Evanescing Beauty and Viability of Coastal Beaches of Colombo District.

Sivakumaran Sivaramanan (✉ sivaramanansr@gmail.com)

Central Environmental Authority <https://orcid.org/0000-0002-9904-2977>

Sarath Wimalabandara Kotagama

University of Colombo

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Abstract

According to a weekly beach survey conducted for two months and data analysis done by Clean Coast Index (CCI) method, some beaches in the Colombo district are located in the backyard of suburb residences and become the dumping sites for the adjacent community, such as Moratuwa and Ratmalana. Beaches in Wellawatte, Dehiwala, Bambalapitiya, and Kollupitiya hold trash from mixed sources such as domestic dumping, wastes from commercial activities such as hotels, from running trains and beach visitors, and beaches in Mt.Lavania, Galle face, and Mattakuliya hold similar kind of wastes that are mostly from beach visitors including tourists. Furthermore, wastes from fishing-related activities are abundant in Dehiwala, they are nylon fishing nets, ropes, and polystyrene floats. Besides, PET bottle usage by the fisherman also significantly high. In urban areas such as Kollupitiya, Bamblapitiya, Wellawatte, and Dehiwala most of the wastes are carried by the drainage canals. Mechanized beach grooming is not possible in most of the locations due to the presence of the Southern railway track and the rocks. Thus, to seek sustainable solutions source-level mitigation plans have to be implemented such as source-level waste categorization (already in action), penalties, waste bins in public transport (trains), and billboards in public transport ("Please do not through your garbage outside"), deposit refund scheme (DRS) for plastic bottles, public awareness and stewardship programmes, waste bins at identified locations in the beach, screening floating plastics at canals by sieves and banning of certain types of plastics (e.g. plastic wraps or packaging materials, straws, spoons, yoghurt cups, and styrofoam). Also, it is possible to design regenerative solutions such as provide incentives e.g. offering travel free pass for waste plastic bottles (in Indonesia) and waste to energy projects (Muthurajawela).

Introduction

Sri Lanka is one of the most famous tourist destinations in South Asia. It is also called as "pearl of the Indian Ocean". According to ("Monthly Tourist Arrival Report," 2019) in December last year alone, 253,169 number of tourists arrived here. However, the natural beauty and the heritage of cleanliness are now under threat due to the public garbage. According to ("USAID", n.d.), Sri Lanka has been ranked at 5th place in the list of the world's most ocean debris-producing countries. Ocean debris comprises the slow decaying or accumulated man-made products at the seashore and deep-sea waters. The location of the beach determines the type of debris produced because sources vary from place to place. In general, beach trash management is highly influenced by rapid urban population growth and tourism. It has been stated that three-fourth of the land sourced plastics come from uncontrolled waste or litter whereas the reminder comes from gaps in the collection system itself ("Ocean Conservancy report," 2017). Beach trash comprises the slow decaying or accumulated manmade products at the seashore. According to the estimates of UNEP (2009), coastal based sources are illegal domestic and industrial garbage dumping, tourist resorts, hotels, restaurants, boutiques found along the coastal belt, fishing harbors, fish anchorages, and fish landing sites, urban centers bordering the coast, waste from construction sites and beach visitors (both local and foreign). Also, pedestrians at the canal bridges, polluted canals or sewage and stormwater runoff, coastal railway passengers, playing children, gathering alcoholics or smokers bring a considerable amount of waste to the beach.

Literature review

According to the recent work done by Hettige, Weerasekara, and Azmy (2015), a litter survey was conducted on monthly basis from November 2012 to February 2013 at Kaluwamodara, Kalutara, Panadura, Mount Lavinia, Dehiwala, Wellawatte, and Negombo coastal beaches. A location at the beach (30*20 square meter area) was selected by the random sampling method. Plastics were identified as the highest type of waste in each location such as Kaluwamodara (41.60 %), Kalutara (35.97 %), Wellawatte (40.65 %), Mount Lavinia (35.64%), and Negombo (40.65%) areas respectively. Polythene took second place as 54.59 % of all wastes collected in Panadura and 49.16 % in Dehiwala. In Kaluwamodara about 32.8% of the collected wastes were biodegradables. Besides, certain foreign materials were also observed in Wellawatte and Panadura beaches. They also noticed that accumulated waste was high during high tide season.

According to Campbell et al. (2016) in Tasmania (Australia), about 21.6% of visitors return with injuries due to beach litter, this is about 1.69 kg of debris per beach. A data collection on the distribution of beach litter along the coastline of Cádiz, Spain revealed that a collection of 59 categories of litter were found at 20 beaches (13 mechanically cleaned and 7 non- cleaned) among them cigarette stabs, plastics, and glass fragments were found (Williams, T. *et al.*, 2016).

A study from sandy shores of Italy showed that among 153 samples taken as 2*2 m square plot from April to May 2012 plastic was the most frequent beach litter, among that polystyrene represents 96% of the total amount of beach litter observed. The study also revealed that the presence of woody vegetation decreases the dispersion of beach litter considerably, the main source of the waste

was found in urban areas. The study recommended that identifying the source of beach litter is one of the best strategies for fighting beach litter pollution (Poeta et al., 2015).

Another study revealed that the adverse effect of discarded bottles on beach micro invertebrates, here among 153 discarded plastic bottles 54 contained animals, and among 21 discarded glass bottles 8 contained animals (Poeta et al., 2015). A 25 yearlong study on beach litter surveys of South-Eastern North Sea coast revealed plastic litter ranges between 52-91% of total litter, it was a long period analysis, and surveys at regular intervals of 4 weeks to 5 months gave more reliable results (Schulz et al., 2015). According to Novotny and Schneider (2009), cigarette butts are the number.1 item of beach trash on annual international beach cleanups, it contains cellulose acetate (plastic), they also contain filtered toxic tobacco remaining.

In a survey held in Denmark on the status of marine Litter, about 2146-9137 litter items per 100 m were found on Skagerrak beach, which is followed by Skagen, 193-413 litter items at the North Sea beach Nymindégab and 31-204 litter items per 100 m on the beaches at the Baltic Sea and Roskilde Fjord.

Also, according to the 2015 data, the North Sea and Baltic Sea, Danish beaches showed little higher waste accumulation when comparing with the neighboring countries German, Norway, and Sweden. Among the litter, plastic contributes to about 48-84 % of total beach litter (Strand and Tairova, 2015).

In a study, a 100 m stretches of 13 beaches on the coast of the Turkish provinces Mersin, Hatay, and Adana in the Cilician basin were sampled for macro-litter in April 2014. Litter density was 0.92 ± 0.36 items/m². According to Clean Coast Index (CCI; see methodology part), 3 of the sampled beaches were very clean, 2 were moderate, and 8 were found to be dirty. When analyzing sources, more than half of the litter were from consumer products and related to smoking (buts and cigarette packets), about 6% from agriculture, industrial, fishing, and shipping activities, and 0.5% were of foreign origin (Linder et al., 2014). Data from San Diego beach cleanups in 2015 showed 197,788 items of beach trash weighing 9,825 pounds that were formed along the coastline were removed by 7,360 volunteers. 4.68 trashes per volunteer in Mission Bay in Fiesta Island, among that 43% of the waste collected was plastics ("San Diego," 2010).

A study took place in Geoje Island of South Korea, where remote sensing of plastic piles was used using unmanned aerial vehicles (UAV), a location containing 9.9 m² of litter on the beach was identified, which contained primarily styrofoam buoys and pellets (Jang et al., 2015). According to OSPAR beach monitoring in the Netherlands 2013 annual report, an assessment of beach litter monitoring during 2008-2013 at Veere, Bergen, Terschelling, and Noordwijk depicted an increasing pattern of total litter count in Bergen, Terschelling, and Noordwijk during the survey, and the decreasing pattern was observed only at Veere.

According to the Ocean Conservancy report (2017), countries such as China, Indonesia, the Philippines, Thailand, and Vietnam recently benefited from the improvement in GDP. However, they emit 60% of their plastic waste to the sea. This shows there is an urgent need for a sustainable beach trash management system. A study on the Israeli coast using Clean Coast Index (CCI) showed the actual cleanness of the beach through plastics. Items such as nylon fishing lines, Styrofoam remains, and plastic bags in all sizes, polyurethane sheets, bottles and bottle cap, cigarette box outer cover, etc. are considered in the measurement while ignoring wood and other wastes (Adapted from Alkalay et.al., 2007).

According to (Jang, et al., 2018), in an Islandwide survey, large pieces (>25 mm) of debris were found at the density of 4.1 per square meter, 55% of the beached debris was packaging material, followed by consumer products (25%) and fishing gear (20%), among the debris plastics contributed the largest portion (93%), and the quantity of the debris was greatly influenced by the beach topology.

Methodology

In the coastal beaches of Colombo district in Mattakkuliya, Galle face green, Kollupitiya, Bambalapitiya, Wellawatte, Dehiwala, Mt.Lavaniya, Ratmalana, and Moratuwa, certain GPS locations were chosen randomly, and continuous weekly data collection was made for two months on the same locations (see figure 1 and figure 2). Plastics were categorized based on the type of plastic such as PET bottles - type 1, HDPE (bags and cans) - type 2, PVC (pipes) - type 3, LDPE cans and packaging material - type 4, Polypropylene (containers and lids) - type 5, Polystyrene cups and lunch packs - type 6, and other (toys and other items) - type 7. CCI (Clean Coast Index) measurement was made in transects of 10 m widths, each further divided into 2 m width strips to facilitate the counting of

plastic trash. An area of (10 m x 6 m) was sampled in each selected beach location of the Colombo district. CCI calculation was done using the following formula:

$$\frac{\text{Total plastic parts counted in lines}}{\text{Beach length 10m x beach width 6m}} = \text{Plastic parts/ m}^2$$

0–0.1 parts/m ²	– very clean	– no litter is seen
0.1–0.25 parts/m ²	– clean	– no litter is seen over a large area
0.25–0.5 parts/m ²	– moderate	– a few pieces of litter can be detected
0.5–1 parts/m ²	– dirty	– a lot of waste on the shore
More than 1 part/m ²	– extremely dirty	– most of the shore is covered with plastic debris.

Results And Discussion

Based on the beach survey of weekly records (figure 1) conducted for four months, and the analysis done by Clean Coast Index method, it is visible that most of the wastes generated in the coastline of Colombo district are plastics, more precisely PET (type 1 plastic): bottles, HDPE (type 2 plastic): grocery bags, and Polystyrene/PS (type 6 plastic): cups/ rigifoam/food containers. However, beaches such as Moratuwa and Ratmalana hold mostly polypropylene (type 5 plastic) and HDPE (type 2): where the domestic containers and materials such as broken buckets and toys took major part (see figure 3).

Other (type 7) plastic wrappers and polystyrene cups (type 6) and rigifoams (type 6) are found everywhere regardless of the source. Wastes from smoking-related activities also depicted the same condition. However, wastes from fishing-related activities are abundant in Dehiwala, the wastes include nylon fishing nets, ropes, and polystyrene floats (see figure 4).

However, PET bottle usage by the fisherman also significantly high. It is also noticeable that wastes carried by the drainage canals do accumulate at the beach or brought back by the ocean tides, such observations are remarkable in the urban areas such as Kollupitiya, Bamblapitiya, Wellawatte, and Dehiwala. However, it was difficult to distinctly identify the source and define the route of such wastes as they later scattered and dispersed at the shore by the wave currents. Even a large quantity of waste (such as a pile of plastic bottles) is dumped under the bridges of the canals at Dehiwala and Wellawatte, this shows that most of the wastes are cast by the pedestrians of the Marine drive (a road) bridges in both locations, this is same for the Galle road bridges of those canals as well. And wastes from sources such as medical and recreation activities are less prominent in all sites.

Unlike advanced countries, the major disadvantage of the waste management system in Sri Lanka is the lack of implementation of strict legislation such as polluter pays law. This has made that any individual can cast waste at any part of the beach without any concern (see figure 5). Thus, the major essential step on the beach trash mitigation could be the effective implementation of such preventive measures; however, it has been realized as a developing country, Sri Lanka has a way ahead to reach that level. When we consider other possible ways of low-cost waste mitigation, obviously, there is a clear need for identification of wastes and their sources; this enables us to find the barriers and success factors affecting sustainable beach trash management in the Colombo district. However, recently implemented source-level categorization of municipal wastes and ban on the plastic bag, polythene tissues, and polystyrene food containers may expect to give positive changes in the abundance of beach trash. Also, existing routine daily municipal beach grooming in certain locations such as Galle face green (stretches for a half km along coastal belt), Crow Island Beach Park, and Mt. Lavana hotel beach is considerably effective in maintaining the clean environment. However, it cannot apply to all other regions as it is labour-intensive and require more financial allocation. In this regard, several social and environmental challenges are faced by the local municipal councils on dealing with beach trash in the coastal belt of Colombo (see figure 6).

Mechanized beach grooming is in practice in over 90 countries on six continents. For more than the past 45 years (“Environmental XPRT,” n.d.). However, implementing such machines in Colombo district coastal belt has major drawbacks: except Mattakkuliya to Galle face green coastal belt a long area lined by the coastal railway line which is relatively elevated from the land, due to this reason it is not possible to move the grooming tractor across the rail track to reach the beach, furthermore, in most of the areas rock fence meets the water level without a sandy beach or with a very narrow gap that are seasonally inundated by tides, due to this reason using machinery for beach grooming is totally impossible in these locations. Thus, it has been recognized that source-level waste management, banning certain waste category (plastic bag, polystyrene containers, plastic wraps or packets, yoghurt cups, spoons, straws, styrofoam), establishing recycling facilities, placing public garbage bins including waste bins in public transport (trains) and billboards in public transport (“Please do not through your garbage outside”), public awareness and stewardship programmes and ascertain the regular municipal waste monitoring or tracking system in all parts of the country shall provide a vital or **sustainable solution** for the issue. Currently, Islandwide, there are about 8 plastic recycling facilities, 143 compost facilities, and few biogas plants are in operation. However, **regenerative solutions** such as waste to energy facility as in Sweden and Muththurajawela- Sri Lanka, and swap plastic bottles for bus tickets as in Indonesia can be implemented as an intelligent way of handling this issue.

Conclusion

To sum up, there is a need to take proper mitigation to stop domestic dumping at beaches in areas of Colombo district such as Ratmalana and Moratuwa. Similarly, dumping from hotels has to be banned in Wellawatte and Bambalapitiya area. It is suggested to keep billboards in such open dumping locations to enhance public awareness or implementing penalties on polluters. It is also suggested to keep stickers mentioning “do not throw your garbage away” in trains and other public transports or introduce waste bins in the trains.

Fisherman should refrain from using PET bottles as already instructed, and also they should change their attitudes towards handling wastes, and this applies to the rural poor population of the beaches in Ratmalana and Moratuwa. However, to reduce the waste from beach visitors, it is advisable to keep public waste bins in well-identified locations in Dehiwala, Wellawatte, Bambalapitiya, and Kollupitiya where the public frequently gather.

Though waste bins, billboards, and frequent beach cleanups are found in beach locations such as Galle face, Mattakuliya, and Mt.Lavaniya, lack of strict rules and penalty systems fail to stop the beach visitors from polluting the environment. In general, in urban areas such as beaches in Colombo (Mattakuliya to Dehiwala) public gather during the evening (usually from 5 p.m.) and till night time (usually till 10 p.m.) thus, it is advisable to use the support of the environmental police division or special staffs from relevant municipal council to monitor and collect the penalty from the offenders only during that time. Also, the impact of tourism on the beach trash is negligible, except for PET bottles, beer cans, and some smoking related wastes there is nothing much to blame, hence, most of such wastes are produced by locals. Furthermore, the presence of beach restaurants is quite beneficial here, as the restaurant staff does maintain the beach sand clean to attract tourists and ameliorate their business. Besides, interestingly, now certain youth movements are actively involved in self-funded beach cleanup programmes at selected locations in the beaches of Colombo. However, after the recent polythene and Styrofoam ban (implemented from 1st of September 2017) in Sri Lanka, these two items are not observed in these locations, but PET bottles and all other kinds of trash are mentioned here are persist (based on recent observations in January 2018). Thus, it is recommended that Colombo Municipal Council, Dehiwala - Mt.Lavania municipality, and Moratuwa municipal council of Colombo district should get appropriate steps to bring the beach trash issue to an end by considering the solutions discussed in this paper. It is also visible that ban on PET bottles, polypropylene straws, polystyrene cups, and polythene wrappers or packaging materials and styrofoam is not too far in the calendar because the biodegradable alternative to these items e.g. cellulose-based ice cream or yogurt cups, paper straws, paper shock absorbents and paper packeting, or methods such as deposit refund schemes (DRS) for PET bottles and electronic wastes are already existed or being discussed in countries such as Japan and the United Kingdom respectively. Also, from the school level, public awareness and stewardship programmes to be designed and implemented.

Also, as a country, Sri Lanka’s status and reputation are, more importantly, determined by its cleanness. Sectors such as tourism, financial strength, public health (including mitigation of vector-borne diseases), disaster prevention (flooding caused due to blockage of the drainage system by wastes), and education all depend on a clean environment. A clean environment also gives a positive attitude to a human being as well as providing a glorious aesthetic environment. Thus, it is time to focus on **regenerative solutions**

such as waste to energy projects (e.g. Sweden, Japan, and Muththuragawela- Sri Lanka), and incentives e.g. swap plastic bottles for a bus ticket (e.g. Indonesia).

Abbreviations

CCI: Clean Coast Index, PET: Polyethylene terephthalate, HDPE, High Density Poly Ethylene, LDPE: Low Density Poly Ethylene, PE: Polyethylene, PVC: Polyvinyl chloride, PS: Polystyrene

Declarations

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-Ethics approval and consent to participate: Not applicable

-Consent for publication: Not applicable

-Availability of data and material: uploaded separately

-Competing interests: Not applicable

-Funding: Not Applicable

-Authors' contributions

Dr. S. Sivaramanan: I conducted a beach survey in the coastal belt of Colombo district. I took photo and identify the type of plastics and quantity in the trash of every 10m length of the beach in all sites.

Prof. S.W. Kotagama: Professor guided and supervised the study. He played a major role as time to time discussed with the researcher (Dr. S. Sivaramanan) and suggested ways for improvements, professor also proof read and ameliorated the entire thesis document at the end of the study. Many grammatical and theoretical errors were corrected by him before the acceptance.

All authors have read and approved the manuscript, and we ensured that this is the case.

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Figures

	Plastics							paper		Glass		Metal		Rubber	Cloth/t/wood	Construction										
	PET(1)	HDPE(2)	PVC(3)	LDPE(4)	PP(5)	Polystyrene(6)	other(7)	paper	cardboa	white	colour	scrap	tin & cans				Latitude	Longitude	Altitude	No. of pla	Dp	CCI	Cleaness			
25.03.2017		shoppin	Cans/caps																							
Wellawatte	4	5	1	0	0	12	3	10	0	0	0	0	0	0	1	1	6.8701964	79.858291	3	25	0.41667	8.33333	Moderate			
Bambalapitiya	11	9	1	2	3	0	46	2	9	1	1	0	4	7	2	0	>100	6.8839594	79.855116	10	74	1.23333	24.6667	Extremely dirty		
Kollupitiya	5	17	0	0	2	0	5	0	7	0	1	0	3	0	4	2	0	6.9081254	79.848975	19	29	0.48333	9.66667	Moderate		
Galleface	1	0	3	0	0	8	15	15	6	0	0	0	0	0	0	0	0	6.9264084	79.843633	46	42	0.7	14	Dirty		
Mattakuliya	1	10	0	0	2	0	7	1	10	0	0	0	0	0	2	0	0	6.9732784	79.868290	0	21	0.35	7	Moderate		
Dehiwala	4	2	2	0	1	1	4	0	0	0	0	0	0	0	0	0	0	6.8557694	79.860613	0	14	0.23333	4.66667	Clean		
Mt.Lavaniya	0	3	4	0	0	1	1	2	0	0	0	0	0	0	0	0	0	6.8381124	79.862993	-4	11	0.18333	3.66667	Clean		
Ratmalana	5	19	8	1	1	12	34	2	15	0	2	0	0	1	3	1	>50	6.8220324	79.864261	5	82	1.36667	27.3333	Extremely dirty		
Moratuwa	14	6	7	0	3	6	8	1	27	0	3	0	0	2	0	1	4	6.7475564	79.889685	-18	45	0.75	15	Dirty		
	Plastics							paper		Glass		Metal		Rubber	Cloth/t/wood	Construction										
	PET(1)	HDPE(2)	PVC(3)	LDPE(4)	PP(5)	Polystyrene(6)	other(7)	paper	cardboa	white	colour	scrap	tin & cans				Latitude	Longitude	Altitude	No. of pla	Dp	CCI	Cleaness			
01.04.2017		shoppin	Cans/caps			Regi+Sp	Cups/spoon																			
Wellawatte	4	13	7	0	0	6	9	10	7	8	0	0	0	3	2	1	1	5	6.8701964	79.858291	3	56	0.93333	18.6667	Dirty	
Bambalapitiya	9	9	11	0	2	8	50	7	8	9	1	3	0	1	4	9	4	>100	6.8839594	79.855116	10	104	1.73333	34.6667	Extremely dirty	
Kollupitiya	0	7	1	0	1	4	3	2	6	6	0	1	0	3	0	1	3	0	6.9081254	79.848975	19	24	0.4	8	Moderate	
Galleface	0	3	6	0	0	5	31	2	9	0	0	1	0	0	0	1	0	0	6.9264084	79.843633	46	56	0.93333	18.6667	Dirty	
Mattakuliya	2	8	4	1	3	10	1	5	4	1	1	0	0	2	0	4	0	0	6.9732784	79.868290	0	38	0.63333	12.6667	Dirty	
Dehiwala	2	4	5	0	0	9	1	4	5	1	0	3	0	0	1	1	0	0	6.8559744	79.860454	0	30	0.5	10	Dirty	
Mt.Lavaniya	0	3	0	0	0	2	2	0	0	1	0	0	0	0	0	1	0	0	6.8381124	79.862993	-4	7	0.11667	2.33333	Clean	
Ratmalana	6	10	13	0	1	13	58	19	12	3	0	1	1	0	1	3	1	>50	6.8220324	79.864261	5	132	2.2	44	Extremely dirty	
Moratuwa	5	9	7	1	2	14	2	8	9	5	0	6	0	0	4	3	0	3	6.7475564	79.889685	-18	57	0.95	19	Dirty	
	Plastics							paper		Glass		Metal		Rubber	Cloth/t/wood	Construction										
	PET(1)	HDPE(2)	PVC(3)	LDPE(4)	PP(5)	Polystyrene(6)	other(7)	paper	cardboa	white	colour	scrap	tin & cans				Latitude	Longitude	Altitude	No. of pla	Dp	CCI	Cleaness			
08.04.2017		shoppin	Cans/caps			Regi+Sp	Cups/spoon																			
Wellawatte	7	14	8	0	1	4	5	14	3	8	0	3	0	0	2	2	0	1	5	6.8701964	79.858291	3	56	0.93333	18.6667	Dirty
Bambalapitiya	13	8	10	1	3	1	56	8	2	5	0	5	0	0	4	7	4	0	>100	6.8839594	79.855116	10	102	1.7	34	Extremely dirty
Kollupitiya	4	15	3	0	3	3	0	5	7	12	0	0	0	1	0	2	3	2	4	6.9081254	79.848975	19	40	0.66667	13.3333	Dirty
Galleface	26	8	28	0	1	21	2	7	31	7	0	0	0	0	1	1	0	0	6.9238224	79.844432	3	124	2.06667	41.3333	Extremely dirty	
Mattakuliya	8	6	7	0	5	13	0	7	36	1	0	4	0	0	0	2	5	0	6.9732784	79.868290	0	82	1.36667	27.3333	Extremely dirty	
Dehiwala	18	13	6	0	1	8	6	7	17	1	0	4	0	0	0	3	0	2	0	6.8559744	79.860454	0	76	1.26667	25.3333	Extremely dirty
Mt.Lavaniya	2	2	2	0	2	4	2	4	4	1	0	0	0	0	1	0	0	0	6.8381124	79.862993	-4	22	0.36667	7.33333	Moderate	
Ratmalana	14	10	15	0	4	15	32	15	19	2	0	0	0	0	3	0	2	>50	6.8220324	79.864261	5	124	2.06667	41.3333	Extremely dirty	
Moratuwa	14	15	3	0	4	17	1	7	11	11	0	4	1	1	2	4	1	6	6.7475564	79.889685	-18	72	1.2	24	Extremely dirty	

Figure 1

Data sheet depicts Clean Coast Index (CCI) of selected beach locations in Colombo district of three weekends

Figure 2
Beach trash evaluation site map in Colombo district

Figure 3
Domestic garbage at Ratmalana - HDPE bag and glass bulb (a) and domestic garbage at Morattuwa - HDPE toilet cleaner can (b), PET bottle (c) and a Polypropylene toy (d) at Galle face and an Other (type 7) plastic wrap (e) and Polypropylene woven sack (f) at Mattakuliya beach (photos taken at beaches on March. 2017)

Figure 4

Waste from fisheries at Dehiwala

Figure 5

The beach visitor: (a) leave the plastic water bottle and left the beach: (b)

Figure 6

Garbage collection bin at Mt. Lavana beach: (a) and Galle face: (b) A billboard from tourist board at Mt. Lavana beach: (c)

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Qualitative15.4.20171.xlsx](#)