



SACEP
South Asia Co-operative
Environment Programme



Marine Litter in South Asian Seas (SAS) Region

Development of Regional Action Plan on Marine Litter
Country Report- Sri Lanka



United Nations Environment Program
South Asian Environment Cooperative and South Asian seas programme
Marine Environment Protection Authority (Ministry of Mahaweli Development and Environment)



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MARINE LITTER IN THE SOUTH ASIAN SEAS (SAS) REGION
Development of Regional Action Plan on Marine Litter

COUNTRY REPORT- SRI LANKA
STATUS OF MARINE LITTER MANAGEMENT IN
SRI LANKA

A J M GUNASEKRA, MANAGER OPERATIONS
MARINE ENVIRONMENT PROTECTION AUTHORITY
SRI LANKA

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FOREWARD

Marine litter is an environmental problem on a global scale adversely impacting marine ecosystem, human health and the socio-economy of the coastal dwellers. It contaminates oceans from the poles to the equator, and from the sea surface and shoreline to the very deep bottoms of the ocean. It has been estimated that 8 million metric tons of plastic enter into the ocean each year. There is no exception to Sri Lanka as a coastal state that this issue becomes a significant issue to its marine environment. Solid litter, enter into the coastal and marine environment persist there for many decades and sometimes centuries cause prolonged, chronic and irreversible damages to ecosystem function.

The initiatives have already been taken internationally to address the marine litter issue. UN Clean Seas campaign has already been launched on 23 February 2017 during the World Ocean Summit in Bali, Indonesia. Member states were requested to announce their new commitment on action on marine litter. Under Paragraph 11 of the resolution 2/11, the Executive Director of UN Environment requested to provide assistance to the development of national or regional measures and action plans to address marine litter at national and regional level. Considering importance of developing national, regional policy/action plan and appropriate programmes and measures to reduce volume of marine litter and stop litter entering the marine environment in the South Asian regional countries, South Asia Co-operative Environmental Programme (SACEP) with the support of UN Environment initiated a programme to strengthen capacity and develop a database for marine litter management in the SAS region through the preparation of Regional Action Plan on the management of marine Litter. As the initial step of this programme, this national status report was formulated with the assistance of South Asian Environment Cooperative Program and UN Environment.

This report aims at highlighting the present status of marine litter management in Sri Lanka and identifies gaps and challenges of management of marine litter and recommended required strategies, actions and ways forward to manage marine litter in Sri Lanka and is primarily based on the information collated from appropriate national agencies and available national and international publications.

I am confident that this report is the first preliminary report on the National Marine Litter in Sri Lanka and provided useful information on the present status of marine litter issue and management strategies. Proposed strategies, actions and policy changes to combat the marine litter issue in Sri Lanka are also discussed in this report. I hope that this report will be a stronger platform for regional institutes to prepare a regional mechanism to tackle, marine litter issue at regional level leading a way to eliminate this problem internationally.

Anura Dissanayake

Secretary

Ministry of Mahaweli Development and Environment

EXECUTIVE SUMMARY

As an Island nation Sri Lanka located at the Indian Ocean is blessed with an abundance of natural assets. These beautiful ecosystems support many endemic species and are ringed by coral reefs and mangrove forests which provide food and shelter for marine life as well as food and livelihoods for humans. Sri Lanka faces several challenges related to the environment management. These challenges include poorly developed waste management infrastructure, vulnerability to extreme weather events, and the location of the majority of their populations and industries within the coastal region of the ocean.

Vital economic sectors such as tourism, fisheries and transportation are highly dependent on these vulnerable coastal ecosystems. Unfortunately, the ecosystems that underpin the economic stability of the country is being severely degraded by anthropogenic impacts resulting in loss of biodiversity and loss of natural habitats such as corals and mangroves. In order to achieve greater economic growth in these key areas, it is vital to prioritize protection of coastal and marine ecosystem. They must be made an integral focus of all aspects of government policy, business, trade and conservation and a valued driver of economic growth.

Marine litter /solid waste management is becoming a significant issue in Sri Lanka as other developing countries. Marine litter is significantly contributing to marine pollution; many types of marine litter enter into the coastal and marine environment persist for many decades and volumes are accumulating and causing particularly damages ecological, economic, recreational and aesthetic values of coastal and marine ecosystems of the country.

Member states of the United nations adopted “resolution 2/11 marine litter and microplastics” during the second session of the United Nations Environment Assembly on 27 may 2016 in Nairobi. A global campaign Clean Seas turn the tide on plastic has already been launched on 23 February 2017 during the World Ocean Summit in Bali, Indonesia. Member states were requested to announce their new commitment on action on marine litter. Paragraph 11 of the resolution 2/11 requested the Executive Director of UN Environment to provide assistance in the development of national or regional measures and action plans to address marine litter. The resolution also recognizes the need for capacity building, knowledge transfer, awareness-raising and partnership to implement the activities.

Considering importance of developing national, regional policy/ action plan and appropriate programmes and measures to reduce volume of litter in the marine environment and stop litter entering the marine environment in the South Asian regional countries, South Asia Cooperative Environment Programme with the support of UN environment initiate the programme to strengthen capacity and develop a database for marine litter management in the SAS region through the preparation of Regional Action Plan on marine litter. As the initial step of this programme a national status report on marine litters should be prepared by each country in the region.

The objectives of this national status of the marine report is to collate existing information about marine litter in Sri Lanka and recommend required strategies/ actions to manage marine litter issues in Sri Lanka.

The main findings of the report/ study can be summarized as follows:

- Although some data on marine litter available, it is inconsistent and limited to some areas. The standard methods for marine litter data collection and research are necessary to assess the situation and future trend and the recommend to future strategies and required policy changes.
- Solid waste management of Sri Lanka is becoming one of the burning issues and the due to non-availability adequate solid waste collection and management infrastructure, the large amount solid waste disposes to open dumping yards.
- There are 14 coastal districts in the country, most of the coastal stretch of these districts is heavily used for tourism and fisheries activities and population density of coastal areas of these districts are very high.
- The most of the marine litter in the country originates from land based sources (80 %) rather than sea based sources. Marine litter on beaches of Sri Lankan mainly originated from recreational and tourism related activities while ocean and waterway activities such as fisheries and commercial shipping activities also generates significant amount of marine litter.
- The types of marine litter include plastic and paper bags, plastic beverage bottles, glass beverage bottles, plastic beverage cans, caps and lids, clothing and shoes, eating utensils, cups and plates, plastic food wrappers and containers, pull tabs, 6-pack holders, straws and stirrers, toys, bait containers and packaging, bleach and cleaner bottles, buoys or floats, traps, crates, fishingline, fishing nets, light bulbs or tubes, oil or lube bottles, pallets, plastic sheeting or tarps, rope, strapping bands etc.
- The increase of non-degradable marine litter among marine litter is significant due to change of human consumption pattern.
- Although the impact on marine litter biota of all tropic levels and marine ecosystems is very clear and increasing importance of studying marine litter impact, there is no major studies carrying out in this regard. Therefore the impact of marine litter biota and the marine environment is not known. Marine litter the marine environment also affect a wide range of economic and social impacts and negative environmental impacts, although the understanding of these impacts and in Sri Lanka remains limited. There is not reliable data on the exact cost of the marine litter. However loss tourism and fisheries related revenue due to marine litter is recognized and so far has not been quantified into monetary values.
- The international coastal cleanup program has been conducted by Sri Lanka since 2008 and coastal and marine conservation week has been declared since 2016 and entire

week beach cleanup programme has been conducted with participation of more than ten thousand people every year.

- Solid waste management responsibilities are scattered number of government agencies; however, due to lack of infrastructure facilities less than 50 percent of waste generated is collected and disposed.
- With the change of life style and consumption pattern, use of non-degradable special plastic has been significantly increased in the recent past and the management of waste become a one of the major issues.
- The plastic recycling is mainly done by the private sector of the country, however the infrastructure facilities available is not sufficient and the separate of plastic waste and collection of waste materials for the recycling has become a major barrier for the recycling industry.
- The legal regime is available for the management of waste also scattered among different agencies and still market base mechanism and principal such as polluter pay has not been introduced.
- There is no comprehensive national legal regime to manage marine litter issue and there is not national marine litter management policy.
- The marine litter monitoring program's incoherent manner is absence and, other than simple scale beach litter surveys. There is no monitoring programme of marine impacts on marine flora and fauna in the country, but need have a comprehensive monitoring program to understand the impact.
- Significantly reduce the overall amount of marine litter in the marine environment by 2025 is the set target under the SDG goal 14.
- A good idea and definitely of baseline and target is required in order to introduce necessary measures to management of marine litter.
- Research to improve the monitoring and identify the sources, types, transport patterns of marine litter are required to facilitate management strategies and policies.
- The transboundary movement of marine litter among neighbouring countries is the obvious and regional level management initiatives are required to manage the marine litter in the future.
- Emerging micro plastic issue and its impact has not been studied yet and need to study types of an amount micro plastic in seawater, sediment and seafood and its impact of ecosystem and human health.

- The assessment identified a number of areas need to be addressed and improved in order to understand the challenge and to introduce science base reduction measures with comprehensive policy.
- Despite the knowledge gaps on marine litter mainly related to amount, fate and in the marine and coastal environment and their impacts existing information is sufficient to take immediate action to implement the measures at the regional level on marine litter.
- To achieve the SDG target related marine litter, the proactive and productive actions need to be taken integrating all sectors at local, national and regional levels to minimize the amount of marine litter and minimize the environment, socio-economic and human health impact of marine litter.

ABBREVIATIONS

BOBLEM:	Bay of Bengal Large Marine Ecosystem Management
SACEP:	South Asia Cooperative Environment Program
CC&CRMD:	Coast Conservation & Coastal Resources Management Department
CEA:	Central Environment Authority
LA:	Local Authority
MC:	Municipal Council
CMC:	Colombo Municipal Council
EFL:	Environment Foundation Limited
GNP:	Gross National Products
GPD:	Gross Domestic Product
HDPE:	High Density Polyethylene
ICC:	International Coastal Cleanup
JICA:	Japan International Cooperation Agency
LLAD:	Local Loan and Development Fund
MEPA:	Marine Environment Protection Authority
CCD:	Coast Conservation Department
MOLGPC:	Ministry of Local Government and Provincial Councils
MOMDE:	Ministry of Mahaweli Development and Environment
MoMWD:	Ministry of Megapolis and Western Development
MSW:	Municipal Solid waste
NCSD:	National Council for Sustainable Development
NEA :	National Environment Act
NOAA:	National Oceanographic Atmospheric Agency
NPCPWMP:	National Post Consumer Plastic Waste Management Project
NSWMS:	National Solid Waste Management Support Center
PC:	Polycarbonate

PC:	Provincial Council
PET:	Polythene Terephthalate
PHI:	Public Health Inspector
PP:	Polypropylene
PS:	Polystyrene
PVC:	Polyvinyl chloride
SLILCG:	Sri Lankan Institute of Local Governance
SLLRDC :	Sri Lanka Land Reclamation and Development Corporation
TCP:	Turtles Conservation Project
UC:	Urban Council
UDA:	Urban Development Authority
SWM:	Solid Waste Management
UNDP:	United Nations Development Programme
WMA:	Waste Management Authority

Table of Contents

ACKNOWLEDGEMENTS	ii
EXECUTIVE SUMMARY	v
ABBREVIATIONS	ix
TABLE OF CONTENTS	xi
LIST OF TABLES	xiv
LIST OF FIGURES	Xv
1.0. Introduction.....	01
1.1. General geographical features.....	03
1.2. Maritime zones of Sri Lanka.....	03
1.3. Waste management and marine litter issues in Sri Lanka.....	03
2.0. Marine litter status at national level.....	05
2.1. Origin, typology, pathways and trends.....	05
2.1.1. Origin and sources of marine litter in Sri Lanka.....	05
2.1.2. Typology of marine litter in Sri Lanka.....	11
2.1.3. Amount of marine litter in Sri Lanka beaches.....	15
2.1.4. Microplastic litter	23
3.0. Circulation of marine litter.....	25
3.1. Marine litter circulation in the South Asian Region.....	25
3.2. Land based sectors generation (Micro and Macro).....	26
3.3. Sea based sectors generation (Micro and Macro).....	26
3.4. National, sub-national and local institutions responsible for solid waste..... management	27
3.4.1. Central government agencies.....	27
3.4.2. Local government agencies.....	29

3.4.3. Status and issues of the solid waste management sector.....	31
4.0. The plastic waste recycling capacity of Sri Lanka.....	36
4.1. Laws and regulations related to the solid waste management.....	38
5.0. National impact of marine litter	41
5.1 Social -human health and food safety.....	42
5.2 Economic from ecosystem impacts to the economic consequences, fisheries and aquaculture, tourism, recreation, rafting, surfing etc	43
5.3 Ecological /environment-impact on marine ecosystem and biodiversity.....	44
6.0 Management agencies, policies, strategies and activities taken to minimize the marine litter	48
6.1 Management agencies and their responsibilities.....	48
6.2 Management policies and Strategies and their effectiveness.....	50
6.3 Management activities done for land base, beach base and marine base litter	51
6.4. Target under the agenda 2030 and UN Sustainable Development Goals for marine litter management	52
7.0. National marine litter monitoring program.....	54
7.1 Monitoring.....	
7.2 Baseline and targets in the context of monitoring marine litter in the sea.....	54
8.0. Gaps, research, analysis knowledge needs, and propose as a basis for setting priorities	55
8.1. Inadequate Institutional frameworks and stakeholder involvement.....	55
8.2. Policy and legislation gaps.....	55
8.3. Lack of infrastructures for waste collection, transport and recycle.....	56
8.4. Unavailability national level marine litter monitoring program.....	56
8.5. Education and awareness.....	56
8.6. Strengthen the management and control efforts and financing mechanism.....	57
9.0. Way forward.....	56
9.1. The dispersion of management authorities of marine litter and the absence of inter-agency cooperation between authorities	56

9.2. The absence of scientific survey and statistics for managing marine litter.....	56
9.3. Poor management of wastes flown from land to ocean.....	56
9.4. Limitations to secure the financing for marine litter management.....	56
9.5. International and regional cooperation.....	56
9.6. Recommendations.....	57
10.0. References.....	59

LIST OF TABLES

Table 1: Waste generation rate at provincial level.....	04
Table 2: Sources of Marine litter in Sri Lanka.....	04
Table 3: Classification of marine litter bead on the source as per the ICC data sheets.....	07
Table 4: Estimated amount of marine litter at Negombo lagoon based on the survey result.....	10
Table 5: Types of marine found in beaches of Sri Lanka.....	11
Table 6: Top ten marine litter collected in ICC in Sri Lanka from 2012 to 2014.....	12
Table 7: Top ten marine litter collected in ICC in Sri Lanka from 2015 to 2016.....	13
Table 8: Quantities of marine litter recorded in 22 beaches around Sri Lanka.....	18
Table 9: Summarize data on dumped site and coastal areas from Puttalam to Hambantota.....	19
Table 10: Plastic waste inputs from land into the ocean	21
Table 11: The amount of waste generation in Sri Lanka.....	21
Table 12: Estimated future waste generation rates for the western province (g/person/day)	23
Table 13: The amount of waste water discharge to the sea by long sea outfall.....	24
Table 14: An overview of the role and jurisdiction of each agency is shown below.....	27
Table 15: Provincial and Local government agencies responsible for waste management.....	30
Table 16: Duties and responsibilities of Western province council and Western Province Waste Management Authority.....	30
Table 17: The amount of plastic materials import to Sri Lanka.....	32
Table 18: The National Level Policies and Strategies related Solid Waste Management.....	39
Table 19: Legal Frameworks related to Solid waste management.....	40
Table 20: Ecosystem services impacted by marine litter.....	45
Table 21: SDG targets related to marine litter	51

LIST OF FIGURES

Figure 1: Sri Lanka Bathymetry and Continental shelf.....	01
Figure 2: Sri Lanka Coastal Wave Climate.....	02
Figure 3: Maritime zones of Sri Lanka.....	03
Figure 4: Types and sources of marine litter collected during the ICC program from 2008 To 2013.....	08
Figure 5: Photograph of different marine litter found on the seabed of the Negombo Fishery Harbor.....	09
Figure 6: Photograph of the underwater side scan sonar.....	09
Figure 7: The percentage of marine litter found on the seabed of fishery harbor Negombo by Weight.....	10
Figure 8: Top ten marine litter collected in ICC in Sri Lanka from 2015 to 2016.....	14
Figure 9: School children engaged in beach cleanup during the ICC Programme 2015.....	14
Figure 10: distance ratio of the marine litter (Kg/Km) calculated analyzing the data collected during the 2015 and 2016 ICC program.....	16
Figure 11: Marine litter in 22 beaches around Sri Lanka (surveyed in 2016).....	17
Figure 12: Global map with each country shaded according to the estimated mass of mismanaged plastic waste [millions of metric tons (MT)] generated in 2010 by populations living within 50 km of the coast.....	20
Figure 13: Waste competition of Sri Lanka.....	22
Figure 14: Land based sources of Micro plastics and their pathways.....	24
Figure 15: Plastic Currents, A giant distribution system for marine plastics.....	25
Figure 16: Future trends in plastic import in Sri Lanka.....	33
Figure 17: The future trend of the consumption types of plastics.....	34
Figure 18: Future trends of the types plastic waste generation.....	35
Figure 19: The Future trends of plastic consumption and wasted amount.....	37

Figure 20: The trend of plastic waste amount and recycling capacity.....	38
Figure 21: The amount PET imported and recycled.....	38
Figure 22: Discarded fishing gear contributes to ghost fishing.....	43
Figure 23: Floating marine litter with fouling organisms.....	43
Figure 24: Sensitive marine ecosystems in coastal areas of Sri Lanka.....	47

1.0 Introduction

1.1. General geographical features

Sri Lanka is located in the Indian Ocean, off the southern coast of India, between latitudes 5°55' and 9°51' N, and longitudes 79°41' and 81°53' E. The total land area of Sri Lanka is approximately 65,610 sq km and the coastline is about 1620 Km (BOBLEM, 2012). Although Sri Lanka is located in a separate island in the Indian ocean, Sri Lanka and the southern tip of India stand on the same continental shelf and separated by the Palk Strait, which is shallow area and average depth is 30 m. However the continental shelf ends more sharply in the south and east of Sri Lanka (BOBLEM, 2013). The extent of the continental shelf is approximately 30,000 km², with an average width of 20 km and depth of 20-65 m. The shelf is narrowest (2.8 km) at Kalpitiya in the northwestern coastline, and between Matara and Dondra in the southern coast (6 km). It is widest from beyond Kalpitiya and the Palk Strait (Survey Department, 2007).



Figure 1: Sri Lanka Bathymetry and Continental shelf

Source: (Survey Department, 2007)

Sri Lanka has a tropical climate and annual weather cycle divided into two monsoon periods, the southwest monsoon, from May to August, which brings rain to the southern and western coastal regions and the central hill country. The dry season in these regions is from December to March. The northeast monsoon, from October to January, which brings rain to the north and east of the Island is weaker and shorter-lived than the southwest monsoon (BOBLEM, 2011). Also, there is an inter-monsoon period from October to November, many parts of the country rain and thunderstorms can occur during this period.

The large-scale oceanic currents around Sri Lanka undergo complete seasonal reversals with the changes of monsoon pattern. Currents to the east of the island are strongest during the north-east monsoon (November-March), and follow a gyre which changes from clockwise to anti-clockwise and back again during the course of the year. Currents to the south of the island flow eastwards from May to October and westwards for the remaining part of the year. (De Bruin, Russell , & Bogusch , 1994). In

general the currents off the east coast are stronger than those off the west coast, while those off the southern coast are among the strongest of all, with velocities of around 1 m/Sec (BOBLEM, 2013)

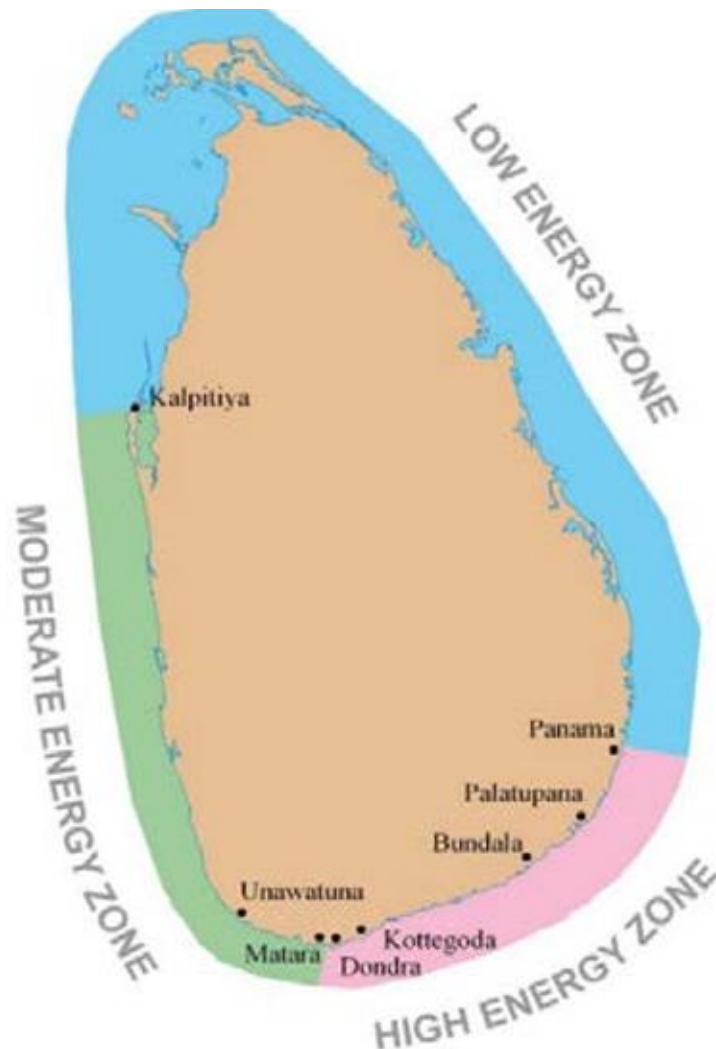


Figure 2: Sri Lanka Coastal Wave Climate
Source: (Survey Department, 2007)

The tidal pattern of the sea around Sri Lanka is micro tidal and mainly semi-diurnal pattern. The rise and fall of the tides is within 0.7 m at spring tides and 0.05 m at neap tides. The highest tidal range is generally around the west coast, while the lowest is around the east coast (BOBLEM, 2013).

1.2 Maritime zones of Sri Lanka

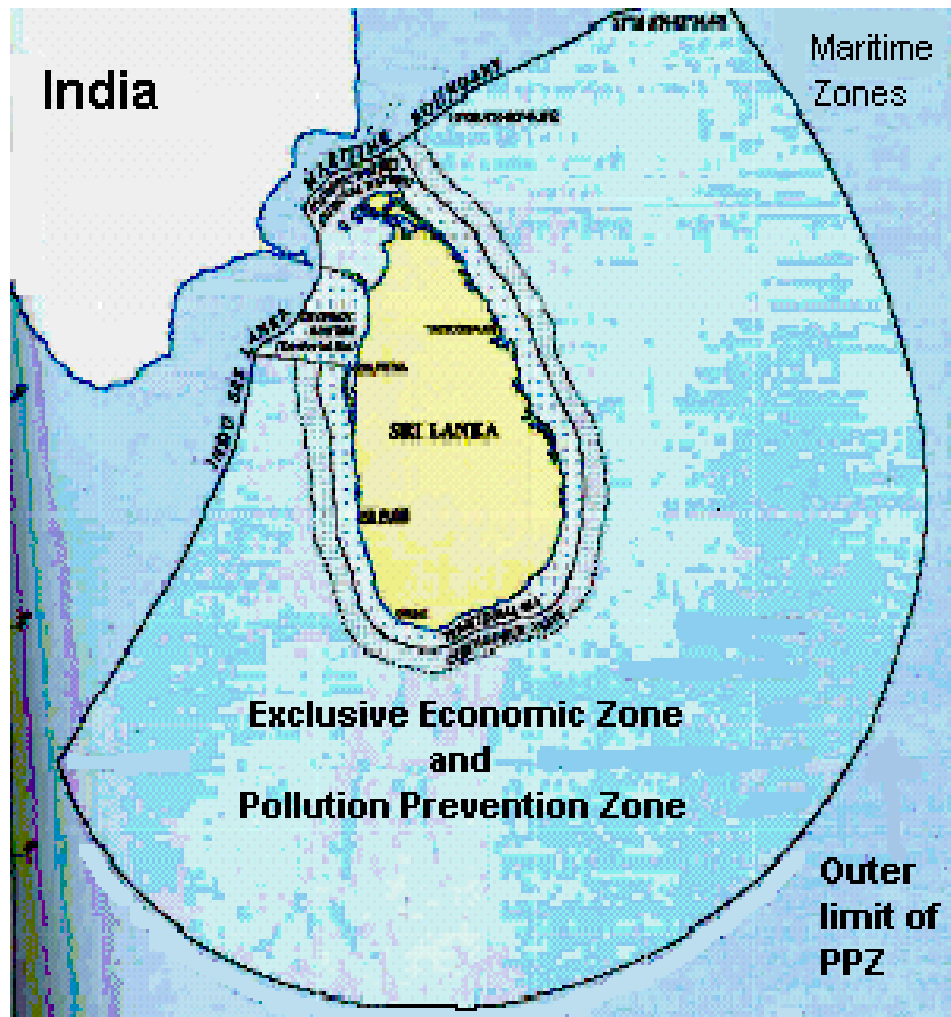


Figure 3: Maritime zones of Sri Lanka

1.3 Waste management and marine litter issues in Sri Lanka

There is no exception that as other developing countries Sri Lanka is facing a waste management issue. The amount of waste generated has been increased significantly with the development of economic status and the population of the country during last two decades (Gunaruwan & Gunasekara, 2016). The urban areas people generate the higher amount of waste than that of the rural areas people. The present urban population of the country is 19.2 percent of the total population (Central Bank of Sri Lanka, 2017). The urban populations are expected to grow from 4 million to 6.5 million in 2030 as the annual rate of change of urbanization is 1.36 percent (Waste Management Authority, 2016).

Present municipal waste generation in Sri Lanka is around 6500 to 7000 Mt/per and per capita waste generation is varying from 0.4 to 1kg per day based the living status and areas of living. Present municipal solid waste collection of the country is 3500 Mt /d. The collection capacity is nearly 50 percent of the total waste generated (Waste Management Authority, 2016). There are nine provinces in

the country and the waste generated is varied in each province while the western province contributes 58 percent of the total waste generated.

Table 1: Waste generation rate at provincial level

Province	Waste generation percentage
Western	58.58
Southern	6.99
Central	8.08
North central	6.00
North Western	2.61
Sabaragamuwa	2.23
Uwa	3.02
Eastern	8.20
Northern	3.29

Source: (Waste Management Authority, 2013)

The other 50 percent is dump or discarded into the nearest environment. As the result of this situation large amount land base waste enters into the coastal and marine areas as marine litter.

Marine litter is defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned into the marine and coastal environment. Marine litter consists of items that have been made or used by people and deliberately discarded into the sea or rivers or on beaches; brought indirectly to the sea by rivers, sewage, storm water or winds; accidentally lost, including material lost at sea in bad weather (fishing gear, cargo); or deliberately left by people on beaches and shores (UNEP, 2005).

Marine Litter has become a one of the major threat to the marine environment of Sri Lanka. The five provinces of the country have coast line and these five provinces population is relatively higher than the other provinces. The 35 percent of the total population is located in the coastal region while 65 percent of organized industries are located in the coastal region. The tourism industry of the country, mainly concentrated in the coastal region. Nearly 80 percent of the tourism related infrastructures are located in the coastal region (CCD, 2004). The fisheries industry is one of the main industry and which mainly rely on the coastal and marine environment.

The marine can be categorized as land base marine litter and sea based marine litter. The land based is contributing more than 90 percent of the litter enter into the marine and coastal areas (MEPA, 2016). The main sources of the litter are varied to place to place based on the uses of coastal areas and

availability of rivers and canals (SACEP, 2007). The main contributor to the marine litter is the land based sources which arrives to coastal areas from rivers and channels.

2. Marine Litter Status at National Level

The marine litter is becoming a one of the major threat to the coastal and marine environment of the country and this section provides details of the national status of the marine litter issue.

2.1 Origin, Typology, pathways and trends

2.1.1. Origin and Sources of Marine Litter in Sri Lanka

Origin of marine litter is traditionally classified into land based or sea based, depending on where the litter enters the water. However the origin of marine litter in Sri Lanka from multiple sources and can be generally classified into three groups; Sea based, inland based, coastal based sources. The type and amount of the litter found in open ocean areas, beaches and underwater areas depend on the several other factors such as ocean current patterns, climate, tides, and proximity to urban centers, waste disposal sites, industrial and recreational areas, shipping lanes, and commercial fishing grounds (UNEP, Marine Litter Assessment in the Mediterranean, 2015)

The marine litter enters into the ocean from various sources travel long distances with wind, waterways and ocean current before being deposited onto a beach or sitting on the bottom of the ocean, sea, lagoon or estuaries due to this reason, identifying the source of the marine litter item is a complex task. It is estimated that more than 80 percent of marine litter originates from land based sources as per global scale (OSPAR UNEP, 2009)

The release of land based litter from coastal waste dumping sites, water transports, recreational beaches, and illegal dumping all contribute to the marine litter problem. Marine litter can be reached indirectly to the sea or beach by rivers, waterways, drains, sewage outlets and storm water outflows, road run-off or can be blown there by winds. Land based sources include tourism and recreational use of the coast, fishery industrial related waste, general public litter or municipal waste, local businesses, industry, harbours and waste dumping sites.

Marine litter entering to the ocean from Sri Lanka can be categorized into three major groups as shown in the table.

Table: 2. Sources of Marine Litter in Sri Lanka

Sea-based Sources	Coastal-based Sources	Inland-based Sources
Merchant ships, Ferries and Cruise liners	Tourist resort and hotels	Discharge of untreated municipal sewage and storm water, including occasional overflows
Fishing Vessels	Restaurants and boutiques along coastal belt	Riverine transport of waste from waste dumping sites, waste dump into illegally to river and waterways
Recreational activities (diving, boating and other water sport)	Domestic households along coastal belt	From indiscriminate dumping sites on marshy land and other low lying wetland areas
Drifting	Harbours, fishery harbours, fish anchorages and fish landing sites Urban centers, boarding the coasts Illegal dumping of domestic waste along the shore	

More than 80 percent of the tourism sector infrastructures are located in the coastal region (CCD, 2004). The most of the small hotel and restaurant do not have a proper waste collection, disposal facilities and they simply discard their waste into the ocean. Fisheries harbours, landing sites is also contributing significantly the marine litter. Boat repairing sites in the coastal areas generate fiberglass, polystyrene and other type of waste and there is no proper mechanism to dispose these wastes in an environmentally friendly manner. Land based sources of pollution can be measured mainly in rivers or storm drains; however, there is temporal heterogenic heterogeneity due to the river flow changes during stream weather events. In Sri Lanka, one study shows that more than 6000 pieces of plastic per day carries to sea by the Kelani river (Ashmy, 2016).

Sri Lanka located in a strategic location in the Indian Ocean in terms of naval and shipping activities. There are 4 major commercial ports and more than 4500 ships arrive in these ports annually (SLPA, 2015). A major international shipping route which connects the west and the east is located through the Sri Lankan waters and more than 250 ships sail through this route per day. The amount of marine litter generates due to the illegal discharge from ships is significant and however there is no research on marine litter enters into the ocean from ships. However surveys carried out by the Marine Environment

Protection Authority shows that foreign marine litter items in coastal areas close to the major shipping route and commercial harbours. As the member country to the MARPOL Convention 1973/78, it is mandatory that commercial harbours should provide adequate port waste reception facilities to ships which arrive in the Sri Lankan ports (MEPA, 2015). Accordingly MEPA provides waste reception facility for ship generated waste, including waste oil and garbage.

Marine Environment Protection Authority has carried out International Coastal cleanup day programme (ICC) since 2008. Marine litter can be classified into other ways based on the International Coastal Cleanup day programme data. The below table indicates the sources of marine litter and their corresponding activities which originate from the ICC's data sheets.

Table 3: Classification of marine litter based on the source as per the ICC data sheets

Shoreline and Recreational Activities
Bags [plastic and paper], balloons, beverage bottles (plastic; 2L or less), beverage bottles [glass], beverage cans, caps and lids, clothing and shoes, eating utensils, cups and plates, food wrappers and containers, pull tabs, 6-pack holders, shotgun shells and wadding, straws and stirrers, toys
Ocean and Waterway Activities
Bait containers and packaging, bleach and cleaner bottles, buoys or floats, traps, crates, fishing line, fishing lures or light sticks, fishing nets, light bulbs or tubes, oil or lube bottles, pallets, plastic sheeting or tarps, rope, strapping bands
Smoking-related Activities
Cigarettes or cigarette filters, lighters, cigar tips, tobacco packaging or wrappers
Dumping Activities
Appliances, batteries, building materials, car or car parts, 55-gallon drums, tires
Medical or Personal Hygiene Activities

The Marine litter data were collected during the International Coastal Cleanup day programme since 2008. The analysis of 2008 to 2013 international coastal cleanup day shows that the shoreline and recreational activities were likely to contribute to over 74.93 percent, while the activities in the ocean and waterways contributed 15.48 percent of all litter items (Gunasekara, et al., 2014). However, this includes only marine litter found on the beaches. The large amount of marine litter can be remained at water column of the sea or sunk into the seabed and remained on the sea bed.

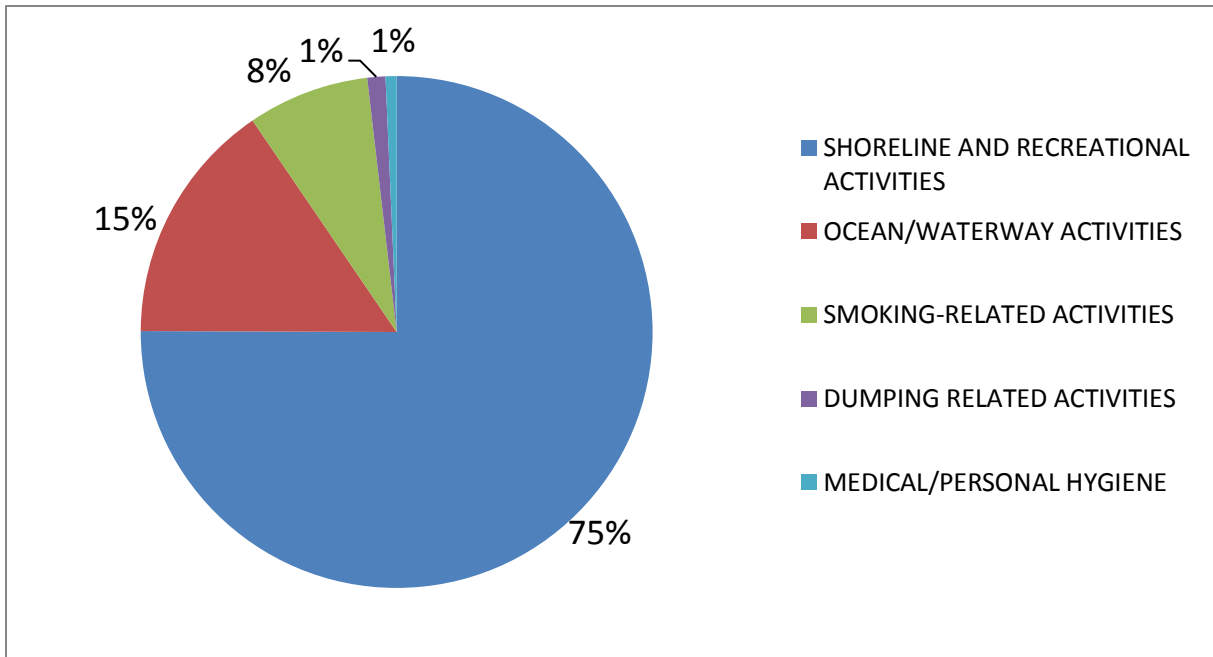


Figure 4: Types and sources of marine litter collected during the ICC programme from 2008 to 2013

Fishing vessels contribute a large portion of marine litter that enters the ocean. There are more than 2000 numbers of multi day boats and more than 15000 other types of boats. Multi day boat carries to sea by the large amount of material and finally the lot of waste material generated on board of the vessel dumped into the ocean. It is estimated that one multi day boards carry more than 50 Kg of waste materials, including, PET Bottle, Polythene bag, and other type wrapping materials and dispose all the materials into the ocean. There are 21 fishery harbours in Sri Lanka and all fishery harbours managed by the Ceylon Fishery Harbour Corporation. All fishery harbours are located very close to the marine and coastal sensitive ecosystem. Ex. Hikkaduwa, Kalpitiya etc. The large amount of litter generated in the fishery harbour and fishery boats anchored in a fishery harbour discarded to a harbour basins.

Marine Environment Protection Authority with the support of the Korea Maritime Institute carried out a Marine Litter Management Project in Sri Lanka. This project carried out surveys to estimate the type and amount of marine litter in the underwater of the Negombo Fishery harbour and adjacent area. The underwater survey carried out using side scan sonar and underwater visual surveys using divers.



Figure 5: photograph of different marine litter found on the seabed of the Negombo Fishery Harbour

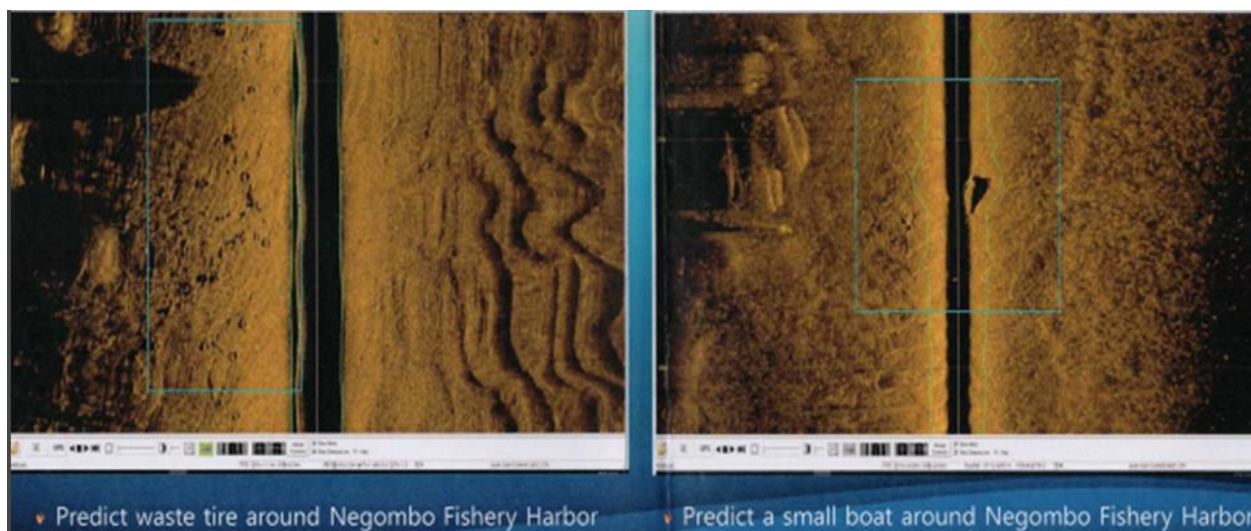


Figure 6: Photograph of the underwater side scan sonar

The estimated amount of marine litter in the Negombo Fishery harbour and adjacent lagoon is shown in below table.

Table 4: Estimated amount of marine litter at Negombo lagoon based on the survey result.

Location	Total Area (ha)	Survey Area (m ²)	Surveyed litter (Kg)	Marine Litter per Unit Area (kg/ha)	Total Marine Litter (ton)	Remarks
Negombo fishery harbor	10.0	100.00	7083	708	7	SSS Survey 2016
	2.4	508	1090	85554	30	Diving, Survey (2017)
	Total					37

Source: (MEPA, 2017)

The total amount of marine litter found on the seabed of the Negombo fishery harbour is 37 tons based on the side scan sonar survey data and the underwater diving survey data. This research also analyzed the type of marine litter in the Negombo fishery harbour. The type mounts of the marine litter in surveying areas given in the below figure.

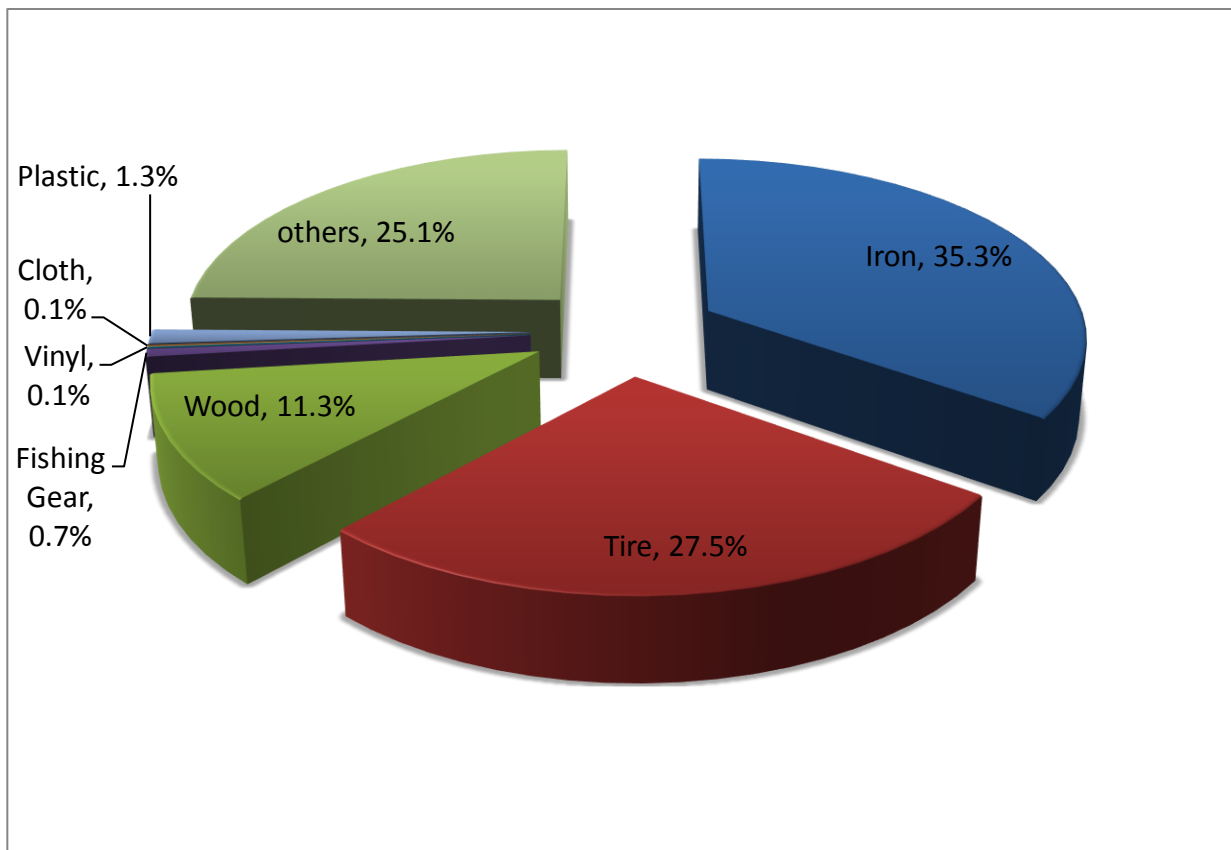


Figure 7: The percentage of marine litter found on the seabed of fishery harbour Negombo by weight
Source: (MEPA, 2017)

2.1.2. Typology of Marine litter in Sri Lanka

Marine litter in Sri Lanka includes a wide variety of substances generated due to land-based, coastal based or sea based activities. The general type of Marine litter observed in Sri Lankan beaches is listed below.

Table 5: Types of marine litter found in Beaches of Sri Lanka

Category of litter	Types of litter
Polythene	Shopping bags, packaging bags, wrappers of soap, butter, toffee, chocolates
Plastics	Bottles, yogurt and ice cream cups, sachet of milk powder, milk, shampoo, hair gel, washing powder, plastic spoons, broken pieces of containers, pieces of plastic sheets, Parts of Plastic story books, torn Rexene covers, tooth paste tubes, medicine tubes, toys, broken plastic buckets, cargo strap bands
Polystyrene	Cups and plates, discarded food packaging boxes, rigid pieces, sponges.

Rubber	Used garden gloves, disposable medical gloves, damaged boots, used tires
Wood	Wastes from construction timbers, pieces of plywood materials, small decayed logs, broken pieces of chairs, tables and other furnishings
Metals	Beverage cans, used perfume aerosol containers, small pieces of scrap metal, old and corroded vehicle parts of various kinds, old car/lorry frames.
Discarded medical and sanitary equipment	Sanitary napkins, tampons, baby and adult diapers, condoms, baby soothers.
Paper and cardboard	Discarded exercise books, parts of school text and story books, packaging boxes of various products like mild food packs, perfume bottles, etc.
Glass	Empty/Broken beer bottles and other liquor (mainly arrack) bottles, medicine bottles, light bulbs and tube lights, discarded / broken jam bottles and cordial bottles.
Tins	Empty canned fish tins, parts of drums from tar and chemical containers, engine oil containers
Fishery sector	Fish offal from landing sites and way side fish markets, discarded and torn fishing nets, fishing boxes, ropes, discarded buoys and other floating devices used in fishing crafts, fiberglass pieces
Tetra packs	Waxed milk carton, fruit juice cartons.
Waste from households	Used torn cloth, hats and caps, cut the garment pieces, pieces of old PVC pipes and connections, parts of toilet cisterns, brooms and brushes, broken slippers, damaged shoes, aluminium cooking utensils, tooth brush, tooth paste containers, perfume and cream containers
Building materials	Discarded / demolished building materials – broken cement blocks and bricks, parts of brick and cement block wall
Pottery/Ceramic	Waxed milk carton/Tetra Pack
Used batteries	Pen torch batteries (AA and AAA size), broken pieces of car battery.
Smoking related	Cigarettes, cigarette fibre, lighters, cigar tips and other tobacco related packaging/wrappers

Source : (SACEP, 2007)

The marine litter data in Sri Lanka were analyzed based on the total number of pieces collected during the ICC program in 2012, 2013, 2014 and 2015. The composition of litter is dominated by food and beverage packaging items. This clearly shows that the behavioral pattern of the public and the attitudes of disposing of their waste.

Table 6: Top ten marine litter collected in ICC in Sri Lanka from 2012 - 2014

No.	Item	Percentage
1	Plastic grocery bag	18.14
2	Plastic beverage bottle	18.05
3	Food wrappers	14.59
4	Straws, Stirers	10.27
5	Plastic bottle caps	8.61
6	Other plastic bags	7.94
7	Glass beverage bottles	7.80
8	Form take away containers	5.05
9	Cigarette butts	4.95
10	Plastic lids	4.56

Source: (MEPA, 2015)

The above table shows that the top ten item collected during the ICC programmes from 2012 -2014. The marine litter collected and categorized during the ICC program from 2012 to 2014 revealed that the most common litter items encountered were pieces of plastic grocery bags and second most common plastic beverage bottles and third common items was food wrappers.

Table 7: Top ten marine litter collected in ICC in Sri Lanka from 2015 and 2016

No.	Item	Percentage
1	Beverage bottles (Plastic)	21.23
2	Grocery bags	18.12
3	Food wrappers	13.17
4	Cigarette Butts	11
5	Beverage Bottles (Glass)	7.92
6	Straws Stirrers	7.12
7	Bottle Caps (Plastic)	6.78

8	Cups and Plate (plastic)	5.86
9	Other plastic bags	5.38
10	Beverage Cans	3.42

Source: (MEPA, 2017)

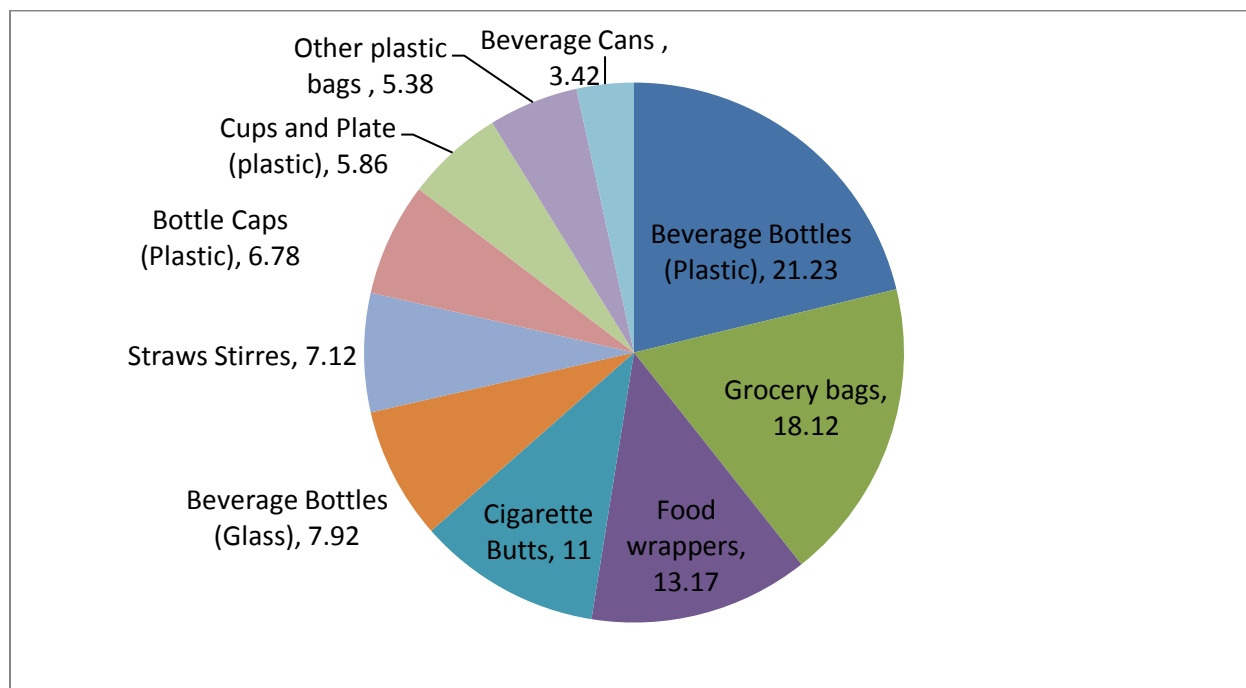


Figure 8. Top ten marine litter collected in ICC in Sri Lanka from 2015 and 2016

Over the years with the increase population and the improvement of living status of the people, production and consumption is increased, the use of different types of materials also increased, especially plastics, where most of the industries produced the short-lived disposable plastic and plastics contained in the packaging. Marine litter collected from this type of activity increased steadily over the period. Also the introduction of plastic beverages can and use of plastic bottle water increases the use plastic bottles and now everywhere in beaches, and waterways discarded plastic bottles can be observed. The waste collection and recycling infrastructure have not been improved in line with increase use of plastic materials. This has become a major issue and most of the plastic materials discarded to land fill or abandoned areas and finally end up with coastal and marine environment. The international coastal cleanup day beach cleanup program data from 2015 and 2016 shows the main type of marine litter collected during the cleanup program. The marine litter collected and categorized during the International coastal cleanup program from 2015 and 2016 revealed that the most common litter items encountered were plastic beverage bottles and second most common item was plastic grocery bags and third most common item was food wrappers.

It is very clear that the number plastic bottle in the marine environment has significantly been increased during the last five year period from 2012 to 2016. Most of the items found in the coastal areas were single time use discarded materials.



Figure 9: School children engaged in beach cleanup during the ICC Programme 2015

2.1.3. Amount of marine litter in Sri Lanka beaches

The amount of marine litter on Sri Lankan beaches has significantly increased during the last decades due to changes in consumption patterns and the change in types of containers and packing materials. The use of plastic packing materials instead of natural and paper has significantly increased. The use of PET bottles in various sectors, including mineral water and beverages, has become one of the major issues. The amount of marine litter found in selected beach stretches (litter distance ratio) varies from province to province. The distance ratio calculated based on the ICC programme data of 2015 and 2016 is indicated in the table below.

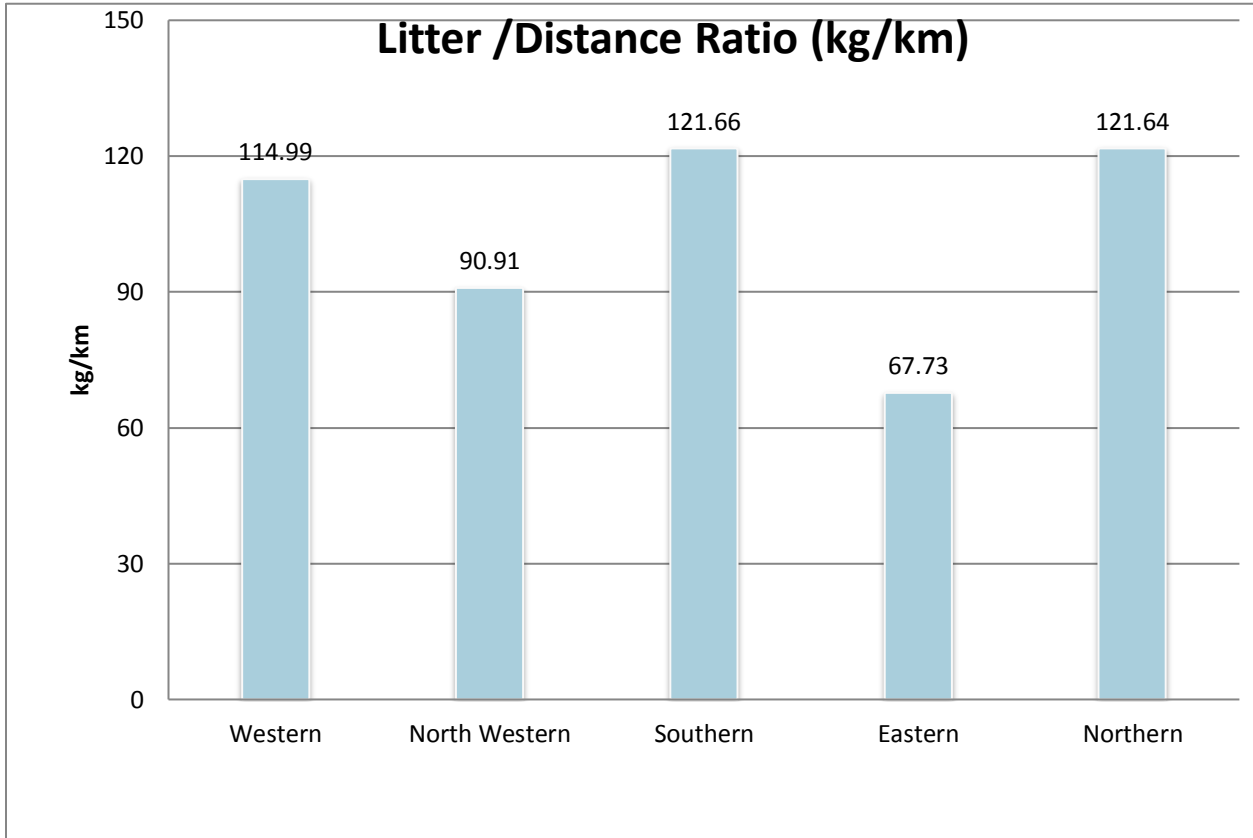


Figure 10: Litter distance ratio of the marine (Kg/Km) calculated analyzing the data collected during the 2015 and 2016 ICC program.

A litter distance ratio data in the above table shows that the lowest ratio is 67.73 Kg/ Km and the highest is recorded in the southern province. This data clearly shows that the marine litter amount in Sri Lankan beaches is very high and the mechanism should be introduced to the regular cleanup beaches and to minimize the marine litter entering into beaches.

The marine litter survey in 22 selected beaches around Sri Lanka was conducted in 2016 under the Capacity Building of Marine Litter Management Project by MEPA with the assistance of the Korean Maritime Institute. The size of marine litter is higher than 25 mm and size of marine litter is between 5-25mm was surveyed and the result of the survey revealed that the amount of marine litter found in the each location is varied and highest number of marine litter in larger size and smaller sizes found Kudawella in the Mathara district (MEPA, 2017).

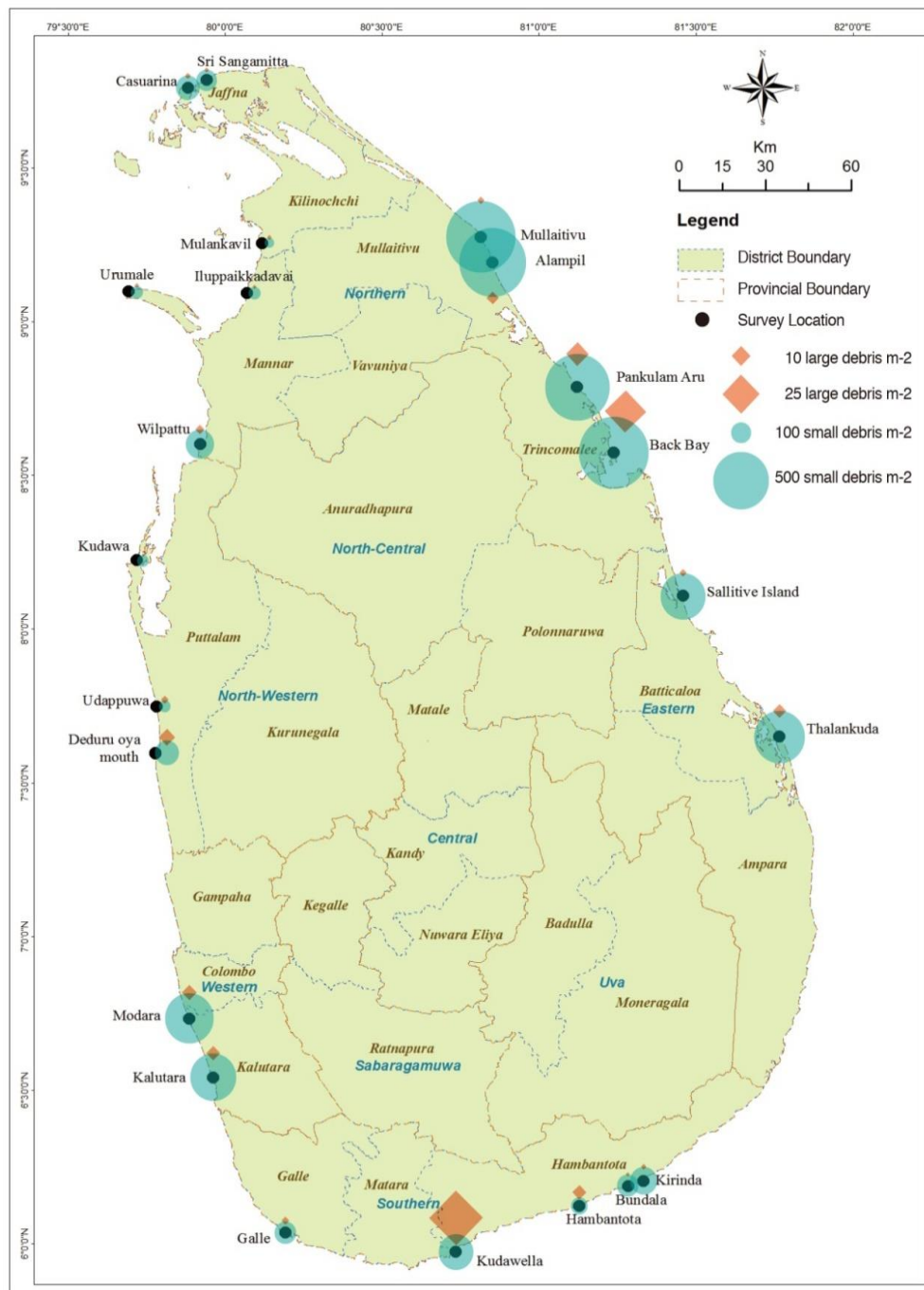


Figure 11: Marine litter in 22 beaches around Sri Lanka (Surveyed in 2016)

Source: (MEPA, 2017)

Table 8: Quantities of marine litter recorded in 22 beaches around Sri Lanka

Province	Beach	Large (>25mm) (per m ²)		Small (5-25mm) (Per m ²)	
		Number	Weight	Number	Weight

			(Gram)		(Gram)
North	1-Deduru Oya	4.2±4.3	142±101	60±42	4.0±4.8
	2-Udappu	0.7±0.2	17±12	12±11	1.8±1.2
West	3-Kudawa	0.1±0.0	5±7	13±23	1.6±2.8
	4-Wilpattu	0.9±0.6	5±2	83±55	1.6±1.0
Northern	5-Urumale	0.3±0.5	29±49	15±19	2.1±2.9
	6-Iluppaikkadavai	0.2±0.2	1±1	15±16	0.1±0.2
	7-Mulankavil	0.3±0.2	14±13	9±8	0.6±0.7
	8-Casuarina	0.4±0.1	2±2	59±32	7.4±7.0
	9-Sri Sangamitta	0.3±0.0	3±2.6	47±5	19.1±13.5
	10-Mullativu	0.5±0.1	5±2.5	505±463	26.8±29.5
Eastern	11-Alampil	1.9±1.3	27±21	460±100	34.4±14.5
	12-Pankulam Aru	6.5±5.0	40±56	419±224	48.7±32
	13-Back Bay	23.2±16.1	721±539	487±242	44.1±24.2
	14-Sallitivu Island	0.6±0.5	6±4	220±97	18.0±9.1
Southern	15-Thalankudah	2.2±0.6	18±5	267±56	36.4±6.5
	16-Kirinda	0.4±0.2	5±6	77±36	24.4±4.6
	17-Bundala	0.2±0.1	1±0	48±33	10.8±8.4
	18-Hambantota	2.5±3.7	8±9	28±17	0.7±0.3
	19-Kudawella	38.8±6.7	2,484±221	124±82	2.6±0.7
Western	20-Galle	0.9±0.5	58±48	48±28	3.6±2.1
	21-Kalutara	2.9±0.5	107±96	223±61	34.9±19.0

	22-Modara	2.7±1.7	159±126	248±56	84.3±32.2
	Average	4.1±9.2	175±538	158±170	18.6±21.6

Source: (MEPA, 2017)

Table 9: summarize data on dumped site and coastal areas from Puttalam to Hambantota

District	No of dump sites	Quantity (m ³)		
		Less than 3	Between 3- 10	Greater than 10
Puttalam	48	20	20	8
Gampaha	27	7	10	10
Colombo	62	18	27	17
Kalutara	48	23	14	11
Galle	75	34	28	13
Matara	28	9	13	6
Hambantota	14	9	5	0

Source: (CCD, 2004)

The above table indicates that the marine and coastal areas of the country are used as dumping ground and finally it can affect the marine environment as well as socio-economic activities and human health.

The most of the coastal areas of Sri Lanka are highly populated and urbanized. More than 65 percent of urban centers and 35 percent of the population lives in coastal areas of the country and due to this the large amount of marine litter enter into the ocean from coastal based sources (CCD, 2004). There are unprotected waste dumping sites in coastal areas and most of the waste dump into the dump sites washed off to sea as marine litter. The study carried out by CRMP project shows that they're more than 300 unprotected dumping sites around the coastal areas of Sri Lanka (CCD, 2004).

The recent international study showed that the estimated amount of plastic litter dumped into the world ocean in 2010 is 4.8 to 12.7 million tons and the average being about 8.8. Million tons (Jamberk, Roland, Cris, Anthony, & Mirriam, 2015).

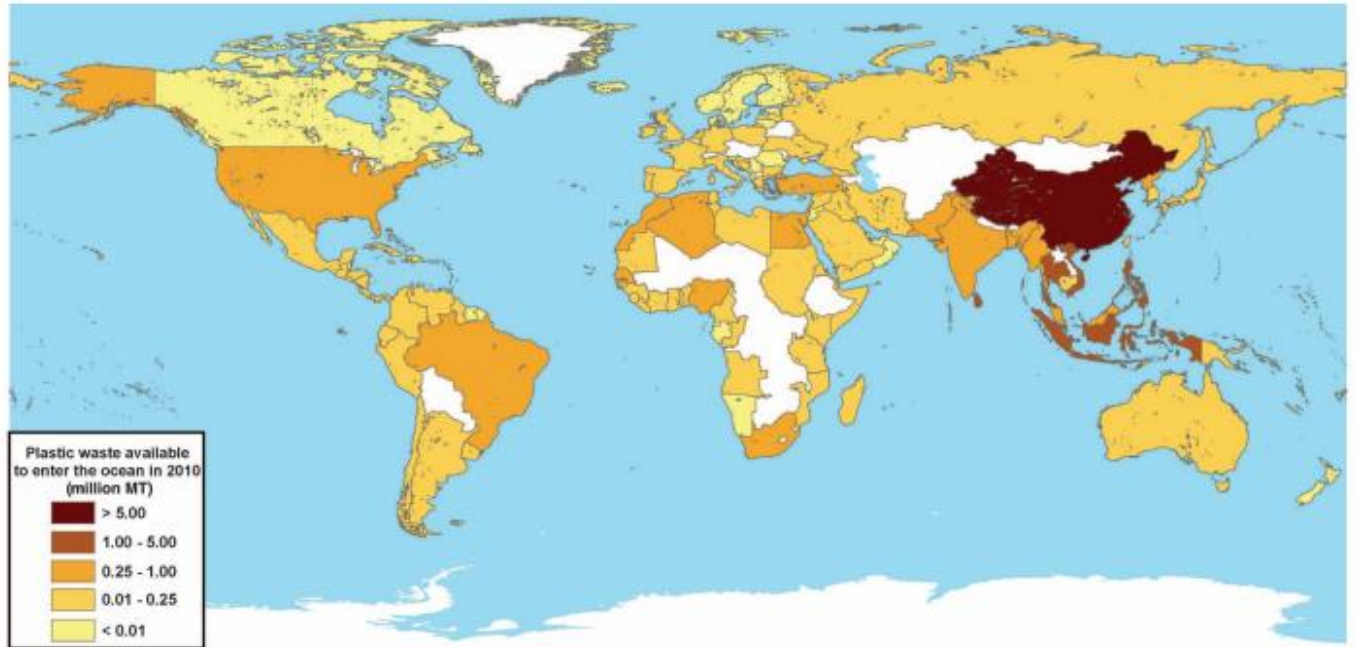


Figure 12: Global map with each country shaded according to the estimated mass of mismanaged plastic waste [millions of metric tons (MT)] generated in 2010 by populations living within 50 km of the coast

Source: (Jamberk, Roland, Cris, Anthony, & Mirriam, 2015)

According to the above report, Sri Lanka is ranked as the 5th largest plastic marine litter generator and this report also estimated that plastic litter enters into the ocean from Sri Lanka is 024-0,64 MMT per year. This paper estimated that the waste generation rate as 5.1 Kg per day. This amount is the highest waste generation in the world.

Table 10: Plastic waste inputs from land into the ocean

Rank	Country	Econ. classif.	Coastal pop. [millions]	Waste gen. rate [kg/ppd]	% plastic waste	% mismanaged waste	Mismanaged plastic waste [MMT/year]	% of total mismanaged plastic waste	Plastic marine debris [MMT/year]
1	China	UMI	262.9	1.10	11	76	8.82	27.7	1.32–3.53
2	Indonesia	LMI	187.2	0.52	11	83	3.22	10.1	0.48–1.29
3	Philippines	LMI	83.4	0.5	15	83	1.88	5.9	0.28–0.75
4	Vietnam	LMI	55.9	0.79	13	88	1.83	5.8	0.28–0.73
5	Sri Lanka	LMI	14.6	5.1	7	84	1.59	5.0	0.24–0.64
6	Thailand	UMI	26.0	1.2	12	75	1.03	3.2	0.15–0.41
7	Egypt	LMI	21.8	1.37	13	69	0.97	3.0	0.15–0.39
8	Malaysia	UMI	22.9	1.52	13	57	0.94	2.9	0.14–0.37
9	Nigeria	LMI	275	0.79	13	83	0.85	2.7	0.13–0.34
10	Bangladesh	LI	70.9	0.43	8	89	0.79	2.5	0.12–0.31
11	South Africa	UMI	12.9	2.0	12	56	0.63	2.0	0.09–0.25
12	India	LMI	187.5	0.34	3	87	0.60	1.9	0.09–0.24
13	Algeria	UMI	16.6	1.2	12	60	0.52	1.6	0.08–0.21
14	Turkey	UMI	34.0	1.77	12	18	0.49	1.5	0.07–0.19
15	Pakistan	LMI	14.6	0.79	13	88	0.48	1.5	0.07–0.19
16	Brazil	UMI	74.7	1.03	16	11	0.47	1.5	0.07–0.19
17	Burma	LI	19.0	0.44	17	89	0.46	1.4	0.07–0.18
18*	Morocco	LMI	17.3	1.46	5	68	0.31	1.0	0.05–0.12
19	North Korea	LI	17.3	0.6	9	90	0.30	1.0	0.05–0.12
20	United States	HIC	112.9	2.58	13	2	0.28	0.9	0.04–0.11

*If considered collectively, coastal European Union countries (23 total) would rank eighteenth on the list

The details of waste generation information about Sri Lanka as per the World Bank Waste Atlas, the per capita waste generation rate are 215.4 kg per year (World Bank, 2013). The details of the waste generation are given in below table.

Table 11: The amount of waste generation in Sri Lanka

Waste Indicator	Value	Units
Generation per capita	215.4	Kg/yr
Municipal waste generation	4 494 139	T/yr
Environmental stress	71.70	T of MSW/km ²

Source: (World Bank, 2013)

Also the waste composition of Sri Lanka is given in the below figure and which shows that the plastic waste amount is 5.9 percent (World Bank, 2013).

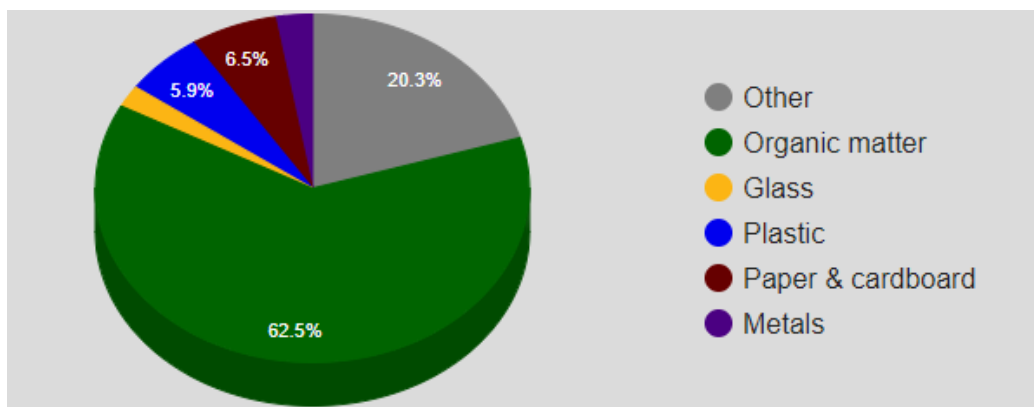


Figure 13 : Waste composition of Sri Lanka

Source: (World Bank, 2013)

As per the above data the per capita waste generation of Sri Lanka is 215.4 kg/yr and the plastic waste amount is 5.9 percent. According to the above information, the per capita waste generation per day is less than 600 g or 0.6 Kg. This clearly shows that the waste generation data and plastic waste input to the ocean from Sri Lanka is much lower than the amount indicated in figure 12.

In addition, the study carried out by the JICA shows that the estimated waste generation rate in western province is much lower than 5.1 Kg per day per person. As stated previously the waste generation rate of western province is much higher than the other province. This further revealed that the waste generation rate of Sri Lanka is less than 1 kg per day per person. Therefore the amount of waste generation and the plastic waste amount enter into the sea is lower than the amount calculated in the above study.

The future waste generation was calculated using the forecast of population growth rate, current waste generation rate and the estimated economic growth rate.

Table 12: Estimated future waste generation rates for the western province (Unit:g /person/day).

District	Colombo	Gampaha	Kalutara	Western
2015	708	480	452	565
2016	719	493	464	577
2017	730	507	477	589
2018	741	521	490	602
2019	753	535	503	615
2020	764	550	517	628
2021	778	565	531	642
2022	791	581	546	657

2023	805	597	561	672
2024	819	613	576	687

Source: (JICA, 2016)

2.1.4. Microplastic litter

There are some amount of data regarding the types and amount of large size marine plastic litter. In addition to that there is growing concern with regards to micro plastic particles.

Microplastics are defined as minute particles of plastic waste, the particle size is smaller than 5mm, and these consist of both plastic matter synthesized to be used as small micro particles and particles formed from the process of weathering and fragmentation of large plastic waste items (Lachmann, et al., 2017). The worldwide research revealed that microplastics in water, sediment, polar ice, and beach sand from the most remote islands in the oceans, as well as in numerous marine species (Lachmann, et al., 2017).

However any data related to microplastic litter in beaches and water column or sediment is not available in Sri Lanka. Based on the origin micro plastics can be categorized into primary and secondary microplastics and sources are given in the below figure.

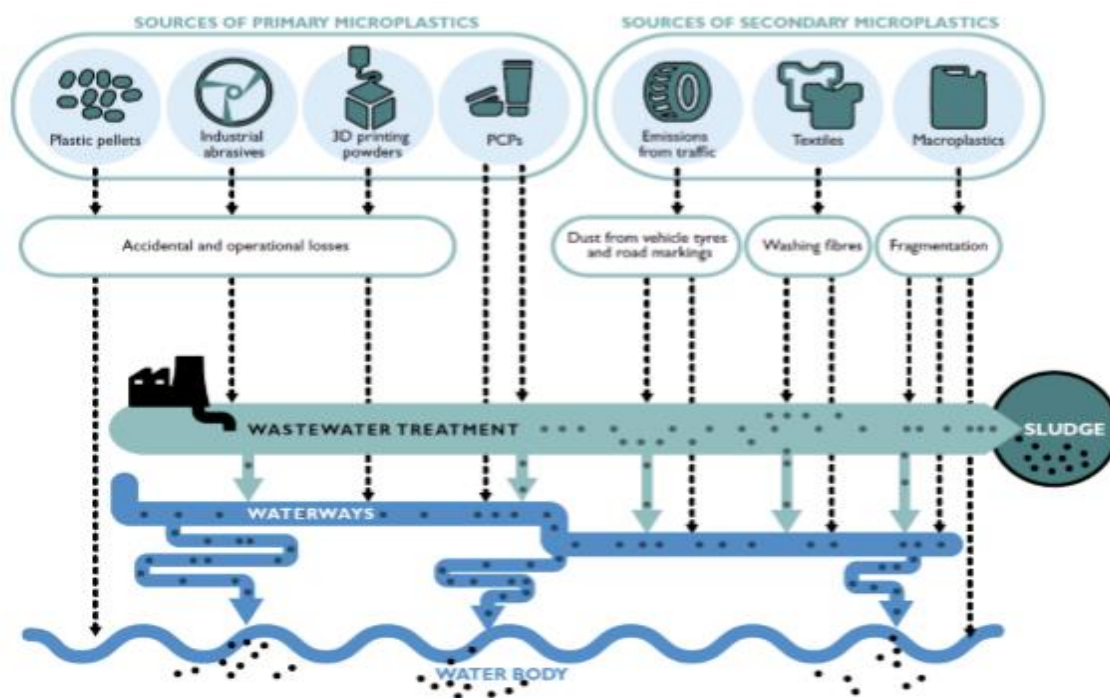


Figure 14: Land based sources of Microplastics and their pathways

Source: (Lachmann, et al., 2017)

There is no data available on micro plastics, however based on the other data available related to the above there can have microplastics in our sea areas and impacts on the microplastic is not known due to no availability of research on this subject.

The waste can carry large marine litter as well as microplastic particles to the sea. Cities around the coastal districts of Sri Lanka discharge almost all waste water into the coastal waters of Sri Lanka. The two large size long sea outfall in Colombo discharge untreated sewage and waste water into the sea and this waste water can carry huge amount of microplastic particles which originated from primary and secondary sources.

Table 13: The amount of waste water discharge to the sea by long sea outfall

Location	Discharge rate(CBM /S)
Wellawawatta long sea outfall	2.2
Mutwall long sea outfall	2.9

Source: (Jayaweera, 2012)

3. Circulation of Marine litter

3.1 Marine litter circulation in the South Asian Region

Marine litter enters into the ocean moving around on the surface of the ocean, in the water column and on the sea floor, sometimes comes to rest. The marine litter geological distribution is strongly influenced by the entry points and the different pathways. However the main factor determined the circulation of marine litter distribution is the density of marine litter coupled with ocean currents, wind and waves (Rech, Macaya-Caquilpan, Rivadeneira, Jofre Madariga, & Thiel, 2014)

Marine litter that is less dense than sea water floats on the sea surface and easily accumulating in the convergent regions. The role of currents in the transport and distribution of marine litter in the ocean may be quite complex and also very difficult to predict. The main large oceanic aggregation patterns (“garbage patches”) are characterized by high density areas of marine litter that are now quite well described and identified (Lebreton, Greer, & Borrero, 2012).

Litter found in a location at any moment in time will be a mixture of locally-derived material plus particles that have been transported by current, wind or wave. More than half of the plastic that gets into the marine environment is less dense than seawater, so until it acquires some ballast (often from the accumulation of organic particles or marine organisms), it floats. Once discarded, plastic can accumulate close to its point of entry into the ocean or it can move long distances, ending up in remote locations far away from its entry point. This, combined with the slow degradation rate of most plastics, means it can drift around the ocean for a long time, becoming a true transboundary pollution problem. Surface dispersion Surface circulation in the ocean is dominated by five large circular currents, called gyres – the North Atlantic, South Atlantic, North Pacific, South Pacific and Indian Ocean gyres. The currents around these gyres are primarily driven by wind and are the major transport mechanism for the dispersal of floating plastic litter (Barnes, Galgani, Thompson, & Barlaz, 2009).

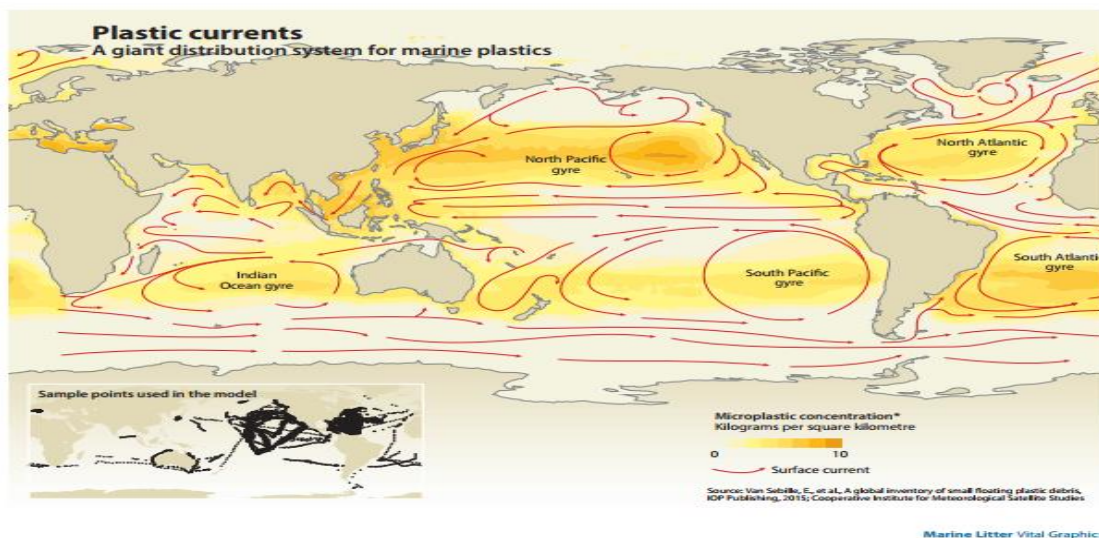


Figure 15. Plastic Currents, A giant distribution system for marine plastics

Source: (UNEP and GRID-Arendal, 2016)

The circulation in bay Bengal and Arabian sea also contribute to the marine litter transport from one place another place in the region. However, there are no studies related to the circulation of marine litter in Sri Lankan waters. Many foreign litter is found from Kalpitiya to Mullaitivu area and it is one of the evidence that the litter from neighboring countries are transported by the ocean current to Sri Lankan coastal areas. A comprehensive study should be carried out to find out the circulation pattern and pathways of marine litter in the South Asian Seas region.

3.2 Land based sectors generation (Micro and Macro)

The main source of the marine litter in Sri Lanka is land based sources (Gunasekara, et al., 2014). The tourism and recreational related activities are generating the highest amount of marine litter. The Land based marine litter can be categorized into two groups, litter generated due to activities in coastal areas and the litter enter into the coastal and marine areas through the waterways. The amount of marine litter coming through rivers and waterways is very high. There is no mechanism presently to prevent marine litter entering from rivers and waterways. There are 103 rivers and several hundred channels in Sri Lanka which carries huge amount plastic litter.

Coastal based tourism and recreational related activities are the main contributor in the coastal area for marine litter. Secondly fishing industry is also generating high amounts of marine litter. Activities related to fishing industry such as boat repairing, boat building, dry fish making are the main contributors to the marine litter issue.

More than 90% of marine litter originates from land based human activities. A significant amount of wastes is entering into the ocean due to a poor land management. Land wastes are generated by increasing population, accelerating urbanization, a lack of waste disposal facilities, growing industrial activities and the lack of public awareness. Specifically, wastes in rivers and canals which are connected to the ocean are not properly managed.

3.3 Sea based sectors generation (Micro and Macro)

The sea based industries which contribute to marine litter are shipping industry and fishing industry. There are five major ports in Sri Lanka and nearly 5000 ships arrive to these ports. In addition, there is an international shipping route in Sri Lankan waters and more than 200 ships pass through Sri Lankan water per day. However, due to the MARPOL convention the discharge of most of the ship generated waste categories is prohibited. Also Waste reception facility is provided to all ship visits to Sri Lankan ports. Therefore the discharge of waste from ships is considerably low. Fisheries vessels have contributed to the high amount of marine litter. Multi day fishing boats dump a waste generates on board of the boat and most of the occasion fishermen did not use the facilities provided to harbours.

3.4. National, sub-national and local institutions responsible for solid waste management

There are several institutions responsible for solid waste management in Sri Lanka; mainly these agencies can be categorized as central government agencies and local government agencies.

3.4.1. Central Government Agencies

The management of waste generated by due anthropogenic activities becomes one of the burning issues in Sri Lanka. Several ministers and agencies are responsible for making necessary policies and legislation for the management of solid waste. The general overview of the role of each agency responsible is shown below.

Table 14. An overview of the role and jurisdiction of agencies

Related Agencies	Role and jurisdiction
Ministry of Local Government and Provincial Councils (MoLGPC)	MOLGPC is responsible for the implementation of policies and plans for Local Authorities (LA) through the nine Provincial Councils (PC). They are mainly responsible for the coordination between the central government and PCs, supporting the formulation and implementation of national policy related to PCs and LAs, financial and technical assistance, and assistance to human resources development and research for good governance. In this Ministry, there are other institutions such as the Local Loan and Development Fund (LLDF) responsible for funding for LAs and the Sri Lankan Institute of Local Governance (SLILG) responsible for administrative capacity building and research for LAs.
Ministry of Mahaweli Development and Environment (MoMDE)	MOMDE formulate a national policy in relation to waste management. In 1998, Ministry has prepared a municipal waste database in Sri Lanka and made a revision in 2005. While preparing the database, they make use of LAs in waste generation amount surveys and waste composition surveys so that the LAs can understand the importance of recycling, proper waste collection, intermediate treatment, and final disposal.
Ministry of Megapolis and Western Development (MoMWD)	<p>MoMWD is a new Ministry appointed by the Cabinet of Sri Lanka after August 2015 elections. The Ministry is in charge of discovering solutions to resolve the garbage, housing of shanty dwellers issues as well as drawing new traffic plans to avoid traffic jams in busy towns. Regarding SWM, since each LA is responsible for managing the regional activities by legislations, the ministry is not directly involved, but responsible for assisting LAs with improvement of SWM.</p> <p>On the other hand, since there are a lot of projects related to SWM being carried out by individual ministries and organizations, there was a need for a mechanism for overall management of these activities. Therefore, the ministry as a decision-making organization in accordance with SWM established the Committee of Secretaries, which consists of the top of the following secretaries. They shall</p>

	<p>collectively manage the activities of the individual institutions that are working individually and all of the SWM projects must be approved by them. MoMWD MoLGPC Ministry of Water Supply and City Planning Sri Lanka Land Reclamation and Development Corporation (SLLRDC) Provincial Council of Western Province (Chief Secretary of the province) MoMDE Currently only the Western Province becomes one of the members of the committee but in the future, all of the provinces are planning to join.</p>
<p>Ministry of Health, Nutrition and Indigenous Medicine (MoH)</p>	<p>MoH has jurisdiction over the policy-making, monitoring and management of medical waste and Ministry prepared the Healthcare Waste Management National Policy to encourage proper disposal of medical waste. They dispatch the Public Health Inspector (PHI) to all the cities and towns and some of the villages and allocate a post called Chief PHI (CPHI) to a senior PHI who is in charge of supervision and management of PHIs. The Divisional Secretary's Division has jurisdiction over the Medical Officer of Health (MOH), and they are working together with the PHI to improve and preserve the health and hygiene of the region.</p>
<p>National Solid Waste Management Support Center (NSWMSC)</p>	<p>The NSWMSC was established by the MoLGPC in 2007. This center assists LAs to improve the solid waste management. Their main duties are as follows: to provide a variety of manuals and guidelines to facilitate LAs to implement proper SWM, to provide a variety of technical assistance on solid waste management to LAs, to collect and study information on the current SWM practices and the practices in LAs, as well as those in foreign countries. The NSWMSC then provides this useful information to LAs, to facilitate LAs to get technical and financial assistance from NGOs and donors, to promote, evaluate, and make recommendations to the National Strategy for Solid Waste Management, to collect and analyze the waste management data of LAs, the organizational chart of the NSWMSC is shown in the following.</p>
<p>Central Environmental Authority (CEA)</p>	<p>The CEA is one of the main implementing arm of the National Environmental Act (NEA) under the mound and is responsible for the supervision and management of solid waste. They consist of six major divisions. The Environmental Assessment Unit under the Environmental Management and Assessment Division is responsible for implementing the Environmental Impact Assessment process according to the NEA. The Environmental Pollution Control Division is engaged in regulatory activities associated with the contamination of air, water, soil and industrial pollutions. These functions are performed by the following four units: Pollution Control Unit, Waste</p>

	Management Unit, Laboratory Services Unit and Monitoring Unit. The Waste Management Unit is in charge of the Scheduled Waste Management. The Project Division consists of the following four units: the Pilisaru Waste Management Project Unit, the Waste Disposal Facility Construction Unit, the National Post Consumer Plastic Waste Management Project (NPCPWMP) Unit and the Sanitary Landfill Site.
Coastal Conservation and Coastal Resources Management Department (CC&CRMD)	The Coast Conservation Department is responsible for control of development activities and the implementation of National Coastal Zone Management Plan. Coastal zone management aspects, recognized the importance of pollution control and included a special chapter on Coastal pollution control.
Marine Environment Protection Authority (MEPA)	The MEPA is the responsible agency for the prevention, reduction and control of marine pollution in Sri Lankan water from sea based and shore based activities. According to the mandate of MEPA one of the main function MEPA to formulate and implement schemes of work for prevention of pollution. Also section 21 of the marine pollution prevention Act has given powers to engage in waste management and provision waste reception facilities to ships.

3.4.2. Local government agencies

Through the 13th amendment of 1987 constituting the supervision right over local Authorities was handed over from central government to the Provincial Council (PC). Accordingly responsibilities related to the waste management were handed over to the PC. LA's are responsible for the collection and disposal of waste generated by the residents who live in the LA respective LA areas.

However, only the Western PC the special agency called Waste Management Authority (WMA) established and WMA is in charge of the cluster waste management system. The role and jurisdiction of the each local government agency responsible for waste management is shown below.

Table 15: Provincial and Local government agencies responsible for waste management

Related Agencies	Role and jurisdiction
Provincial Council (PC)	There are nine PCs across the country. They provide substantial administrative guidance to the District and LAs of the region. Their duty is to provide administrative services for the basic daily life of citizens and community such as waste management. Regarding financial assistance for waste management in LAs.
Local Authority (LA)	LAs, under the supervision of the PCs, are responsible for providing administrative services in accordance with the regional environment such as health and hygiene, waste disposal, regional environmental

	<p>protection and park management. Although they are able to formulate the laws through parliament and to give instructions to the regional police, it is said that the legislative system of local government is not fully functional. The CPHI (Chief PHI) or the Public Health Department in LAs that is directed by the PHI conduct actual operations and management of municipal waste. The (C) PHI conducts not only collection, transportation and disposal of waste, but also supervises the health management of waste collection workers and gives guidance and training on waste collection</p>
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Source: (JICA, 2016)

Table : 16 Duties and responsibilities of Western province council and Western Province Waste Management Authority

Related Agencies	Role and jurisdiction
Western Provincial Council (WPC)	The WPC provides substantial administrative guidance to the District and LAs of the Western Province; however SWM is delegated to the Waste Management Authority (WMA), which was established under the WPC. All of LAs in the Western Province are supposed to manage their wastes in accordance with the MSW Management Rule No.1 (2008) formulated by the WPC. The Department of Local Government (DLG) under the WPC is responsible for coordination between LA and the central government / WPC in the Western Province, for monitoring the financial status of each LA and also for the allocation of subsidies from the central government and WPC to each LA taking into account the sector-specific maximum expenditure (Ceiling) defined by the Finance Commission and the priority of expenditures.
Waste Management Authority of Western Province (WMA)	WMA, established in 2004 under Waste Management Statute No.9 of the Western Provincial Council in 1999 is responsible for supervision of waste management of the entire WP. The WMA Statute No.1 was formulated in 2007 and it specifies jurisdiction, function and responsibility of the WMA. According to the statute, WMA is responsible for providing technical and financial assistances to all LAs of the WP to build their capacities in SWM, collecting waste data in WP, developing common final disposal sites to LAs and also assisting to LAs to inculcate waste management discipline among the public (through public awareness activity and environmental education etc.).

Source: (JICA, 2016)

3.4.3. Status and Issues of the Solid Waste Management Sector

The solid waste management has become a major burning issue in Sri Lanka. The estimated present municipal solid waste generation in Sri Lanka is around 6500 to 7000 Mt per day and only 50 percent total waste generation is collected by authorities (WMA, 2016).

Disposal of solid waste is a major environmental problem in Sri Lanka at present and has become a national burning issue. A haphazard disposal of solid waste is identified as major causes of environmental degradation by the National Action Plan of Sri Lanka (Gunaratna, 2012) In almost all of the urban municipalities in Sri Lanka, the most common method of Municipal Solid Waste disposal is open dumping.

The management of non-degradable wastes such as plastic waste has become an issue. Due to low cost and durability of plastic product, the use of plastic has significantly increased during last two decades. Sri Lanka imports annually a considerable amount of plastic raw materials and finished product. Plastics imported to Sri Lanka are divided into two categories as primary forms and waste, parings and scrap semi-manufacture/articles. Among the above amount considerable amount is exported to the other countries as primary forms and waste, parings and scrap semi manufactures/article (Gunaratna, 2012). Sri Lanka is exporting plastic products to a large number of countries and United States of America is the buyer of the plastic product.

The below table shows the amount of plastic materials import to Sri Lanka during the period of 2001 to 2011.

Table: 17 The amount of plastic materials import to Sri Lanka

Year	Quantity imported	The quantity exported
2001	161693	19704
2002	171785	22043
2003	173059	26882
2004	212135	29767
2005	224371	30010
2006	238423	29354
2007	259435	26832
2008	226865	24760
2009	211629	27191
2010	270599	21764
2011	300042	23791

Plastic import and export of the county varies with year to year and other than 2008 and 2009 the export and import quantities of plastic has been significantly increased. It is estimated that the demand for the plastic materials increased of 10 percent in Sri Lanka.

It is estimated that in 2025 the annual plastic imports would reach 430000 metric tons, which is the double of the quantity that has been imported in year 2005 (Gunaratna, 2012).

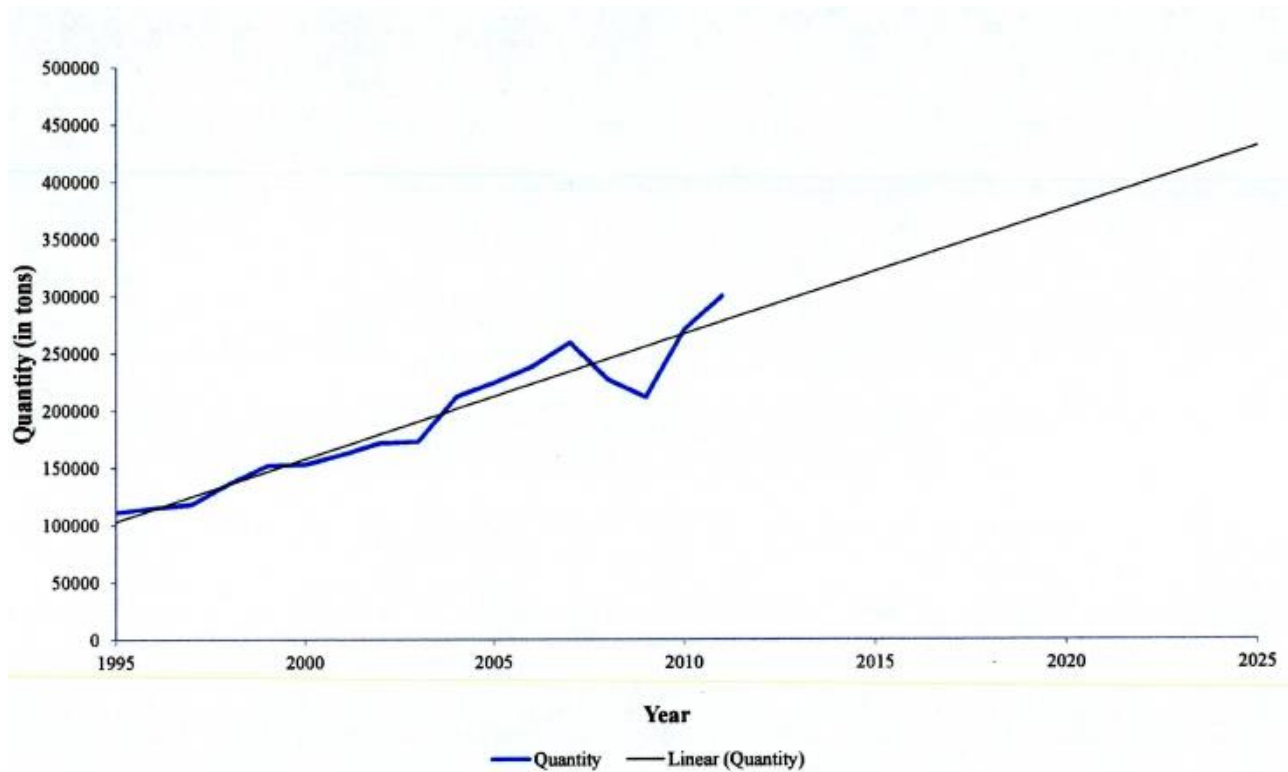


Figure 16. Future trends in Plastic import in Sri Lanka

Also, it is estimated that the in the year 2025 the annual plastic exports would reach a value of 44000 metric tons, which is the double of the quantity that has been exported in year 2002 (Gunaratna, 2012). The mostly consume a plastics product of Sri Lankan is Polyethylene (PE), Polypropylene (PP), Polystyrene (PS), Polyethylene terephthalate (PET), and Polycarbonate (PC). The future trend of the consumption of above type plastic is given in below.

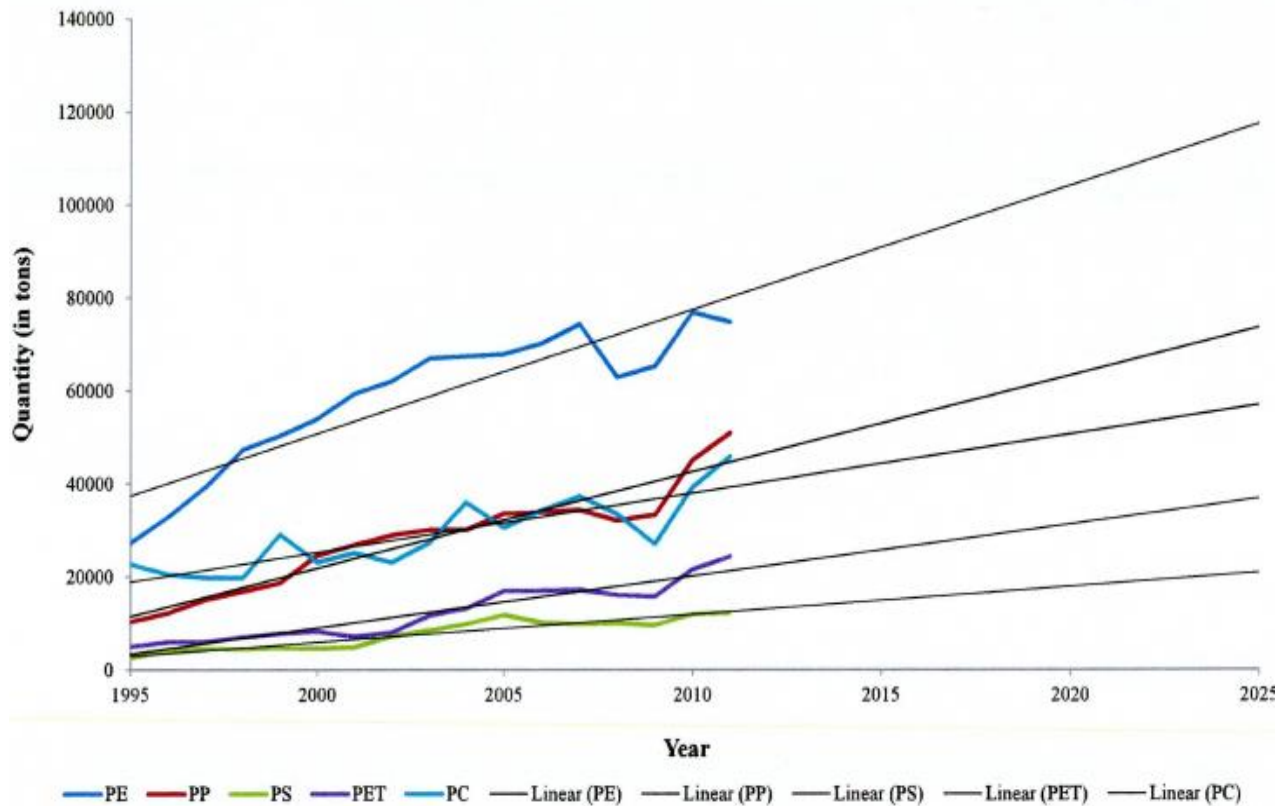


Figure 17. The future trend of the consumption types of plastics

According to the above figure, the most of the plastic items consumed by Sri Lanka are made of PE, PC, and PP. The amount of the type of plastic consumed by Sri Lanka is higher than PET and PS. It shows that PE would be the highest consumed plastic material in the year 2025, recording a value of 116,000 tons. Further, out of 430,000 tons of plastics imported, 310,000 tons (72.09%) would be consumed in the year 2025 (Gunaratna, 2012).

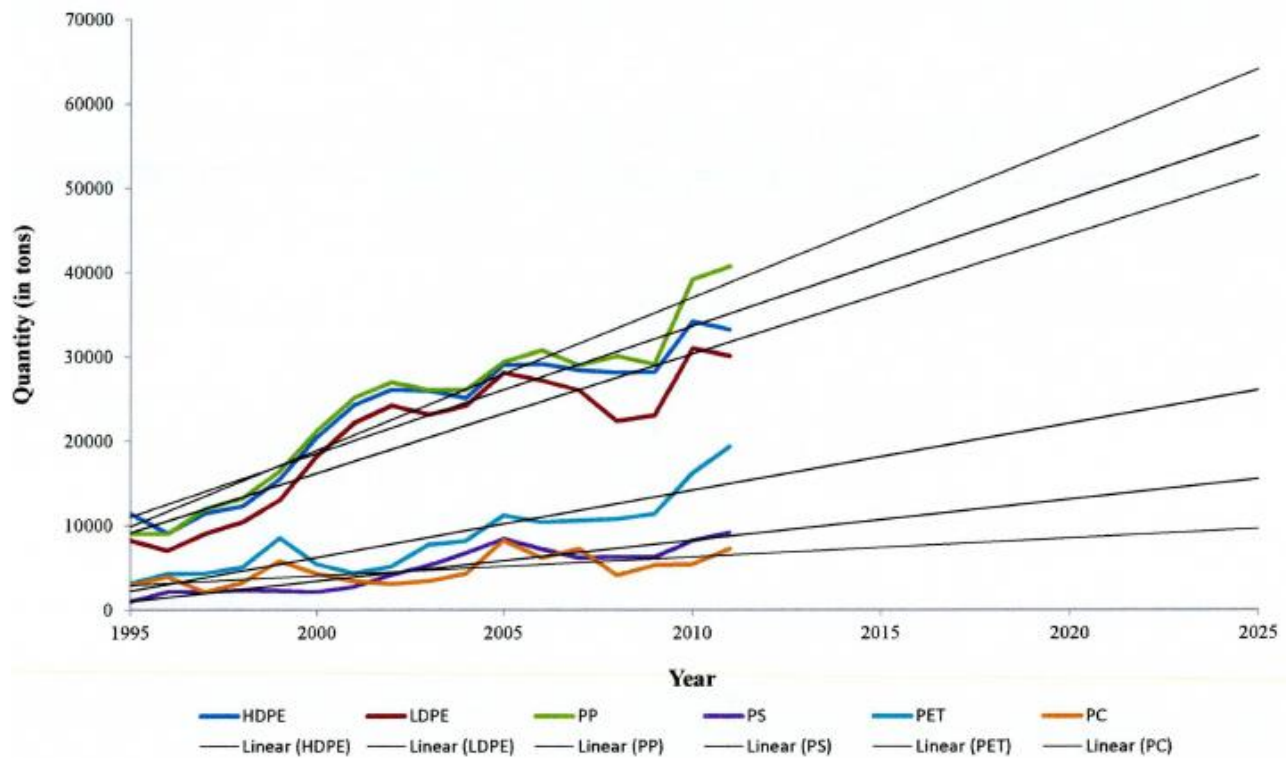


Figure 18: Future trends of the type's of plastic waste generation

With the increase of plastic consumption, the amount of plastic waste will be increased in future. Future trends of the type's plastic waste generation indicate that the all types of plastic waste would be increased and the highest amount of plastic waste type would be HDPE, LDPE. PP has generated a higher quantity of waste while PS, PET and PC generating a lower Quantity. It is also noted, that PP would generate the highest waste quantity in year 2025 while PC would generate the least (Gunaratna, 2012).

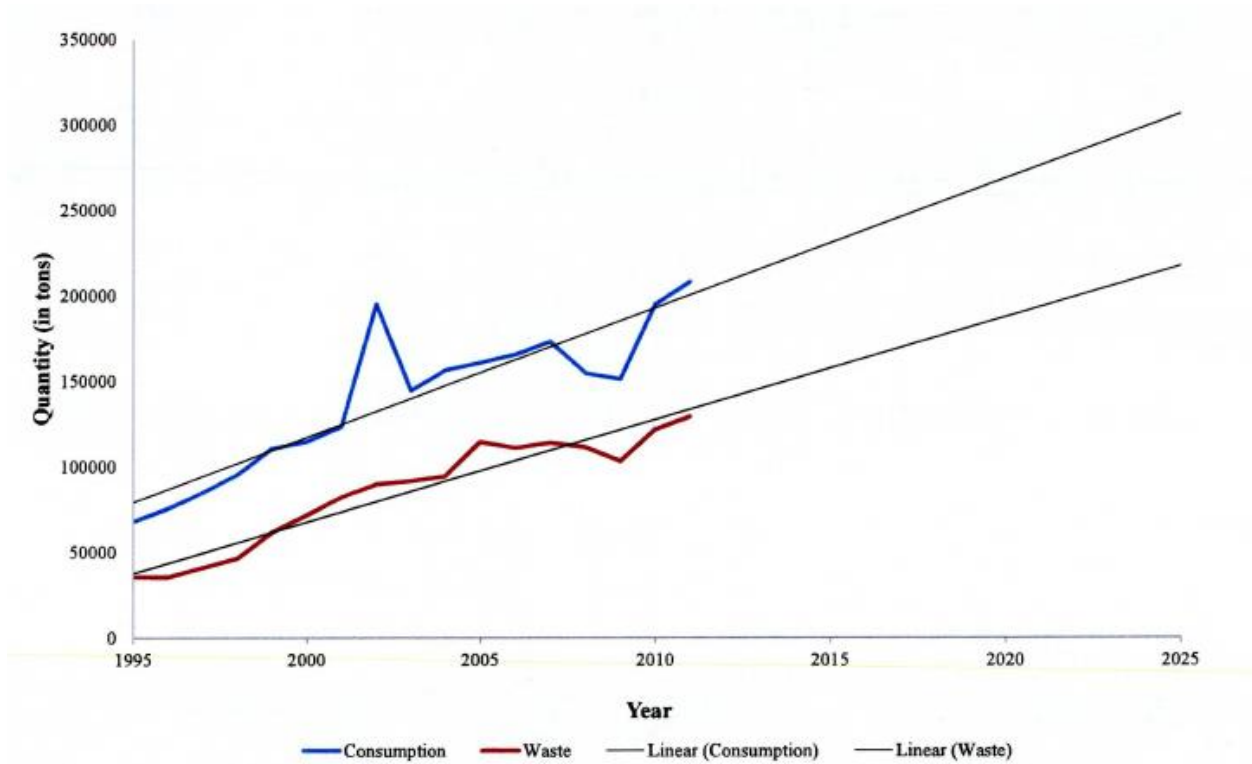


Figure 19. The Future trends of plastic consumption and wasted amount

The above graph shows that out of 310000 tons of plastics consumed around 220000 tons (70.99%) would be wasted in the year 2025. Also, it was noted that the annual plastic imports would be 430000 tons in the year 2025. According around 51.16% of imported plastics would be wasted in the year 2025.

4.0 The Plastic waste recycling capacity of Sri Lanka

The main type of plastic used in Sri Lanka fall into the group of thermoplastics and therefore this plastic waste can be mechanically recycled. Presently private companies engage in plastic waste recycling business and most of the plastic recycling companies are small scale operations, generally processing, recycling 75- 100 tons per month in 2011 (Gunaratna, 2012).

The number of plastic waste collectors and recyclers is increasing annually and there are 126 plastic waste collectors and recyclers in Sri Lanka (CEA, 2017).

The most commonly recycling plastic waste materials are PP, HDPE, LDPE, PET, and PS, with polycarbonate and PVC also is being recycled. Presently the total amount of plastic import of the country is 500000 tons and nearly 30 percent of the total imports again exported to other countries and the rest are consumed (70%). The total plastic waste recycling capacity is 140000 tons (40%) and the rest is dumped as a waste.

The future waste amount and recycling capacity data shows that the plastic recycling industry of the country is growing. The plastic recycling capacity of the country is estimated to reach a quantity of 170000 tons (77.27% of the wasted) in the year 2025. However around 50000 tons (22.73% of the wasted) of plastic waste would still not be recycled in the year 2025

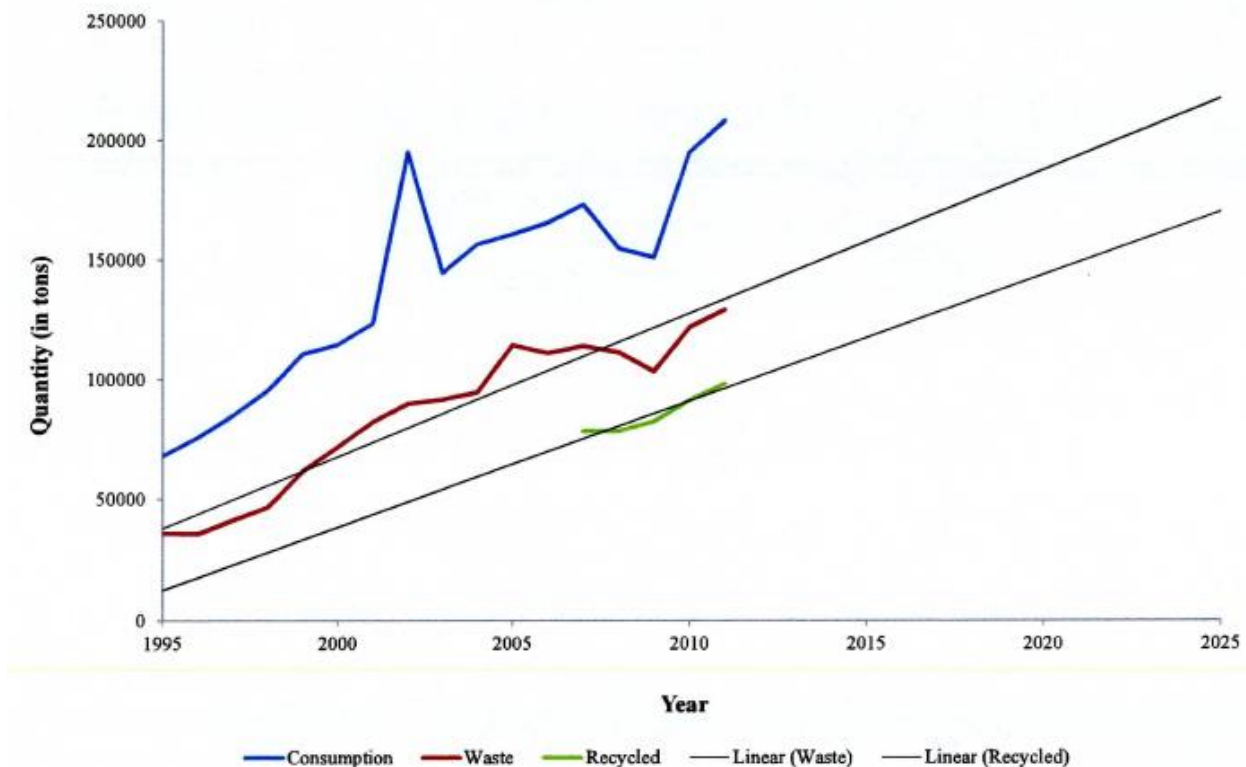


Figure 20. The trend of plastic waste amount and recycling capacity

Central Environment Authority data shows that the total amount of plastic waste generated per day is 350-400 Mt and only the 100-150 Mt is recycled per day. 300-350 Mt of plastic waste is dumped to the

waste disposal site. There is high potential to develop a plastic recycling industry in Sri Lanka (Jalotha, 2017).

The waste recycling companies are facing a lot of issues promptly and they could not collect the amount required for recycling. This is mainly due to present waste collection and disposal system. A list of plastic waste recycling agencies is attached as appendix 1

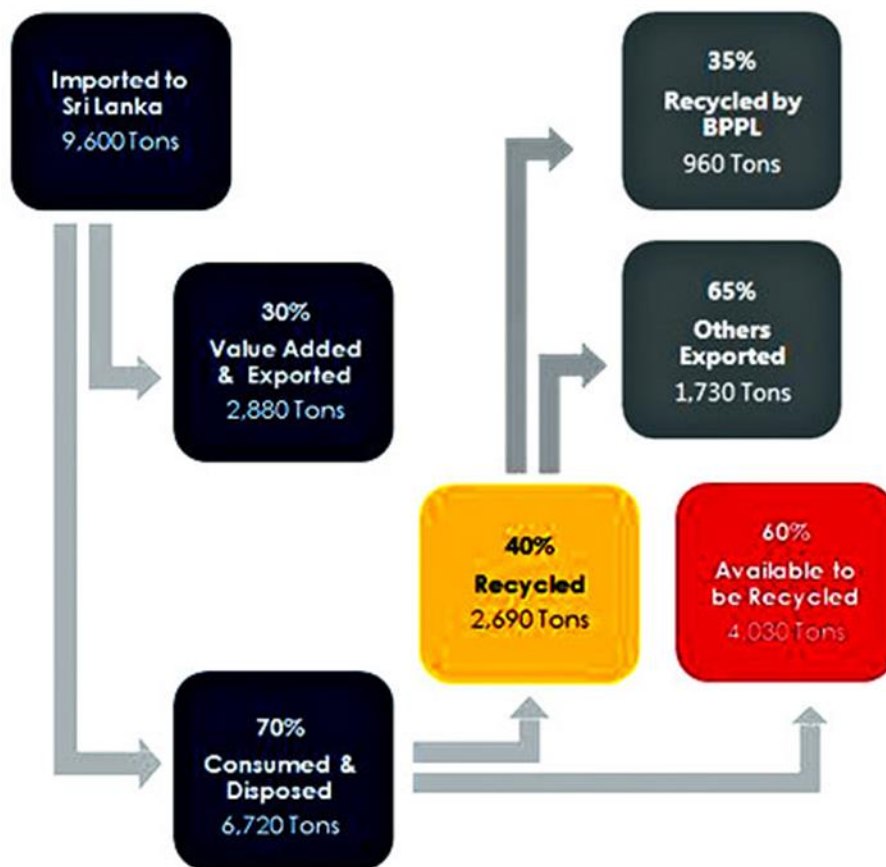


Figure 21: The amount PET imported and recycled
Source: (Srirajiv, 2017)

The National Strategy for Solid Waste Management (NSSWM) has been formulated in 2000 by the ministry of environment. Accordingly to this strategy solid waste management to be conducted as follows: Prioritize waste avoidance and reduction over the next stage of waste recycling and other forms of environmentally sound disposal, is an unavoidable waste as much as possible, maintain the content of hazardous substances in waste at the lowest possible level and guarantee an environmentally sound residual waste treatment and disposal as basic prerequisites for human existence.

The National Policy on Solid Waste Management formulated in 2007 and it defines the environmental accountability and social responsibility of all waste generators, waste managers and service providers and aims to actively involve individuals and all institutions in integrated and environmentally sound solid waste management practices.

Consequently, the CEA initiated the “Pilisaru” National Solid Waste Management Program in 2008 and donated a grant totaling about 5.6 billion rupees to the local governments that implement solid waste management activities. On the other hand, the Sri Lanka Government prioritizes appropriate and sustainable SWM, “Ten-year Horizon Development Framework (2006-2016)” and identifies the importance of the promotion of the 3Rs and the establishment of an environmentally friendly final disposal site for sustainable SWM system. The government is preparing the investment plan. In 2009, they also formulated the "National Action Plan for the Haritha Lanka Program (2009 ~ 2016)" with the aim of sustainable development, in which they identify SWM as one of the priority issues and set a strategy for adopting appropriate infrastructure and/or alternative methods necessary for SWM in each LA.

The national level plans and policies/strategies in Sri Lanka are summarized in the following table.

Table 18. The National Level Policies and Strategies related Solid Waste Management

Year	Policy /Strategy	Description
2000	National Strategy for Solid Waste Management (NSSWM)	3-year action plan, Waste reduction, 3R implementation
2003	Caring for Environment Phase I (2003-2007) Phase II (2008-2012)	Funded by United Nations Development Program; UNDP National Environmental Action Plans
2005	Vision for A New Sri Lanka	A Ten Year Horizon Development Framework 2006-2016 formulated by the Ministry of Finance and Planning ☐ Solid waste and pollution management included in the investment plan
2006	Coastal Zone Management Plan	Policy Solid waste management within the Coastal Zone will be promoted to minimize coastal zone pollution. Solid waste management plan be prepared to reduce adverse impact on the coastal environment
2007	National Policy on Solid Waste Management	Waste reduction, 3R implementation, Sanitary landfills, Capacity building, Research and development (Best Available Technologies (BAT), Best Environmental Practices (BEP)
2008	Pilisaru Program Phase I (Jan. 20 –Dec. 2013) Phase II (Jan. 2014–Dec. 2018)	National level program for solid waste management under the chairmanship of Ministry of Environment, CEA, and others. Initial budget amount: 5.675 bill LKR. Target is to introduce small and medium waste treatment system in all local government authorities by year 2018 and to cover 50% by the year 2016.

2009	National Action Plan for Haritha Lanka Program	Establishment of National Council for Sustainable Development (NCS) Sustainable development: Haritha (Green) Lanka Program
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4.1. Laws and regulations related to the solid waste management.

LAs are mainly responsible for the collection and disposal of waste generated by residents who live in the respective LA areas as the Municipal council Ordinances No 16, Urban council Ordinance No 61 and Pradeshiya Sabba Act No 15. The act has given authority to formulate rules and regulation for managing waste and to impose penalties that violate the rules and regulations promulgated by the LAs.

Provincial Council has mandated under the 13 amendment to the constitution of 1978 supervision of all LAs and waste amendment powers. At the central government level National Environment Act No 47 of 1980 was introduced to preserve the environment, to maintain environmental quality and to prevent pollution. Also the Central Environment Authority was established as per the provision of the above Act.

The legislation related waste amendment is shown in the below table

Table 19. Legal Frameworks related to Solid waste management

Year	Legislation and regulation	Description
1939	Urban Council Ordinance No 61 of 1939	Section 118, 119 and 120 specify waste management responsibilities of UCs
1946	Nuisance Ordinance No 62 of 1939 and No 57 of 1946	Section 1-12
1947	Municipal councils procedure Act No. 15 of 1979- Public Nuisances	Section 98
1987	Provincial Councils Act No 42 of 1987	Amended by by Act No. 56 of the 1988 LAs contains provisions for waste management
1987	Pradeshiya sabba Act No 15 of 1987	Sections 93 and 94. Specify waste management responsibilities of Pss
1980	National Environment Act No 47 of 1980	Section 12 and 26
2007	Prevention of Mosquitoes Breeding Act No 11 of 2007	Prohibition against creating conditions favorable to the breeding of mosquitoes
2008	National Thoroughfares Act No 40 of 2008	Section 64 (a) (b) and section 65
2009	Gazette No. 1627/19 National	General Rules on SWM discharge and

	Environmental (Municipal Solid Waste) Regulations, No. 1 of 2009.	collection of waste (Prohibition of waste dumping at national highway and at any place other than places designated for such purpose by the LA
2008	Marine Pollution Prevention Act no 35 of 2018	Section 21, section 26 and section 27
2012	Marine Environment Protection Sea Dumping Regulation 2013	Waste water discharge standards and issuance of sea dumping permit

The solid waste management has become a major issue in Sri Lanka. However, most of the policies and strategies are mainly focused on the solid waste management inland areas. When the waste enters to sea or coastal areas, management of such waste (Marine Litter) is still the responsibility of LAs. However the when it reaches to coastal beaches, there is no mechanism to collect the waste and regular mechanism to collect the marine litter stranded on beach areas. Marine Pollution Prevention Act has given mandate to MEPA to take legal action against polluters.

One of the main source of marine litter is commercial ships and fishery vessel. Ship generated waste cannot be disposed into the sea as per MARPOL Convention 73/78, Sri Lankan is being party to the convention, provision of waste reception facilities in Sri Lankan port is one of the main obligation. MEPA as the responsible party to provide waste reception facilities for ship generated waste is providing this service through service providers. Waste reception facilities regulation is promulgated by MEPA as per the provisions of Marine Pollution Prevention Act.

5. National Impact of Marine Litter

Marine litter is one of the major threats to marine environment and it can negatively affect the coastal and marine environment, including important ecosystem such as coral reef, sea grass beds and mangroves etc. It can also affect the national economy through the destruction of livelihoods of people who depend heavily on ocean-based industries such as the tourism and fisheries. The health and safety of people who beaches for recreational activities are also at risk in areas where can accumulate.

5.1 Social -Human health and food safety

Marine litter can be a hazard to human health and safety in different ways; however, most incidents related to impact on human health are unrecorded or not studied well in Sri Lanka. Beaches in Sri Lankan attract large number local and foreign visitors who are aware of the potential hazards due to marine litter. Visitors who come to the beach can be injured by the shard of brittle plastic, metal and glass, and risk of possible infection through contact with used needles, sanitary products or medical waste. The pollutant enters with marine litter to the beach and water can have serious impact on beach water quality and beach cleanliness (SACEP, 2007). This can negatively affect tourism industry in the country. Tourists visited to some areas of the beach in Sri Lankan reported that the pollution due to

marine litter as a one of the major issues (EFL, 2017). The marine litter can block waterways and can contribute to flooding of that area during the rainy season and that can affect coastal people health and safety. Marine litter accumulated in coastal beaches can also provide a reservoir for stagnant water, providing a breeding ground for mosquitoes and flies that spread diseases to human such as Dengue Fever, Malaria and filaria.

Marine litter can also wrap around and damage boat propellers or engines, as well as entangle swimmers and divers due to submerged or floating litter such as fishing nets and lines. Also, it is observed that large amount of marine litter entangle with fishing nets and it pose threat to fishing activities. Marine micro plastic contaminated with pollutant consumed by fish and other seafood can bio accumulates in animal tissue and be transported up the food web to humans. However, studies in in these areas have not been carried out so far to give a clear idea regarding the impact human health.

5.2 Economic From ecosystem impacts to the economic consequences, Fisheries and aquaculture, Tourism, recreation, rafting, surfing etc.

All ocean based industries such as fisheries, coastal tourism, aquaculture, sea transportation and seabed mineral industries highly depend on sustainable healthy marine and coastal ecosystem. These industries represent major contributions to countries' Gross Domestic Product (GDP). For example, Tourism is the 5th foreign income generator in Sri Lanka (Central Bank of Sri Lanka, 2017).

Tourism plays an important role in Sri Lanka's economy, generating USD 2.2 billion in revenue in 2015, with coastal tourism contributed to a major component of this revenue (EFL, 2017). Tourism plays a very important role in coastal economies, and while recreational beaches are widely used for other activities such as scuba diving, snorkelling and marine safaris are growing in popularity and are directly dependent on thriving marine ecosystems. Marine litter which accumulates along the beaches and waterways disrupts the natural aesthetic beauty of the beaches which reduces the recreational value and tourism quality of these resources. Sustaining the tourism sector will require not only trash removal, but also improving solid waste disposal practices on land, and investment in sustaining coastal and reef ecosystems. Ships also rely on clean harbours free of litter in order to navigate safely. Countries that do not maintain clean, clear waterways suffer from loss of business. Ships, light craft and fishing vessel can be subjected to severe damage caused by submerged litter such as lost shipping containers.

Marine litter is becoming a growing problem for the tourist industry in Sri Lanka, not only as the resultant biodiversity loss affects activities such scuba diving, whale watching and snorkelling, but also destroys the recreational value of beaches as stretches of pristine coast become polluted with marine litter. Marine litter pollution has already affected popular tourist beaches in Mount Lavinia and Negombo (EFL, 2017). The beaches in North and East due to intensified tourism activities are also trashed and degraded (EFL, 2017).

5.3 Ecological /Environment-Impact on marine ecosystem and biodiversity

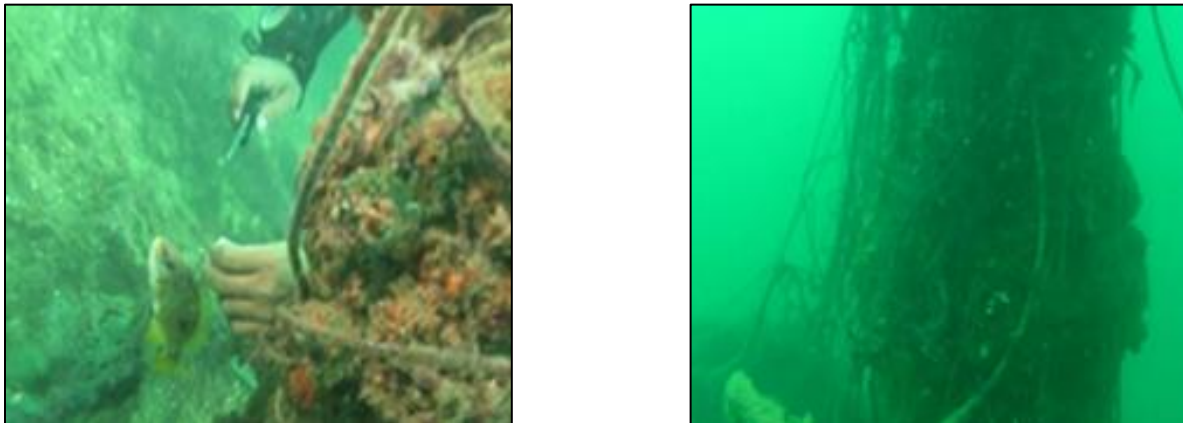


Figure 22: Discarded Fishing gear contributes to ghost fishing

Source : MEPA

Marine litter results in the entanglement of and ingestion of organisms, and poses a threat to marine biota. The data show that the more than 663 species adversely affected by marine litter and more than 50 percent of these incidents reported entangled in, and ingestion of, marine litter. Data also shows that all known species of sea turtles, about half of all species of marine mammals, and one-fifth of all species of seabirds were affected by entanglement in, or ingestion of, marine litter (United Nations, 2016). Damaged fishing nets and gears discharged to marine and coastal areas in Sri Lanka and due to this impact are very high.



Figure 23: Floating marine litter with fouling organisms

Both aquatic and terrestrial animals can be negatively affected by the presence of marine litter. The species can mistake trash for food, which when ingested may cause damage to the throat and stomach, cause feelings of satiation resulting in starvation, and leach toxins that may be absorbed into the animal tissue.

Marine litter pollution claims the lives of many marine turtles, Leatherback turtles feed on jellyfish and they eat mistake plastic bags floating in the water for jellyfish, as the plastic bag block the turtle's gut the animals starve to death (TCP, 2015). Beach trash can impede sea turtles from access to nesting sites as well as block access to the sea for hatchling making them prime targets for predators.

Abandoned fishing nets and lines may entangle marine wildlife, such as sea turtles, birds and fish, which may hurt or kill them. Many of these animals are threatened or endangered and consequently, the biodiversity of the areas can be significantly impacted.

Marine sensitive ecosystems such as mangroves are also facing serious threat due to marine litter. Mangrove ecosystem is considered as among the world most productive ecosystem. Mangrove forests are also popular for human activity as a source of food and wood. Because of their proximity to urban areas and the rapid advance of urbanization the coast in tropical regions, mangroves encounter a range of environmental stresses among which is marine litter (NOAA, 2016). Marine litter can be directly and indirectly with wind and water entered into mangrove habitats. Marine litter becomes trapped among mangrove trees and their aerial roots, which may block mangrove tidal channels and prove detrimental to near shore habitats and their associated species (NOAA, 2016). Mangroves in Negombo lagoon areas and other areas are impacted by marine litter generated from fishing activities and large number plastic marine litter accumulated in mangrove areas.

The coral reef scatted along the coastal areas is one of the sensitive ecosystem. The high biological diversity of coral reefs also makes them popular commercial and recreational fishing grounds, which often results in the presence of derelict fishing gear abandoned fishing gear is known to cause significant and persistent threats to the coral reef ecosystems in many areas. Most of the researchers indicated that the marine litter physically damaged to Sri Lankan coral ecosystem and damage to reef-forming or hard corals can reduce the integrity of coral reef ecosystems, since hard corals provide the substrate from which the reef structure is formed.

Marine litter also acts as a vector for invasive species; floating litter transports 'alien' organisms around the world, introducing new species into places where they out compete or predate native organisms.

Marine and coastal ecosystem provide the range of benefit, including ecosystem Services. The most of the ecosystem services provided by marine ecosystem cannot be valued in term of monetary value. Marine litter present in marine and coastal areas has significantly compromised a range of ecosystem services.

Table 20: Ecosystem services impacted by Marine

Type of Ecosystem Service	Ecosystem services	Potential impact on ecosystem services by Marine
Supporting services: The services that are necessary for the production of all other ecosystem services	Soil formation, photosynthesis, primary production, nutrient cycling and water cycling	Plastic sheeting on seabed reduces nutrient cycling and gas exchange between water column and seabed and can block sunlight restricting photosynthesis
Provisioning services: The products obtained from ecosystems	Food, fiber, fuel, genetic resources, biochemical, natural medicines, pharmaceuticals, ornamental resources and fresh water	Ghost gear has continued to indiscriminately catch marine organisms. Contamination of resources. Potential loss of new pharmaceuticals
Regulating services: The benefits obtained from the regulation of ecosystem processes,	Air quality regulation, climate regulation, water regulation, erosion regulation, water purification, disease regulation, pest regulation, pollination, natural hazard regulation;	Transportation and distribution of aliens, bacteria and viruses. Exacerbate erosion with the potential for larger marine litter items, colliding with the coast during storm activity. Collision and entanglement risk with vessels.
Cultural services: The non-material benefits people obtain from ecosystems	Spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences – thereby taking account of landscape value	Beach users and recreational water user experience can be diminished by the presence of significant levels of beach litter. Glass, metals and shards of rigid plastics can pose a danger to beach users. Entanglement with ghost gear could cause distress, and in extreme events, death for recreational water users.

Source: (Surfers Against Sewage, 2014)

5.4. Hot spots (accumulation areas, areas at risk) of marine litter

Marine litter enter into coastal and marine areas through various pathways can be accumulated in the coastal areas and the accumulation of marine litter in specific areas will depend on the various factors such as current, wind and depth and other natural factors. Most of the shallow lagoon becomes a hot spot and marine litter enters into the lagoon accumulated in that environment due to shallow and low water dispersion pattern. Also, coastal semi enclosed areas are becoming a litter accumulation area. The most sensitive ecosystems such as coral reefs, sea grass beds and mangroves are located in semi enclosed areas due that nature's litter enter into tight areas accumulated which can pose a severe threat to this sensitive ecosystem.

The sensitive ecosystems are scatted along the coastline of Sri Lanka and marine litter can pose a heavy risk on these ecosystems.

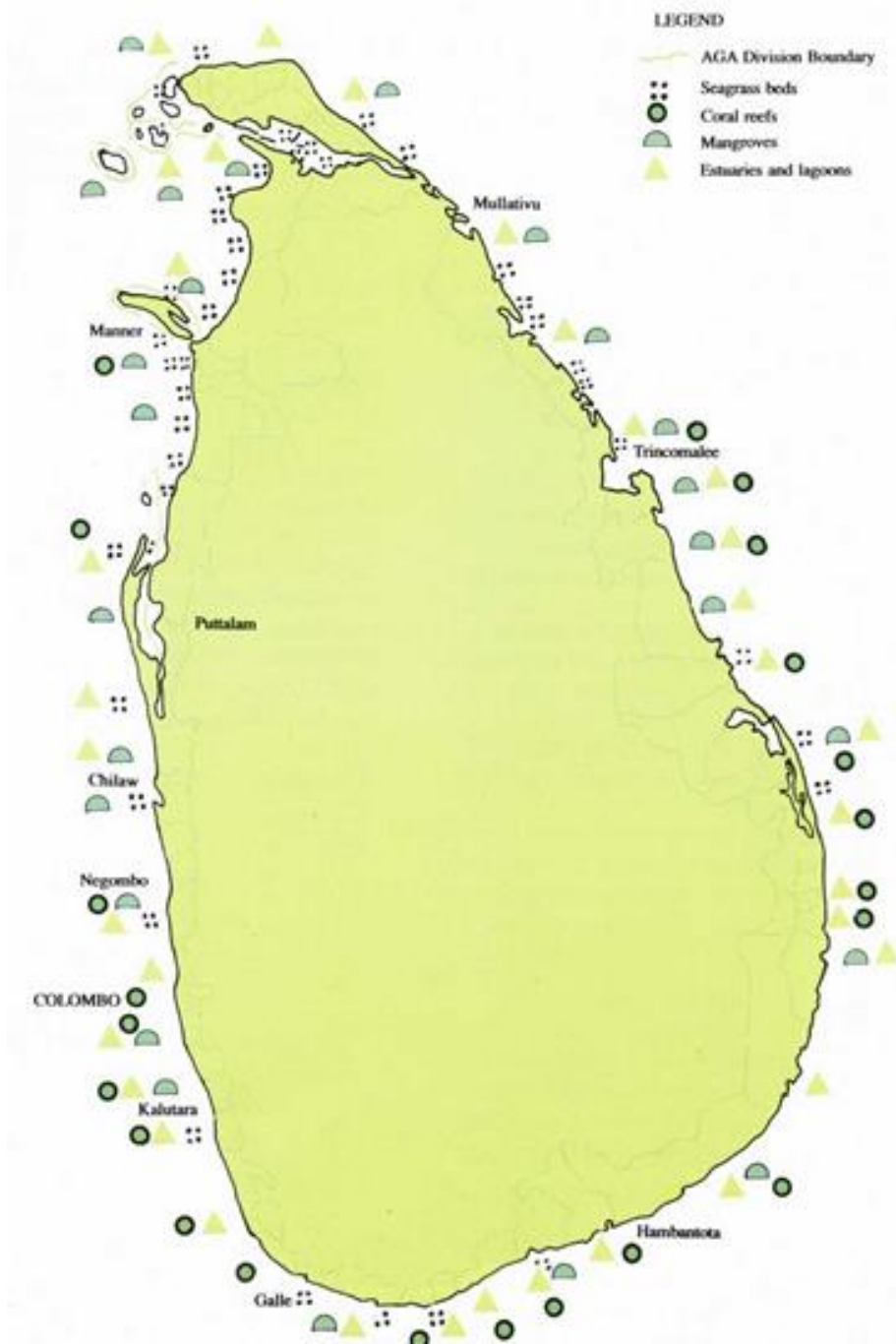


Figure 24 Sensitive marine ecosystems in coastal areas of Sri Lanka
 Source: (MENR, UNEP, 2009)

6. Management agencies, policies, Strategies and activities taken to minimize the marine litter

6.1 Management agencies and their responsibilities

The management of solid waste is the primary responsibility of municipal councils, urban councils and other local authorities. Maintenance of clean beaches also falls within the purview of these local authorities. However, at present, removal of marine litter-floating or deposited on the sea bed has not dealt with any of these authorities.

However, two important state institutions in Sri Lanka are mainly vested with the responsibilities of management and pollution abatement in the coastal zone and marine waters. They are Marine Environment Protection Authority (MEPA) and Coast Conservation and Coastal Resources Management Department (CC& CRMD).

The Marine Pollution Prevention Act No 35 of 2008 has given mandate to Marine Environment Protection Authority. According to the act main responsibilities of MEPA to prevent, reduce and control marine pollution in Sri Lankan waters from ship based sources and shore based sources including the Coastal zone of Sri Lanka.

One of the main function of the MEPA as per the above act is to prepare schemes of work for the prevention, reduction and control of marine pollution. Further, as per the section 21 of Marine Pollution Prevention Act, sections 21 waste management, MEPA is responsible for the provision of waste reception facilities to ship generated waste and MEPA has provided waste reception facility to the ships through the service provides.

Accordingly MEPA has established waste reception facilities to ship generated waste in all commercial ports with the support of registered service provides in line with MARPOL Convention requirements. Fishery vessel generated waste also becomes an issue and there are more than 2000 multimedia boat in Sri Lanka. MEPA has taken initiatives to establish a waste collection facility at the fishery harbour in collaboration with Ceylon Fishery harbour Cooperation.

MPP Act also stipulates provisions for preventing dumping activities in the marine environment. Section 4 of MPPA Act prohibits dumping of oil or any other pollutants into Sri Lankan waters without valid sea dumping permit from MEPA. The Marine Environment Protection (Sea dumping) regulations 2012 introduced by MEPA prohibits the sea dumping of waste and other matters without a valid permit. This regulation introduces the some of the provisions in the London Dumping Protocol.

The MEPA is empowered to take legal action against any pollution in the coastal or marine environment. Section 26 criminal liabilities of the act has given necessary provisions to take legal action against pollutant who discourage or dump any oil or any other pollutant to Sri Lankan waters including coastal zone of Sri Lanka.

Considering the impact of marine litter, MEPA has conducted research projects with support of the Korea Maritime Institute and studied the amount of marine litter in fishery harbor areas and sources of

marine litter. Based on the finding of the study a marine litter management strategy for Negombo Lagoon was formulated.

The Coast Conservation and Coastal Resources Management Department are responsible for control of development activities and the implementation of national Coastal Zone Management Plan. The Coastal Zone Management Plan (CZMP) published in 1990 in accordance with the provisions of the act and revised in 1997. The second revision was done in 2004. Although the initial CZMP document was only dealing with coastal zone management aspects, subsequent revisions recognized the importance of pollution control and included a special chapter on Coastal pollution control. The CZMP of 1997 as a management objective proposes the following on solid waste management in the coastal zone;

Objective: - Improve the coastal environment by reducing the types and volume of solid waste disposed in the coastal zone.

Policy 1: - Assist in preparing solid waste management plans for identifying coastal urban centers, coastal tourist centers and fishing harbours.

Policy 2: - Discourage local authorities to disposal, solid waste in the coastal zone.

Policy 3:- Collaborate in public education and awareness programs and join with other agencies in promoting public participation in solid waste management.

Further, draft revision of Coastal Zone Management Plan 2004 places emphasis on the solid waste management as follows;

Policy 2.1: - Solid waste management within the Coastal Zone will be promoted to minimize coastal water pollution.

Strategy 2.1.1: - Solid waste management plans will be prepared to reduce adverse impacts on coastal water pollution.

The Coast Conservation Act and its Coastal Zone Management Plan have the mandate to monitor, control/reduce/prevent dumping of in the coastal zone as defined by the Coastal Conservation Act.

The Central Environmental Authority (CEA) was established by the National Environmental Act (NEA) No 47 of 1980. The NEA was amended by Acts No. 56 of 1988 and 53 of 2000. The main functions of the CEA include;

Making necessary provisions for protection, management and enhancement of the environment, regulation, maintenance and control of the quality of the environment. - Prevention, abatement and control of pollution. Ministry of Environment and Natural Resources is the foremost policy making entity with regard to any matters related to environment in the country. The Ministry has put forward "National Environmental Policy and Strategies" and "National Strategy for the Solid Waste Management".

6.2 Management policies and Strategies and their effectiveness

The above agencies have taken several measures to overcome marine litter issues as stated in the previous section. However, there is no national comprehensive policy or strategy to deal with this

marine litter so far. The agencies responsible has addressed this issue independently and ad hoc manner. It is obvious that the prevention strategies need to be introduced to solve the marine litter issue. All solid waste management strategies and policies mainly limited solid waste management inland areas and these policies have not focused on the main and coastal areas. There is a clear gap between policies and strategies regarding the marine litter. Also one of the prevention strategies the government introduce ban on use thickness less than 20 micron grocery plastic bag and lunch sheet made of plastic. It is very clear that this policy intention of reduction of one time uses plastic such as grocery bag and lunch sheet. However, there was not any reduction of use of the above materials. However, the volume of plastic waste was increased due to the above decision. In addition to the above rule recently the government has introduced a new rule according to this new rule, ban the use and manufacture of plastic grocery bag, lunch sheet, form containers. However, still the ban is not practically implemented and the still people are using the above mentioned products. The effectiveness of the above regulatory mechanism is low mainly due to the lack of alternatives and lack of enforcement of the regulations.

In addition to the regulatory tool the government introduced market base instrument to the minimize the use of plastic. The government imposed a CESS on imports of all plastic raw materials and finished products. Initially the CESS was 1 percent and in 2009 the amount of CESS increased 10 percent with drop plastic price in the world market (Gunaratna, 2012). The fund collected through above CESS was allocated to provide funding for the activities of national post-consumer plastic management project. Under that project necessary facilities provided to increase the plastic waste recycling and plastic waste collection capacity of the country. However the still plastic waste recycling capacity is the country is very limited and 30 percent of plastic waste generated can be recycled. The private sector investment of the plastic waste recycling is quite significant.

In addition to the above market based instrument the government in a process of introducing an extended producer responsibility (EPR). The main aim of this initiative is to use of private sector contribution to improve the disposal of post-consumer plastics and to encourage material and energy recovery (CCC, 2017).

The prevention of marine litter enters into coastal and marine environment is the best way to solve this issue. However, any of the national level policy or strategy does not focus on the prevention strategies. The actions taken to prevent entering of marine litter is not sufficient through water and land. Also the strategies include waste minimization, waste collection and waste disposal mechanism. However, the municipal waste collection and disposal facilities are not sufficient to collect all waste generated in municipal areas. The lack of waste collection facilities has become a major factor in this issue, especially in some coastal areas household generated waste is not collected by the municipal council due to transport issues. The one of the major issues is lack of plastic waste recycling capacity.

6.3 Management activities done for Land based, Beach based and marine based litter

The management activities to prevent land based, coastal based and marine based have been taken from several agencies.

MEPA has initiated programs to address marine litter issue in 2006. ICC program has been initiated since 2008 with the support of other stakeholder agencies. SACEP as the regional body agency has supported to take necessary measures to solve the marine litter issue. Since 2008, SACEP has been

supported to carry out ICC programme. Also first South Asian Region Marine Litter Assessment Report was conducted by SACEP with the support of UNEP. However the first assessment has proposed several recommendations, most of the measures could not be implemented due to various reasons.

Land based activities generate the highest amount of marine litter. Use of plastic is significantly increased and due to the non-availability of proper collection, disposal and recycling facility, most of the plastic waste dumped into open areas. The reduction of use of plastic specially the use of single use plastic items such as food wrappers, shopping bags, lunch sheets should be encouraged. Considering the importance of this issue, the government recently has introduced new regulatory measures.

The regulation on polyethylene and plastic management was introduced with effect from 1st September 2017 (CEA, 2017). Under these regulations, following 6 orders issued to control of use of plastic and polythene and manufacture of the plastic and polythene.

- i) Order to prohibit the manufacture of polythene or any polythene product 20 microns or below.
- ii) Order to prohibit the manufacture of food wrapper (Lunch sheet) etc
- iii) Order to prohibit the manufacture of any bag of high density(grocery bag)
- iv) Order to prohibit burning of refuse and other combustible matters inclusive of plastic
- v) Order to prohibit the use of polyethylene products as decorations
- vi) Order to prohibit the manufacture of food containers, plates, cups, spoons from expanded polystyrene

These new regulatory measures will help reduce the manufacture and use of most of the single use products. The most of these items cannot be recycled and reuse and frequently uses items. The effectiveness of these regulatory measures will be heavily depended on the enforcement agencies..

The prevention of marine litter based generated from ships and fishing vessels, MEPA as per the mandate has taken initiative to provide a waste reception facility to ship generated waste in ships arrive to Sri Lankan port. The waste reception facility is established through registered service providers. All categories of ship generated waste as per MARPOL convention is accepted.

There are 21 fisheries harbours and several anchorages in Sri Lanka and with the support from Ceylon Fishery Harbour Cooperation MEPA established waste reception facility at fishery harbours. This facility used by fishermen, still the use of facilities by fishermen is quite low. Multi day boats carry huge amount of plastic packing materials and most of these materials dumped into the sea without bringing to the land.

Several measures have been taken to prevent a litter entering into the beach and clean up marine litter entered to the beach areas by several agencies. MEPA with the support of other relevant government agencies and private parties each year organize an International Coastal Cleanup day program. The number of participants for the national program has been increased recent years and with that initiative the Government has declared the entire week as marine and coastal conservation week. The coastal and marine area cleanup activities were organized and conducted by MEPA and other agencies during this week. Also waste collection facilities were established in popular recreation, beaches by MEPA and local authorities to collect and transport waste generated in batches.

6.4. Target under the Agenda 2030 and UN Sustainable Development Goals for marine litter management

The multi-faceted problem such as marine plastic litter can be addressed only through a collective attempt and needs to have regional and international level actions. UN sustainable development agenda is providing an overarching framework to place other international, regional, national and local initiatives in context (UNEP, 2016) .

UN sustainable goals encompass 17 Sustainable Development Goals and 169 targets. Goals 11, 12 and 14 appear particularly relevant to the issue of marine plastics, although all 17 goals are in some way involved (UNEP, 2016). Among 169 targets eleven targets under Goal 11, 12 and 14 are of relevance to reducing marine litter with those of most relevance highlighted in below table.

Table 21. SDG targets related to marine

6.3 By 2030, the proportion of untreated wastewater should be halved
11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
12.1 Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries
12.2 By 2030, achieve the sustainable management and efficient use of natural resources
12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse
12.b Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products
14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine litter and nutrient pollution
14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans
14.7 By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism
14.a Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries
14.c Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of The Future We Want
15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species

Sri Lanka has already committed to take necessary actions for tackling plastic waste, from reducing single-use plastic bags to introducing marine litter action plans.

7.0 National Marine Litter monitoring program.

7.1 Monitoring

The responsibility of the management, marine litter is associated among several agencies. Different agencies carried out a marine litter monitoring program in selected areas of the coastline. However, there is no comprehensive national program monitor marine litter in beaches, coastal areas and ocean. MEPA has conducted International Coastal Cleanup day program and the data collected during this program analyzed to get the idea reading the source and amount of marine litter. Other than that MEPA has conducted marine litter survey in the Negombo lagoon area, which include under water marine litter survey using side scan sonar and divers and beach survey. The MEPA regional office also carries out marine litter monitoring project, however, these monitoring programs were limited in the some places.

There is still the need for the establishment of a comprehensive national marine litter program to provide for a continuous assessment of coastal areas and sea. The collection of regular data will be a positive step to protect marine and coastal areas more effectively.

Monitoring should be scaled up to conduct trend analysis to study the effects of marine litter and determine if there are peak periods and to look at how litter returns to the same site. Monitoring of marine litter flow by incorporating the ocean currents to determine if there are areas which will be more prone to marine pollution will be beneficial. Also the monitoring program should be established to assess the impact marine litter to socioeconomic activities, environment and human health such a study will be very helpful to estimate the cost of the marine litter. It will eventually helpful to get government priority on this issue.

There are no research programs focused on studying of the abundance and the impact of micro plastic within Sri Lanka. The marine micro plates abundance, distribution in the marine environment and seafood should study and human health impact of micro plastic should be assessed.

7.2 Baseline and targets in the context of monitoring marine litter in the sea

Other than the above surveys no survey has been conducted related to the marine litter in the sea in Sri Lanka. Therefore, there are no baseline data to analyze the trend or the study of the impact marine litter on the ecosystem.

8. Gaps, Research, Analysis Knowledge needs, and propose a basis for setting priorities

The following gaps and needs related to marine litter management in Sri Lanka were identified as a result of the discussion carried out with relevant agencies, expert groups and researchers.

8.1. Inadequate Institutional frameworks and Stakeholder Involvement.

The responsibility of management of marine litter is dispersed among multiple sectors and multiple agencies. Many agencies have partial responsibility for selected components, which leads to a division of resources and ineffectiveness in overall management of marine litter related issues. The marine litter, mainly generated from the users of coastal and the sea areas as well as marine litter generates from far away areas from coastal areas and reaches to marine and coastal areas. The management, marine litter two folds, source prevention and control depression sources. It has been suggested that there needs to be reduced duplication of efforts as well as identification of clear lines of responsibility and authority in order to be more effective. Government agencies also need to share information amongst each other in an efficient manner and keep each other up-to-date on the issues and accomplishments.

8.2. Policy and Legislation gaps.

It is clear that there are several agencies to regulate and enforce management, solid waste in terrestrial areas. However, there is no clear policies and mechanism to manage marine litter in the beach and the sea areas. There is no national level policy to manage marine litter. The impact of marine litter to marine environment and social economic activities are significant. It is necessary to implement integrated national policy to manage marine litter.

Existing waste management legislation needs to be evaluated for its effectiveness and whether or not it is being enforced. Substantial legislation and regulations do exist, but are poorly enforced due to a variety of reasons.

A lack of an integrated approach in dealing with different types of waste, and the lack of cooperation between agencies that have jurisdiction for managing the waste, have adversely impacted the enforcement and monitoring of waste.

Many agencies have partial responsibility for select components which leads to a division of resources and ineffectiveness in overall marine litter management. Collaboration between NGOs and government agencies should be enough to save the marine litter issue.

8.3. Lack of infrastructure for waste collection, transport and recycle.

The impact of marine litter is clear that, however, there are not sufficient waste collection facilities in recreational beaches, harbors and marinas collect marine litter. Present waste management system is limited to, waste collection and transport and dumping to dumping sites. Only a very small amount of plastic waste is recycled by private sector companies. The lack plastic waste recycling facilities are

becoming a major issue and most of the plastic waste collected and finally dumped in the yard due to this issue. Therefore the increase of plastic waste recycling capacity is one of the major requirements to solve the marine litter issue. Waste collection facilities at the beaches are not sufficient and due to this waste discharged to the sea. The analysis shows that the use of plastic will be further increased significantly in future and eventually this will increase the amount of plastic waste and the amount of plastic recycling will be increased. However the gap between the amount of plastic waste and the amount can be recycle using will be further increased. Therefore necessary measured should be taken to establish recycle facilities.

8.4. Unavailability national level marine litter monitoring program

There is no national level marine litter monitoring program to identify the amount and type of litter in beaches, underwater and other sensitive ecosystems. A national marine litter monitoring program can support an expanded understanding of the problem and function as an ongoing component of management strategies that deal with pollution by marine litter. Periodic and consistent monitoring can be used to clarify the problem of marine litter, for example, what are the types, sources, impacts and how widespread is the problem. Data and research on marine litter can be used to help formulate management solutions, which must in turn be implemented by management agencies with support from the community, the private sector and other groups.

The objectives for monitoring programs must be clearly outlined. The policy could be developed through monitoring efforts to develop legislation or funding for, source-reduction programs, to assess trends, to identify the pathways by which litter gains access to the water, to assess wildlife

8.5. Education and Awareness

Waste collection and disposal methods have heavily depended on the person's attitude and the most general public do not have idea regarding the impact of marine litter and due to this they discard waste into the environment. The change of human attitude is one of the ways to minimize this issue. The properly design awareness and education programs need to be conducted to various segments of the society. The children should be educated in their childhood stage regarding the waste management.

Education and awareness campaigns need to be developed and implemented as a way to encourage increased involvement of NGOs and the private sector in the development and programming stages. The use of radio and television advertisements, printed educational materials need to be used more effectively to reach government agencies, general public, non-government agencies, and business and industry groups.

Educational components need to be more accessible to educators in the integration of the solid waste management issue into the school curriculum. There is a lack in the use of social media to aid in delivering the message to the younger audience and other groups so this is an area for further exploration. Education and awareness campaigns should target schools and communities to get into waste minimization practices such as composting, recycling, etc. Some programs have started in schools by MEPA but more can be done.

The beach areas of the country are heavily used in the entertainment industry. This has been growing and most events be likely to be held on the or near to the beach area, producing a lot of waste there. Therefore, education should target event managers and organizers to manage waste at the event properly. They could also notify or hire the local solid waste management agencies to clean after the events.

8.6. Strengthen the management and control efforts and financing mechanism

The use of plastic in the future will be increased and the amount of waste will also be increased. Therefore the investment needs to be done for collecting, treating and recycling facilities. It is very difficult to allocate the required amount of funds for the this purpose and market based tool such as the polluter pay principle and extended producer responsibility content need to be integrated into the system and all collected levy need to utilize for the intended purpose. Though this mechanism required financing can be generated without extra burden to the government. While financing may be available for infrastructural improvements, there is competition for those resources based on hierarchical needs. There are limited finances to develop the educational programs, research and to keep the monitoring programs functioning constantly. Therefore required amount fund need to be allocated.

9. Way forward

As stated in the previous sections there are various problem and issues related management of marine litter.

9.1. The dispersion of management authorities of marine litter and the absence of inter-agency cooperation between authorities.

Marine litter management responsibilities in Sri Lanka has dispersed and scattered across various organizations such as those in charge of land wastes, marine litter, fishery wastes, and beach wastes, etc. Addressing the most common causes and sources of marine litter will require engaging a variety of stakeholder organizations that have the institutional mission and capacity to carry out actions. These responsible organizations range from municipalities to the tourism and fisheries to neighbourhood associations and other community based organizations.

9.2. The absence of scientific survey and statistics for managing marine litter.

It is necessary to have a scientific field survey and statistics for effective and systematic collection and disposal of marine litter. The lack of statistical data on marine litter is highly affected to implementation of policies effectively.

9.3. Poor management of wastes flown from land to ocean

Although 90% of marine litter originates from land and 10% comes from the ocean, a significant amount of wastes is entering into the ocean due to a poor land management. Land wastes are generated by increasing population, accelerating urbanization, a lack of waste disposal facilities, growing industrial activities and the lack of public awareness. Specifically, wastes in rivers and canals which are connected to the ocean are not properly managed.

The absence of field-based management policy for depositing marine litter in the coastal and sea areas is one of the main reasons. Since the field survey of deposit marine litter in the coastal and sea areas has not been conducted, it has been impossible to understand the amount and the composition of marine litter. As a result, preventive management of marine litter flowing into the ocean has never been considered

9.4. Limitations to secure the financing for marine litter management

Currently, it does not have an organized management system to dispose of land wastes, particularly with disposal facilities in extreme shortage. Given the Sri Lankan government's conditions in allocating the financial budget, financing should be considered first for marine litter management policy. Also, it is necessary to implement prevention-oriented policy.

9.5. International and regional cooperation

It is well known that the most of the region has prepared a regional action plan solve the marine litter issue. Hence the marine litter issue is international and regional issue, the international and regional level program should be initiated to minimize the amount marine litter and its impact. However, the south Asian region could not still have a regional program in this regard.

9.6 Recommendations

Marine litter is becoming one of the major threats to the marine and coastal environment and to the industries which depend on the marine environment. So far there is no comprehensive marine litter management policy in Sri Lanka.

- **Introduce integrated National marine litter management policy, strategy and management plan**

The marine litter is coming from various sources and management of the marine litter issue is scatted among the several agencies. Therefore, it is necessary to introduce integrated national marine litter management policy and strategy. The implementation of the policy and strategy will be helpful to introduce comprehensive system. It is also required to obtain international and regional agencies to support implementation of such plan.

- **Intensive management of marine litter sources**

It is necessary to establish a coordination mechanism among agencies who have responsibilities to manage marine litter. Rigid enforcement of existing regulation related to marine litter should be done and if necessary new legislations/ regulations should be formulated to cover the identified gaps. Prevention strategies should be introduced to minimize the amount of marine litter entering into the marine environment through the establishment of beach waste collection system, minimizing marine litter coming through the waterways. Establish facilities and improve the available facilities for the prevention of marine enter into the marine environment through waterways is one of the significant initiatives and physical barriers can be put across the waterways and can be trapped most of the floating litter.

- **Building of marine litter collection system**

Continuous marine litter collection system should be introduced to remove marine litter from beaches and sensitive ecosystem. Adequate waste reception facilities should be established at commercial port and fishery harbours.

- **Building of marine litter disposal and recycling**

The lack of infrastructure facilities to properly dispose and recycle of waste is one of the major issues. The adequate infrastructure facilities should be established to recycle each type of marine litter.

- **Customized education and research**

Awareness and education programme should be formulated to educate all segments of the society. Research and development activities need to be carried out to identify new technologies and new ways in various aspects of marine litter.

- **Further strengthen public private partnerships**

The public private partnership for the collection and transport and dispose the waste should be further strengthened. Presently the private companies engage in plastic recycling faces several challenges related collection of plastic waste material for recycling purpose. Development of public private partnership will be helping to solve these issues and allocate adequate funds required for establishment of waste recycling facilities and proper functions of these facilities.

- **Use of market based instrument for reduce and manage marine litter**

The present legal tools, mainly focused on or limited to prohibition of the use and manufacture of several types of plastics. However, it is very clear that due to non-availability of alternative it is quite difficult implement the above measures. Use of plastic material should be reduced using market based instruments and also the polluter pays principle should be used to generate required funds for recycling and managing plastic waste.

- **Regional and international cooperation**

Marine litter can be freely moved from one area to other areas of the sea with sea current. The South Asian countries are home to one fifth of the world population and with rapid economic growth and the change of consumption pattern of the people, the amount of use of plastic and plastic waste generation will be increased significantly in the future. It will eventually be increased the amount of marine litter in the ocean. Also, this can affect to other countries. Regional mechanism is required to solve this nature issue. Hence the South Asian region as one of the regional seas areas should be introduced regional level measures to solve marine litter management issue. It is necessary to establish a regional level task force to prepare a regional level strategy, and carry out regional level research and development programmes as well as a data sharing mechanism related to the best available technologies and other areas of management of marine litter.

10. References

- Democratic Socialist Republic of Sri Lanka. (2017). *The Gazette of the Democratic Socialist Republic of Sri Lanka*, No. 2034/33. Colombo: Government Printing .
- Ashmy. (2016). *Marine Issues overview*. Retrieved 11 5, 2017, from <https://cdn.prezly.com/97/4e14a03a2011e6957b2b3af8b67d46/WFO-Marine--Issues-Overview-June-2016.pdf>
- Barnes, D. A., Galgani, F., Thompson, R. C., & Barlaz, M. (2009). Accumulation and Fragmentation of plastic Litter in Global Environments. *Philosophical Transactions of the Royal Society of London, Series B*, 364, 1985-1998.
- BOBLEM. (2011). *National Report Sri Lanka on the Formulation of a Transboundary diagnostic Analysis and Strategic Action Plan for the Bay of Bengal Lrge Maritne Ecosystem Programme*. Bangkok: BOBLEMP.
- BOBLEM. (2012). *Nationla Report of Sri Lanka on the strategic Action Plan for the Bay of Bengal Large Marine Ecosystem Programme*. bangkok: BOBLEM.
- BOBLEM. (2013). *Country Report on Pollution- Sri Lanka BOBLEM-2011- Ecology-14*. Bangkok: Bay of Bengal Large Marine Ecosystem Project.
- CCC. (2017, 6 22). Retrieved 11 30, 2017, from Response of the Ceylon Chamber of Commerce to the proposed Extended Producer: <https://www.chamber.lk/wp-content/uploads/2017/06/Ceylon-Chamber-of-Commerce-on-EPR-June-22-2017.pdf>
- CCD. (2004). *Coastal Zone Mngagment Plan of Sri Lanka*. Colombo: CCD.
- CEA. (2017). *Regulations on Polythene & Plastic Management 2017*. Retrieved 12 23, 2017, from http://www.cea.lk/web/?option=com_content&view=article&layout=edit&id=1080
- Central Bank of Sri Lanka. (2017). *Sri Lanka Socio Economic Data 2017*. Statistics Department . Colombo: Central Bank of Sri Lanka.
- De Bruin, G., Russell , B., & Bogusch , A. (1994). *The Marine Fishery Resources of Sri Lanka*. Rome, Italy: FAO.
- EFL. (2017). *Sustainable Tourism and Biodiversity: Tackling Marine Litter in Sri Lanka*. Retrieved 11 30, 2017, from <http://efl.lk/sustainable-tourism-biodiversity-tackling-marine-litter-sri-lanka/>
- Gunaratna, D. N. (2012). *Analysis of Future Trends of Plastic recycling in Sri Lanka*. Colombo: University Of Sri Jayawardenapura.
- Gunaruwan, L. T., & Gunasekara, N. W. (2016). Management of Municipal Solid Waste in Sri Lanka:A Comparative Appraisal of the Economics of Composting. *NSBM Journal of Managment*, 2(No 1), 27-44.
- Gunasekara, A. J., Priyadarshana, R. N., Ranathunge, K., Ranasinghe, T., Fernando, E., Ranaweera, R., et al. (2014). Status of marine litter accumulated in coastal areas of Sri Lanka. Colombo.
- Jalthota, S. (2017, 11 27). Plastic Waste Recycling Capasity of Sri Lanka.

- Jamberk, J. R., Roland, G., Cris, W., Anthony, A., & Mirriam, P. (2015). *Plastic waste inputs from land into*. Retrieved 11 4, 2017, from http://wedocs.unep.org/bitstream/handle/20.500.11822/17969/Plastic_waste_inputs_from_land_into_the_ocean.pdf?sequence=1
- Jayaweera, M. (2012). *Faecal Pollution from Mutwall Seaoutfall*. Colombo.
- JICA. (2016). *Data Collection Survey on Solid Waste Management in Democratic Socialist Republic of Sri Lanka*. Colombo: JICA.
- Lachmann, F., Almroth, B. C., Baumann, H., Brosrom, G., Corvellec, H., Gipperth, L., et al. (2017). *Marine plastic on Small Island Developing States (SIDS): Impacts and Measurs. Report No. 2017:3*. Gothenberg: Swedish Institute of the Marine Environment.
- Lebreton, L. C., Greer, S. D., & Borrero, J. C. (2012). Numerical modeling of floating litter in the world's ocean. *Marine Pollution Bulletin* , 61-64.
- MENR, UNEP. (2009). *Sri Lanka Environment Out Look 2009*. Colombo: MENR and UNEP.
- MEPA. (2015). *ICC Report of Sri Lanka*. Colombo: MEPA.
- MEPA. (2015). *Marine Environment Protection Authority Annual Report 2015*. Colombo: MEPA.
- MEPA. (2016). *International coaststal Cleanup programme report*. Colombo: MEPA.
- MEPA. (2017). *ICC Report of Sri Lanka 2017*. Colombo: MEPA.
- MEPA. (2017). *Marine Litter Managment plan for Negombo Lagoon*. Colombo: MEPA.
- NOAA. (2016). *National Oceanic and Atmospheric Administration Marine Litter Program. Report on Marine Litter Impacts on Coastal and Benthic Habitats*. Silver Spring, : National Oceanic and Atmospheric Administration Marine Litter Program.
- OSPAR UNEP. (2009). *Marine : Preventing a Sea of Plastic*. Retrieved 11 5, 2017, from http://plastics.earthmind.net/files/REP_OSPAR_2009.pdf
- Rech, s., Macaya-Caquilpan, V., Rivadeneira, M. M., Jofre Madariga, D., & Thiel, M. (2014). Rivrs as a source of marine - A study from the SE Pacific. *Marine Pollution Bulletin*, 66-75.
- SACEP. (2007). *Marine in the South Asian Region*. Colombo: South Asia Co-operative Environment Programme.
- SLPA. (2015). *SLPA Annual Report 2015*. Colombo: SLPA.
- Srirajiv, S. (2017, 5 2). *Recycling Plastc the BPPL way*. Retrieved 11 25, 207, from <http://dailynews.lk/2017/05/02/business/114626/recycling-plastic-waste-bppl-way>
- Surfers Against Sewage. (2014, 10). *Marine Report*. Retrieved 11 25, 2017, from <https://www.sas.org.uk/wp-content/uploads/SAS-Marine--Report-Med.pdf>
- Survey Department. (2007). *The National Atlas of Sri Lanka*. Colombo: Goverment Press.
- Survey Department. (2007). *The National Atlas of Sri Lanka*. Colombo: Survey Department.
- TCP. (2015). *Sri Lanka Turtle Conservation Project*. Retrieved 11 30, 2017, from <http://www.sltcp.org/marine-turtles-tcp-sri-lanka/>

- UNEP. (2005). *Marine and Analytical Overview*. Nairobi: UNEP.
- UNEP. (2015). *Marine Assessment in the Mediterranean*. Retrieved 11 5, 2017, from <https://wedocs.unep.org/rest/bitstreams/9739/retrieve>
- UNEP. (2016). *Marine plastic litter and microplastics – Global lessons and research to inspire action and guide policy change*. Nairobi: United Nations Environment Programme.
- UNEP and GRID-Arendal. (2016). *Marine litter Vital Graphics*. Retrieved 11 30, 2017, from United Nations Environment Programme and GRID-Arendal: <http://staging.unep.org/docs/Marine.pdf>
- United Nations. (2016). *Chapter 25 Marine Litter*. United Nations.
- Waste Management Authority. (2016). *Business Opportunities Available in the Waste*. Western Province Waste Management Authority. Colombo: Waste Management Authority.
- WMA. (2016). *Waste Generation database*. Colombo: WMA.
- World Bank. (2013). *waste Atlas*. Retrieved 11 17, 2017, from Waste Atlas: <http://www.atlas.d-waste.com/>
- World Bank. (2013). *Waste Atlas 2013 Report*. Retrieved 11 18, 2017, from http://www.iswa.org/fileadmin/galleries/News/WASTE_ATLAS_2013_REPORT.pdf



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