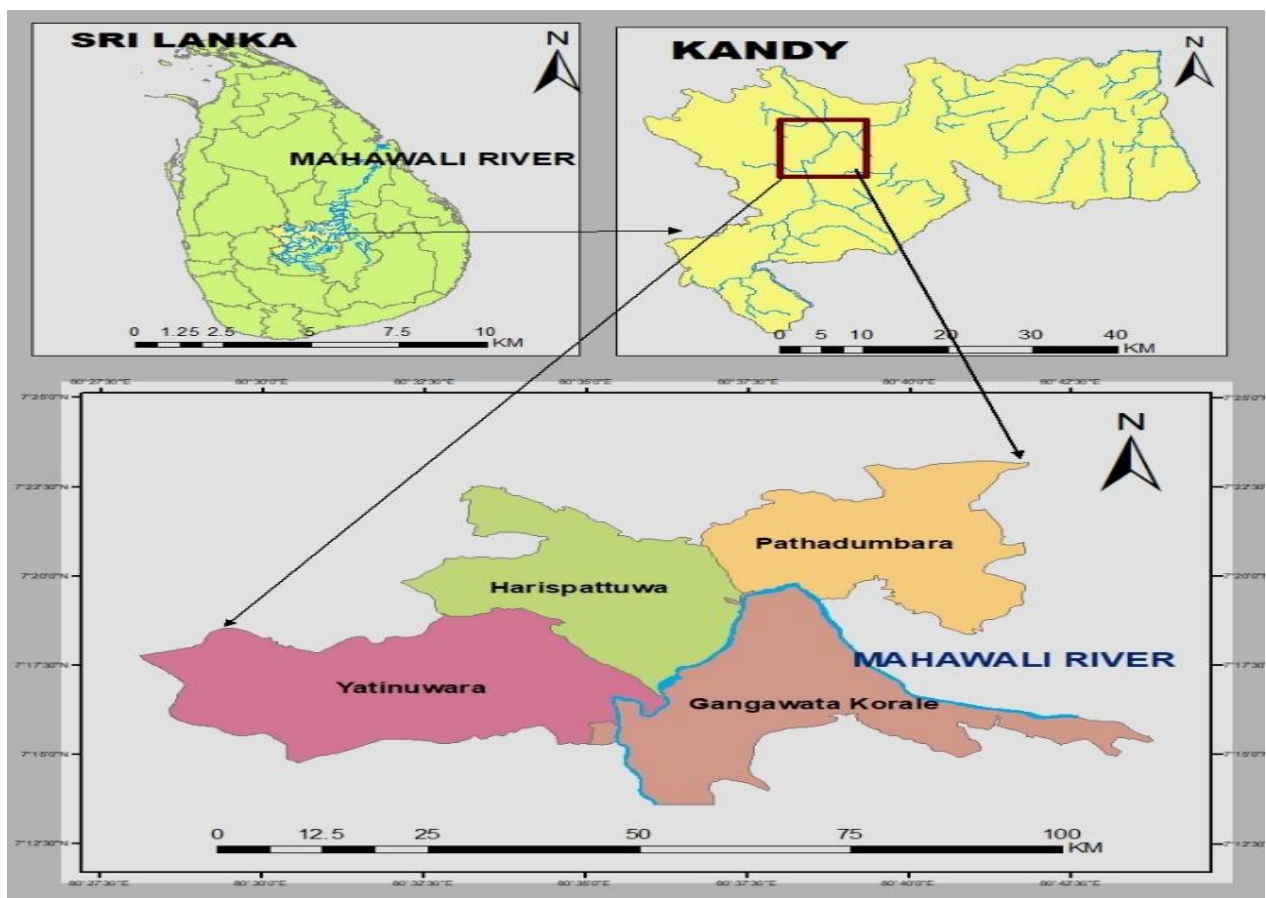


Figure 1: Location of the study area

## Results and Discussion

In the study area, solid waste collection and disposal are under the auspices of service providers MC, PS, and UC. Kandy Metropolitan City (KMC) administers the collection and disposal along the proximal areas of the river basin. In the opinions of the people of the study area, the disposal of soil wastes, the activities of the workers involved in the disposal of solid wastes, and those of the waste-carrying trucks are not satisfactory for 57.6 per cent of the people interviewed, as opposed to 42.4 per cent of them being satisfied (FIGURE 2).

For various reasons, however, the Mahaweli River gets polluted. Anthropogenic causes are the principal causes of pollution. Also, the solid waste land in the river comes from various land sources. The informal waste accumulation in the river, the lack of proper disposal methods, and the lack of unfit technological means of collection and disposal in the KMC have been identified by the city people as a shortcoming of the city administration.

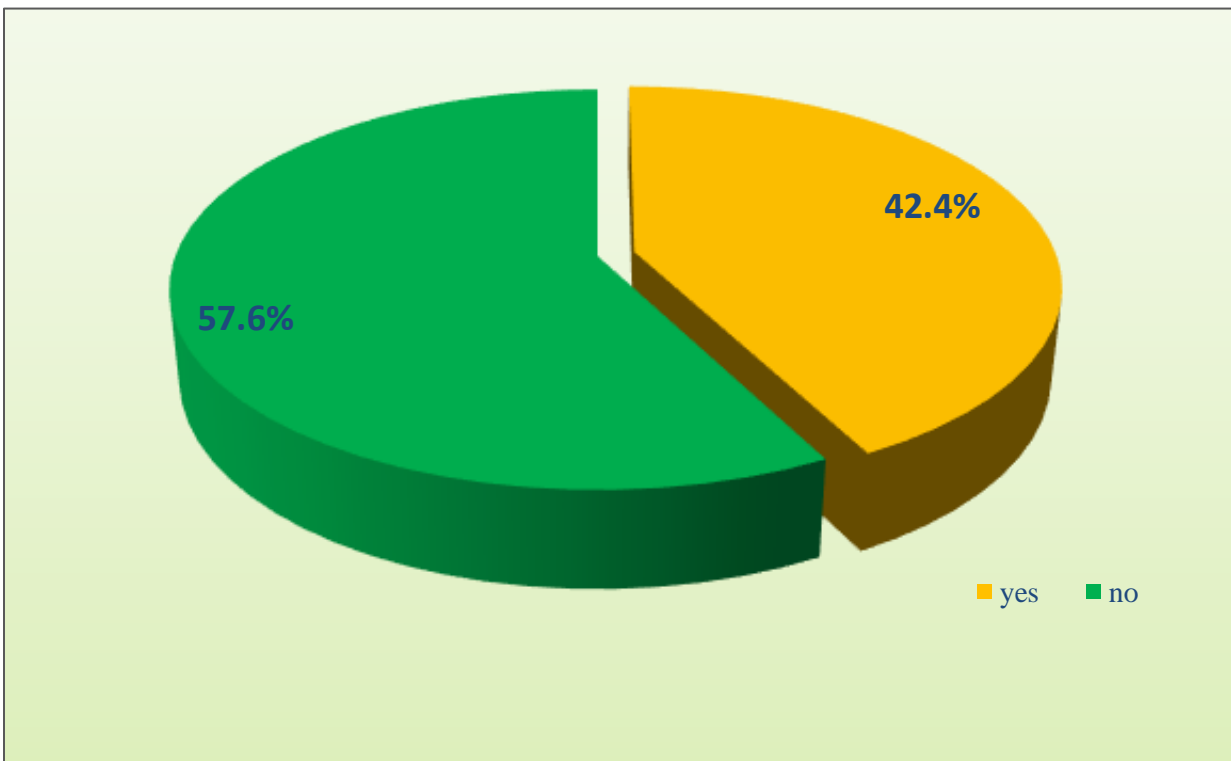


FIGURE 2: Satisfaction with Collection and Disposal of Solid Wastes

According to the views of the people on the impacts of the collection and disposal in the KMC, 32 per cent of them say that there is a lack of awareness among the people, 23 per cent of the interviewed say that the KMC's activities are not proper, and only 16 per cent of them say that there is a lackadaisical attitude among the service personnel (FIGURE 3).

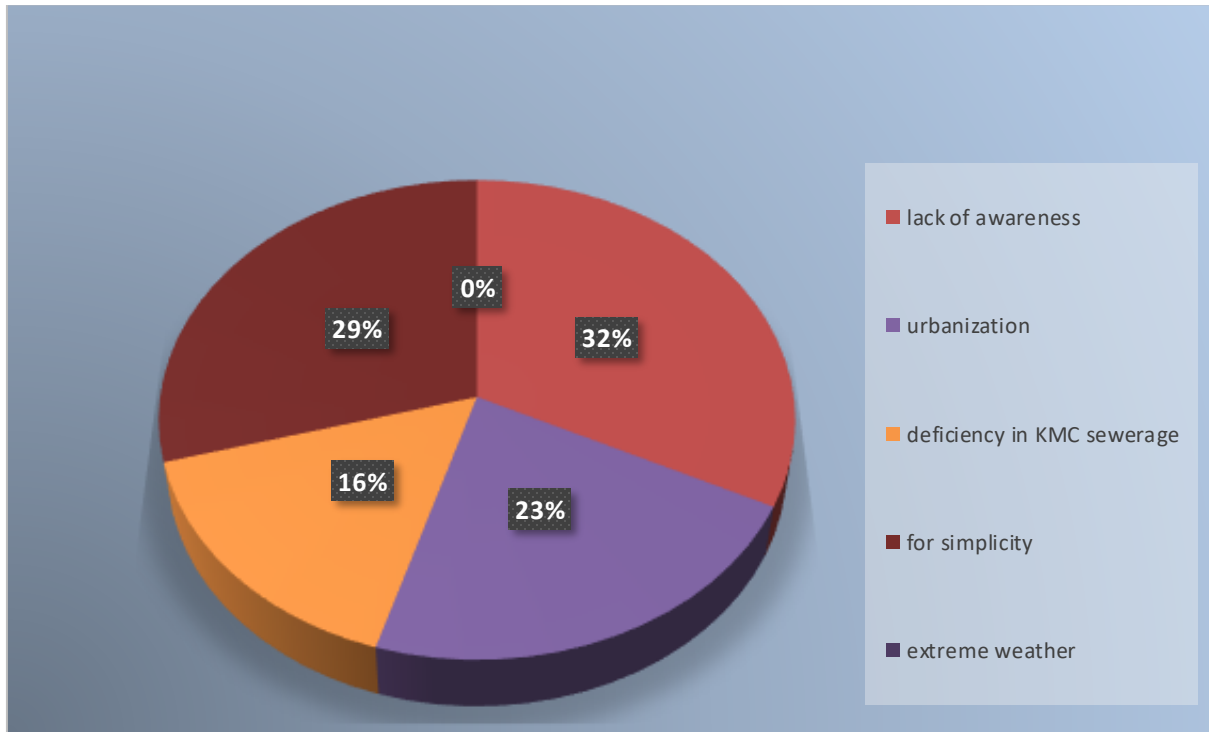
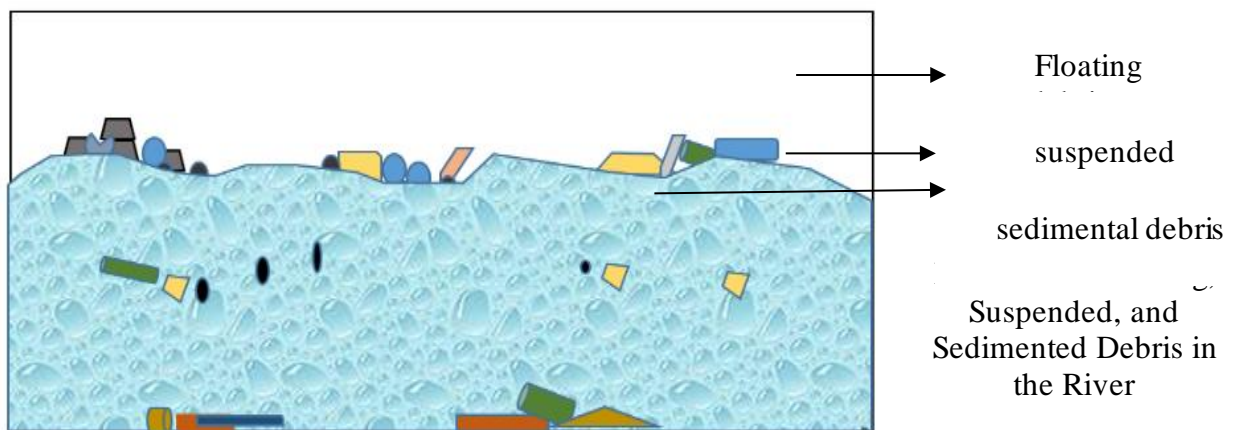


FIGURE 3. Causes of Improper Solid Waste Disposals

Generally, when solid wastes gather in waterbodies, such gatherings happen through three important means. (FIGURE 4). The places along the river where the solid wastes from varying locations reach the study area are shown in FIGURE 5.



In the study area, the Mahaweli River runs for 13.6 km, and along this stretch, there are several places where the solid wastes are found floating, suspended, and sedimented. The examples of locations shown in FIGURE 5 are shown on Google Earth Pro maps embedded as annotated photographs using ArcGIS. Thus, we can identify the spots where debris is found floating in the river channel. We can also see places such as Polgolla, Katugastota, Pinga Oya, Halloluva, Meda ela, Peradeniya, Getamba, and Mavilmada are proximal to the Mahaweli River. As per the

evaluation of the sampled population of the study area, 82 per cent of them account for water pollution, 64 per cent for health hazards, 58 per cent for changes in water quality, and 49 per cent for the drainage basin's structural problems. (FIGURE 6).

### **1. Shallowness of the Riverbed results in Flooding of the Floodplains**

The hilly areas of the study area have given rise to more than 20 floods during the period 2001 - 2022. In the area, the rivers such as Pinka Oya, and Kasavatha cause greater flooding-related damage to the environment. The improper collection and disposal of solid waste in the area thus increases the occurrence of floods. The 260 - 490-meter area in this study area is low-lying and prone to flooding during monsoons. Also, there are high chances of flooding due to improper disposal of solid waste in the water bodies of the study area. The small streams of Pinka Oyo and Pusalu Oyo and other small streams show large amounts of waste and thus cause worry. Solid wastes are transported in large quantities from these streams as well. This causes shallow river beds, facilitating flooding. Thus, the rainy seasons give rise to several floods (FIGURE 7).

Solid waste is discharged into tributaries and canals. Due to this, the depth of the water body decreases and solid wastes are deposited on the side of the stream, the width of the water body also decreases and the path of water flow is blocked. So it causes flooding during the rainy season.



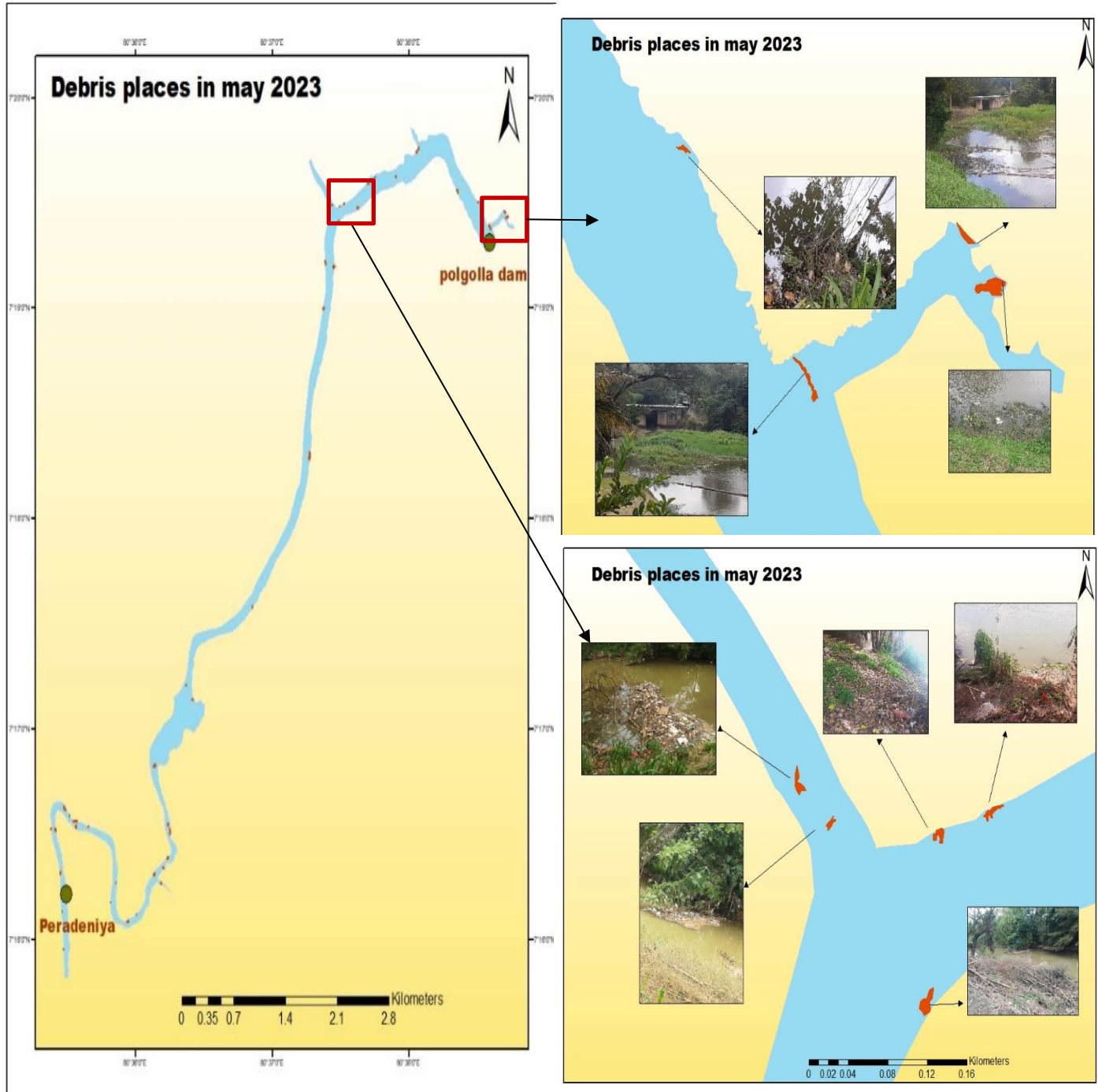


FIGURE 5. Places where debris gathers along the Mahaweli River



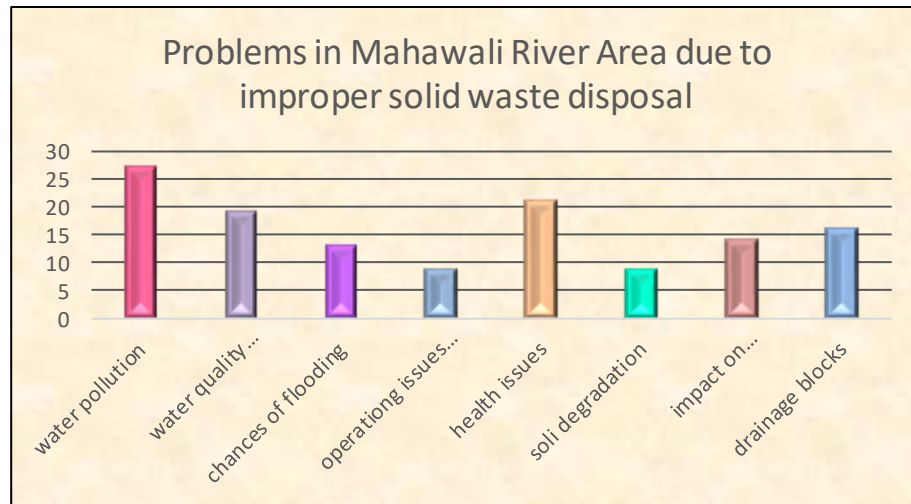


FIGURE 6: Problems are aggravated by the improper disposal of solid wastes



FIGURE 7: Flood-affected areas of the Mahaweli River Basin

## 2. Blocks in the Drainage Basin

Most of the study area's significant water bodies and drainage features are located close to important roadways and towns. Every day, improper disposal of solid waste in these wastes is found. A good example of this is the Meda-Ela Canal in Kandy. This causes drainage issues, which in turn causes monsoon flooding. In the study's area, the Mahaweli River eventually collects all of the waste that is collected in the drains.



Plate 1: Kandy Meda and Kattugas Drainages

## 3. Difficulties in Regulating Polgolla Dam

The smaller streams of the Mahaweli River, such as Pingaoya, Ravanoya, Medela, and others, as well as the homes, businesses, and institutions that surround the riverbanks, are improperly disposing of the solid waste in the river for simplicity, increasing its accumulation. Also, Polkollai Water Reservoir has a jogging track on both sides, which many people improperly use as a recreational area to dispose of their solid waste. Also, these wastes build up more during the rainy season than during the hot season, which clogs the dam blocks and complicates their operation. (Plate 2).



Plate 2: Accumulation of Solid Wastes along the river bed and

### Problems at Polgolla Diversion Areas

Through a tunnel, the water of the Mahaweli is diverted to Ukuwela. At the diversion, there is a heavy load of solid waste, and the tunnel is clogged with waste. There is a gate along the tunnel to block the waste, but during the rainy season, the waste enters and blocks the channel. Details of the waste accumulating in the tunnel, particularly at the Polgolla water intake region, are shown in Figure 8. These are the details of the monthly accumulation of waste collected using tractors. That means how much garbage is collected per day on average.

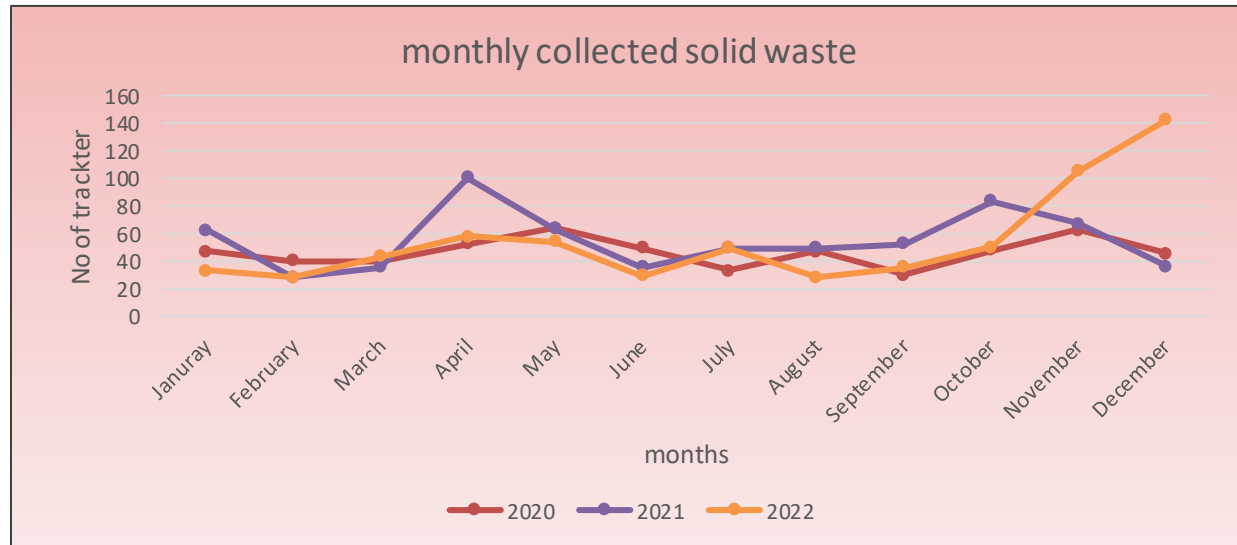


FIGURE 8: Mothly collected solid waste in water intake polgolla

- 1 day - 3 trackter
- 1 trackter = 75kg solid waste (maximum)
- 3 trackter 3 x 75 = 225kg

As per this detailed collection of waste, the increase in waste accumulation goes up, step-by-step. In the year 2022, a great accumulation of waste was noticed in the Mahaweli River stretch of the study area. The details also show a higher accumulation of solid waste in the rainy season than in the dry season.

### 4. Exposure to Health Effects

It was reported after the questionnaire and discussion study that improper solid waste disposal is the reason for the health hazards and effects on the area under investigation. There is a lot of debris in the Mahaweli River in the study area because solid wastes are present everywhere in a stationary state. The prevalence of dengue has been rising among individuals recently. It is the reason for solid waste to accumulate in one place.

FIGURE 9 shows the health impacts of improper disposal of solid waste in the study area, particularly about the prevalence of dengue over the years 2018-2022. It appears that dengue began to show up in good numbers in 2018 and then quickly increased over the next two years, only to dip again in 2021 (154 cases) and then show a sharp increase in 2022 (794 cases).

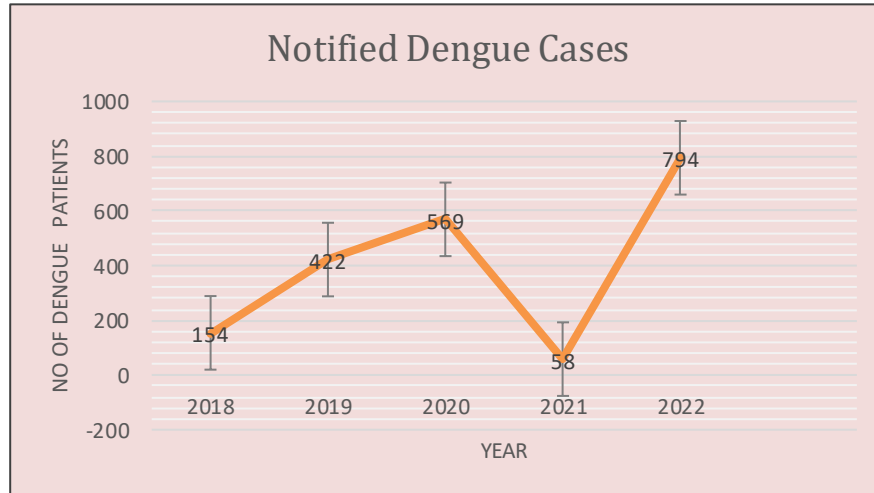


FIGURE 9. Dengue Prevalence in the Study Area 2018-2022

The graph shows the number of dengue cases in Kandy Metropolitan City, Sabah. In the five years of dengue prevalence, 2022 has shown many infections. In 2021, however, the number of dengue patients declined to just 58. In the same part of the study area, COVID-19 has shown infections in large numbers, and as such, there have been lockdowns and serious guidelines for safety. Most people have been confined to their homes, with working people attuned to work from home (WFH). This helped greatly in reducing the incidence of COVID-19. But, even now, there are several incidences, with 90 active cases in June 2023. Thus, the efforts of the government to control the pandemic.

## 5. Impacts on Biodiversity

In the Mahaweli catchment areas, there are diverse plants and animals, representing the diversity of the island's biodiversity. However, the improper disposal and lack of a scientific approach to it have caused them harm, and there has been an ongoing destruction of biodiversity in the area. Plate 4 shows the decay of vegetation on the river banks and part of the floodplains. This has happened mainly because of the uncontrolled reach of the waste into the river and its transport downstream. It is also because of additions to the soil in the area.



The fauna of the waterbodies, that is, the Mahaweli River and its tributaries, is also affected by solid waste, primarily because of dumping waste in them.



Plate 3: Destruction of Flora in the Mahaweli River Floodplains

Plastic waste in water bodies interferes with fish and other animals. Oxygen depletes with increasing waste such as solid and plastic waste, in these waterbodies. BoD also experiences a drop in the demand for oxygen from the water flora and fauna. Over time, the depleting oxygen is unable to meet the demands of the flora and fauna, and thus biodiversity declines.

## 6. Loss of Soil Quality

Soil pollution is another problem created by the improper collection and disposal of solid and plastic waste. Plastic waste causes havoc on animals as they eat it and thus suffer from several animal health issues. Often, death has an imminent impact. With waste disposal, the chemical and physical properties of soils get changed for the worse. This is caused by hazardous waste and its improper disposal. There is thus greater harm to the soil of the area. Some of the wastes have a long half-life, and such wastes keep changing the character of the soils over space and time (Plate 4).



Plate 4: Soil Mining in Navayalatanna and Polgolla area

Also, soil mining is a primary activity of the Mahaweli River. The people interviewed from the study area have said that in the early years, soil and sand mining was practised in the area at approximately 10 loads per boat, but now it has come down to 6 or 7 boatloads. The people said that the soil and sand mined were found to be of lower quality now than ever before. The solid waste makes mining more difficult as well.

## 7. Impact of Plastic Waste

Plastic is a byproduct of crude oil. It is an artificial carbon-based polymer. It is not biodegradable. It takes a long time to degrade and, over time becomes disintegrated into micro- and nanoplastic particles. Nanoplastic particles are very much found in drinking and domestic water as well. Plastic pollution has thus a widespread impact on and severely affects the water environment. This impacts water health, the health of living organisms, food security and quality, human health, tourism, and, of course, climate change. However, about 64 per cent of the interviewed have indicated that they have absolute knowledge about plastic pollution and nanoplastics whereas 36 per cent of them have indicated that they know about their impacts. So, a majority of the public is unaware of the impacts that necessitate creating awareness among them (Plate 5).



Plate 5: Plastic Pollution of the River Waters

The floating plastics frighten the biodiversity and food web of the waters. Chemicals used in making plastics are known to cause cancer and cause trouble for the nervous systems of living organisms. Also, this creates immunity-related problems in humans, the growth of the animals in the forests, the biological growth of the diverse species, and their nervous systems. And, when the water-living organisms eat the floating plastics, the pollutants make changes in their digestive systems, and the resulting accumulation of plastic pollutants disturbs their food web very severely. This is then passed on to those humans who consume fish and other organisms living in fresh and brackish waters; the same problems are transferred to human populations.



## 8. Loss of Natural Beauty

Yet another problem that the improper collection and disposal of solid waste brings about is the loss of natural beauty or disturbance to nature. This is likely to be a disturbance also to tourism development as well. Dumped in the waterbodies, the disposal of waste indiscriminately has severely disturbed the natural beauty. The surroundings of the Mahaweli River offer the urban environment (Kandy, Peradeniya, Plate 6) the best landscape possible. However, the shortcomings of the waste disposal processes impact the physical environment directly as well as indirectly.



Plate 6. Kandy and Peradeniya Cities

## Conclusions and Recommendations

When wastes of whatever kind accumulate and are only partially and improperly disposed of, it creates environmental problems for the area. The Mahaweli Basin is one such area. In the study, both primary and secondary databases have been used to determine the areas of such problems. From the study and analysis of the data, the challenges, and problems that people in the area face have been identified.

However, the requisite strategies for resolving the physical and environmental challenges in the area cannot be completely given. Yet, recommendations to control the situation can be spelt out. The primary shortcomings are essentially the means to stop the accumulation of solid waste, the proper disposal of the waste, and the absence of means to properly manage the solid waste. And so, it is the responsibility of every concerned citizen of the area and the disposal agencies to

adopt the best methods of collection, transport, and disposal of the same in full. To reduce and control, however, the following three means of solid waste management.

- Introduce management strategies to block the current waste disposal practices in the river basin.
- Identify management activities for removing improper waste disposal from the river.
- And strictly follow the proper waste disposal management activities.

### **1. Management activities to block waste disposal in the river**

- Introduce Awareness-creation activities.
- Use social media to advertise the use of improper waste disposal and to create awareness about what is being done.
- place differently coloured waste bins in places where walkers and revellers frequent so that they may separate waste and thus help in waste separation.
- Teach in schools and higher institutions the right kinds of waste disposal methods.
- Legislate bills and laws to control improper solid waste disposal.
- Set up CCTV cameras to monitor the disposal of solid waste in the river.

### **2. Waste Management Measures to remove waste**

- Put up fencing around the banks of the rivers and tributaries to block the disposal of plastic waste, mirrors and glasses, and vegetation waste.
- At the confluence of the main and tributaries, place floating barriers, and floating nets to remove such waste every week (FIGURE 10).

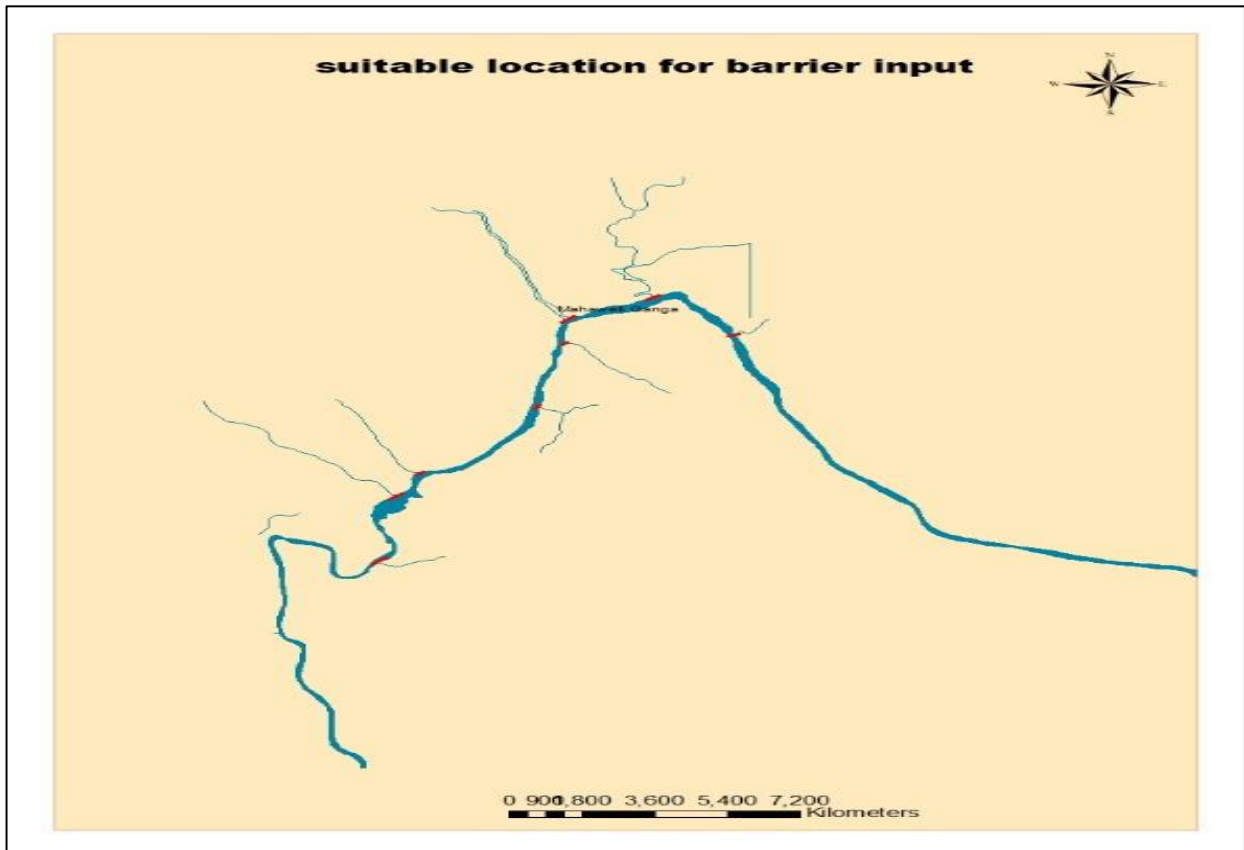


FIGURE 10: Suitable locations for barrier input

- All the 22 Gramasababs in the study area must come together to cooperate with the village officers to perform **Ramadhan** activities. Villagers and private institutions may also be brought together in this effort to accomplish proper waste disposal.
- Use of modern Technological Inputs





Floating barrier  
Interceptor original

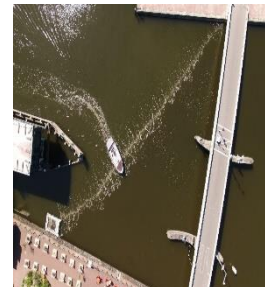
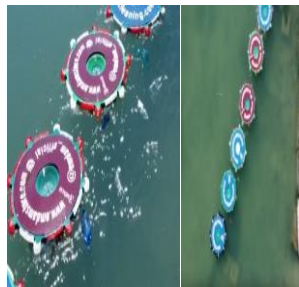
River skimmer  
Water shark

Seabin v5  
River cleaning floating

Trash-wheel  
Bubble Barrier

### 3. Solid Waste Management Strategies

- Implement 5R plans (Reduce, Reuse, Recycle, Recover, Refuse)
- The solid waste that gathers in the river is wet; it may be amenable to fermentation and therefore manure may be produced.
- Sanitary landfills may be adopted.
- Effective solid waste management resources may be procured and provided.



- Creating awareness among people about the proper use of waste containers and bins and making them learn how the waste may be separated and its quality for use.
- Across the country, set up resilient centres. And keep them open. And keep them open.
- When storing the resources, the reusables may be stored as well.
- Give training to those who make handicrafts in a properly instituted training centre.
- When making solid waste management plans and policies, internalise the ideas of the public for effective popular participation.
- Help from external capital and training may be accepted.

Implementing the waste management plan will reduce the amount of solid waste dumped in the waterbodies, and using technologies that are effective in waste disposal and removal will result in the proper use of management activities. Thus, improper disposal of waste could also eliminate impacts on the physical environment of the study area.

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