Commonwealth Litter Programme – Sri Lanka
Waste management system in Sri Lanka

Review of and recommendations

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CLiP Commonwealth Litter Programme

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Contents

Acronyms	
BOI	Board of Investment
CCET	IGES Centre Collaborating with UNEP on Environmental Technologies
CCOA	Commonwealth Clean Oceans Alliance
CEA	Central Environmental Authority
Cefas	Centre for Environment Fisheries and Aquaculture Science
CLiP	Commonwealth Marine Litter Programme
Defra	Department for Environment, Food and Rural Affairs
DRS	Deposit Return Scheme
DS divisions	Divisional Secretary's Division
EPL	Environmental Protection Licence
EPR	Extended Producer Responsibility
ERP	Environmental Remediation Programme
FAO	Food and Agricultural Organisation
GDP	Gross Domestic Product
GN division	Grama Nildahari divisions
GNI	Gross National Income
IGES	Institute for Global Environmental Strategies
IWMI	International Water Management Institute
KPS	Kalutara PS
KUC	Kuliyapitiya Urban Council
LA	Local Authorities
LEED	Leadership in Energy and Environmental Design
MC	Municipal Councils
MEPA	Marine Environmental Protection Authority
MoH	Ministry of Health, Nutrition and Indigenous Medicine
MoLGPC	Ministry of Local Government and Provincial Councils
MoE	Ministry of Environment
MoMWD	Ministry of Megapolis and Western Development
MoPAHA	Ministry of Public Administration and Home Affairs
MSW	Municipal Solid Waste
MTPD	Metric ton per day
NARA	National Aquatic Research Centre

Acronyms	
NEA	National Environmental Act
NGO	Non-Governmental Organisation
NMC	Negombo Municipal Council
NPSWM	National Policy on Solid Waste Management
NSWMSC	National Solid Waste Management Support Centre
PET	Polyethylene Terephthalate
PPP	Public Private Partnership
PPS	Pathadumbara PS
PRC	Plastic Recycling Centre
PS	Pradeshiya Sabhas
PVC	Polyvinyl Chloride
SATREPS	Science and Technology Research Partnership for Sustainable Development
SDG	Sustainable Development Goals
SPC	Sampath Piyasa Centres
SW	Solid Waste
SWM	Solid Waste Management
SWML	Scheduled Waste Management License
UC	Urban Councils
UN	United Nations
VBB	Volume Based Bag
WEEE	Waste Electrical and Electronic Equipment
WMA-WP	Waste Management Authority
WMF	Waste Management Facility

1. Background

1.1. Structures

The Commonwealth Marine Litter Programme (CLiP) is an initiative delivered by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) and funded by the United Kingdom's Department for Environment, Food and Rural Affairs (Defra). The initiative contributes to the UK meeting its responsibilities under the Commonwealth Blue Charter, which calls for Commonwealth countries to drive action and share expertise on issues affecting the world's oceans. CLiP contributes to the Commonwealth Clean Oceans Alliance (CCOA), which calls on countries to pledge action to eliminate avoidable plastic waste. CCOA also promotes actions in line with the United Nations Sustainable Development Goal 14 (*life below water)* to conserve and sustainably use the oceans, as well as contributing to the UK Government's 25 Year Environment Plan.

Cefas work with partners across the Commonwealth to share expertise and find solutions to the environmental and socio-economic problems caused by litter in the marine environment. Scientists collaborate with national Governments, local authorities, regional sea conventions, NGOs, Universities, and industry to identify country specific solutions. Cefas also work alongside international organisations, to ensure actions are coordinated on national, regional, and global levels, with activities that are already taking place to tackle marine litter.

CLiP aims to develop a network of specialist advisors who will lead the development and implementation of national litter action plans in some Commonwealth countries. The action plans will aim to reduce the amount of waste entering the marine environment, contributing towards making our oceans cleaner, healthier and more sustainable. Although the action plans will be country specific, they will also provide regional templates for other countries across the Commonwealth. CLiP's main objectives are set out in figure 1-1.

Figure 1-1 CLiP Main Objectives

1.2. Plastic Pollution

Marine litter is found in all the oceans of the world. It is found not only in densely populated parts of the Commonwealth but also in remote areas, far from obvious sources and human contact (UNEP, 2019). Marine litter originates from both land and sea-based sources and it is mostly composed of plastics, which are estimated to represent up to 95% of the litter accumulating on coastlines worldwide (Galgani et al., 2015). This makes plastic pollution one of the most widespread problems facing our oceans today. Globally, it is estimated that 6.4 million tonnes of marine litter enter the oceans each year, with about 8 million items entering the oceans every day (UNEP, 2019) (McIlgorm, et al., 2008). The social, economic and environmental impacts on people and communities globally are huge. It is estimated that in the Asia-Pacific region, the cost of marine litter to marine industries is a minimum of €1.26 billion per year, including losses from tourism, entangled ship propellers and time lost for fishing (McIlgorm, et al., 2008).

Preventing plastic pollution from entering the environment will require focused efforts on behaviour change (reducing our reliance on single-use plastics), improvements in waste management, and developing a more sustainable life cycle for plastics.

2. Scope

As poor waste management on land is a major source of marine litter, understanding what contributes to this, determining waste composition and understanding why it is mismanaged is important. Cefas engaged Wood Plc (Wood) to develop a desktop study to assess the current situation of waste management within the Democratic Socialist Republic of Sri Lanka (Sri Lanka). Wood were to base their analysis on existing scientific literature, official reports and interviews with experts from relevant local or international stakeholders that can address possible knowledge gaps or provide unpublished data ('grey literature').

The overall aim of the desktop study is to understand how the solid waste management practices in Sri Lanka are contributing to marine litter, considering both major leaks of waste into the environment and the status of the initiatives that are currently diverting waste from disposal (recycling, reducing, reusing, composting, bans etc).

The desktop study sets out to:

- Estimate current waste production and composition rates from households and commercial premises in Sri Lanka
- Describe the waste management system at a national level and analyse the legislation that regulates duties of national and local administrations
- Assess the efficiency of the existing waste management system (access to collection service of populations (rural, urban, semi-urban), adequacy of infrastructure, funding, efficacy of policies, legislation and enforcement mechanisms) including:
    - Estimating the percentage of waste that is mismanaged; and
    - Identifying what portion of that escapes into the marine environment to become marine litter.
- Assess the effectiveness of special waste (i.e. e-waste, toxic waste, quarantine waste) management in Sri Lanka.
- Assess the effectiveness of current best practices, initiatives and legislation at local and national level related to diversion from landfill and reduction of waste (including product bans)
- Undertake a gap analysis of Sri Lanka's waste management system at national and local levels suggesting a method to prioritise addressing these gaps.
- Identify a series of recommendations to improve the current status of solid waste management, including enhancing and scaling up of best practices.

3. Country Information

3.1. Background

The Democratic Socialist Republic of Sri Lanka is an island country in South Asia located in the Indian Ocean off the South Eastern tip of India. Sri Lanka became an independent country in 1948, after nearly 150 years of British rule. This country is now part of the United Nations and a member of the Commonwealth and South Asian Association for Regional Cooperation (Peiris, 2021). Sri Jayawardenepura Kotte is its legislative capital, and Colombo is its largest city and centre of commerce.

3.2. Geography

3.2.1. Topography

Sri Lanka, seen in figure 3-1, covers an area of 65,610 km^2 and is located north of the equator with a tropical climate. Due to its location, Sri Lanka is affected by two monsoon rainfall seasons occurring every year from December to March and May to October. The terrain is mostly low, flat or rolling plains with a more mountainous region in the South-Central interior, the island is surrounded by a coastal belt.

Figure 3-1 Map of Sri Lanka (Mapsofworld, 2021).

The highland area consists of a high plateau containing the main peaks of the Country. From the high plateau the landscape descends to the plains, these are the most extensive landform in the Country. They lie between 200 and 30m above sea level with ridges and occasional exposed rock formations. The coastal belt surrounds the island and consists of sandy beaches and coastal lagoons.

There are 103 rivers in Sri Lanka and sixteen major rivers (over 100km), the rivers rise in the central highlands and flow in a radial pattern towards the coast. Twelve rivers carry approximately 75% of the freshwater discharge. The Mahaweli Ganga is the longest river in the island and has drainage basin covering more than one-fifth of the island. The lower reaches of the rivers have had human intervention with the development of water storage and flood relief measures implemented, this interventions impact on the natural flow of the rivers. Figure 3.2 shows the topographical relief map and points of discharge for major rivers around Sri Lanka.

Figure 3-2 Relief Map of Sri Lanka showing river discharge points.

The five most important rivers in terms of water quality, passing through major cities and urban areas within Sri Lanka are (De Alwis, 2019):

- Kelani River
- Kalu
- Mahaweli
- Walawe
- Gin

3.2.2. Climate

Sri Lanka's climate can be described as tropical, its position ensures that it is warm throughout the year with average daytime temperatures ranging between 28 and 30^{o}C topographical variations mean that there is a regional variation with the highlands being considerably cooler whilst the northern coastal areas are warmer.

Rainfall is influenced by the monsoon winds of the Indian Ocean with four distinct seasons. Between mid-May and October winds from the South-West bring moisture laden air which causes heavy precipitation over the central highlands, windward slopes can receive as much as 2.5m rainfall per month during this season. Following this there is an intermonsoonal season with periodic squalls and occasionally tropical cyclones bringing localised rainfall particularly to the Eastern seaboard. Between December and March, the monsoon winds come from the North-East, the precipitation in this season is less intense due to the reduced fetch with up to 1.25m/month falling on the North-Western slopes. There then follows a second intermonsoonal period characterised by lighter, variable

winds and evening thunderstorms. Recently the average rainfall and the intensity of rainfall events has increased resulting in more frequent flooding incidents (Dubbeling, 2014).

The rainfall tends to be restricted towards the south of the Country with the Northern area being relatively arid with what rainfall there is restricted to the winter monsoon.

3.2.3. Marine Environment

The coastline and adjacent waters support highly productive marine ecosystems such as fringing coral reefs and shallow beds of coastal and estuarine seagrasses. The coastal areas of Sri Lanka are important for both for its population and its industry, with 35% of the total population being coastline inhabitants, as well as 65% of the industries located in the coastal areas, and 80% of the tourism industry based in coastal areas (Mafaziya, et al., 2020).

Located on the tip of the Indian Sub-Continent the Sri Lankan coastline is affected by three major ocean surface current systems within the Indian Ocean, seen in figure 3-3 (National Ocean Service, 2021):

- The North Equatorial Current
- The Bengal Gyre and
- The Arabian Current.

The presence of these currents has the potential to both distribute low density material released into the ocean from Sri Lanka over a considerable distance and also transport marine litter from other Countries to the Sri Lankan coastline. Material released from the North and East coasts of the Country have the potential to become entrapped in the centre of the Bengal gyre. Material from the South and West coasts have the potential to become entrained in the North Equatorial Current which may result in material collecting in either the Arabian Sea or the Indian Ocean Gyre. The nature of these rotational currents accumulates and concentrates marine pollution at their centre.

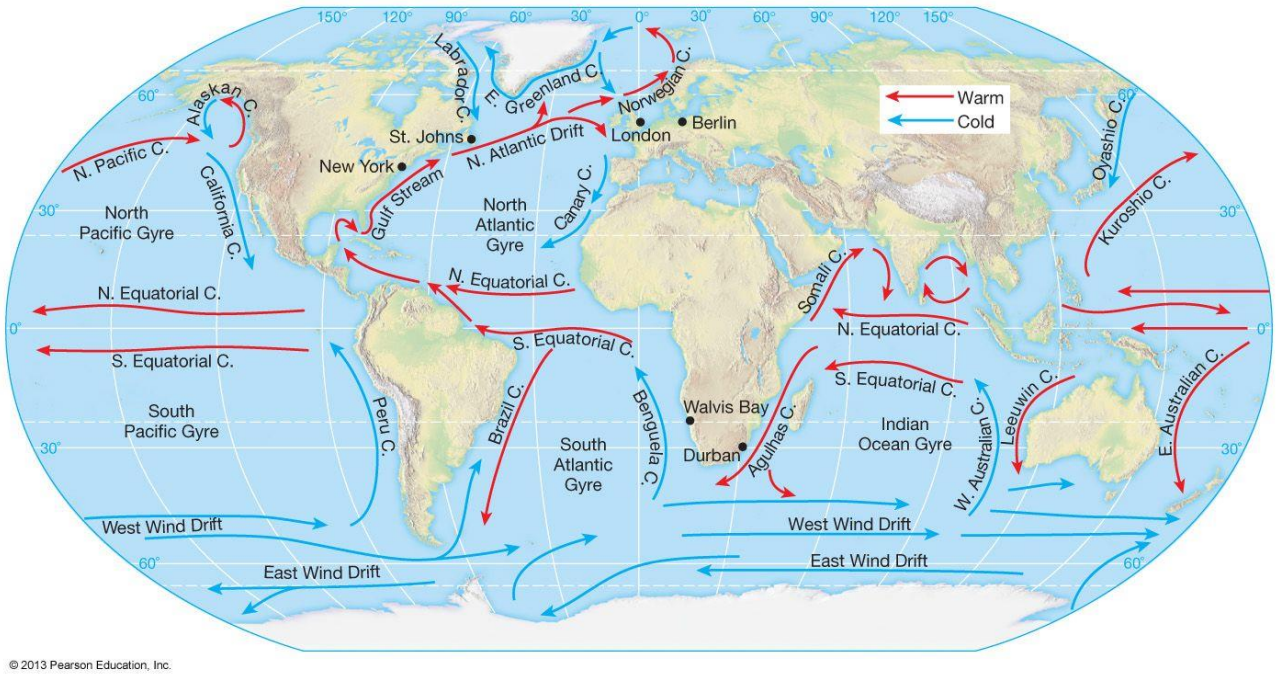

Figure 3-3 Map showing the currents affecting Sri Lanka. (Pearson_Education, 2013)

3.3. Population

The population distribution in Sri Lanka has remained broadly constant during the last decade and there is a significant difference between the size of the population in the Western Province and the other 8 Provinces. The mid-year population in 2018 was 21,670,000 divided per Province as shown in table 3-1.

Table 3-1 Population, Land Area and Per Capita Income by Province (Finance Commission of Sri Lanka, 2019).

Province	Mid- Year Population - 2018 (000')	Land Area 2018(Sq.km.)	Per Capita GDP - 2018 (Rs)	Median Per Capita Income 2016 (Rs)	Provincial Prosperity Index -2018
Central	2,750	5,575	618,280	9,890	0.490
Eastern	1,710	9,361	473,640	8,261	0.168
North Central	1,366	9,741	597,695	11,248	0.256
North Western	2,536	7,506	624,530	11,420	0.456
Northern	1,131	8,290	516,721	8,434	0.399
Sabaragamuwa	2,047	4,921	532,622	9,711	0.341
Southern	2,637	5,383	542,893	11,253	0.470
Uva	1,364	8,335	603,870	10,139	0.201
Western	6,129	3,593	901,562	14,400	1.301
Total	21,670	62,705	662,949	11,307	0.783

19% of the population of Sri Lanka live in urban areas with 2.25 million living in the Colombo district, on the West coast (Tradingeconomics, 2019). The remaining 81% of the population live in rural areas. The ten biggest cities in Sri Lanka by population in 2018/2019 can be seen in Figure 3-4. The cities are in the coastal areas, except for the city Kandy which is located in the central part of Sri Lanka (Mongabay, 2019). Five of the provinces are boarded by a coastal belt where 35% of the population lives (Mafaziya, et al., 2020).

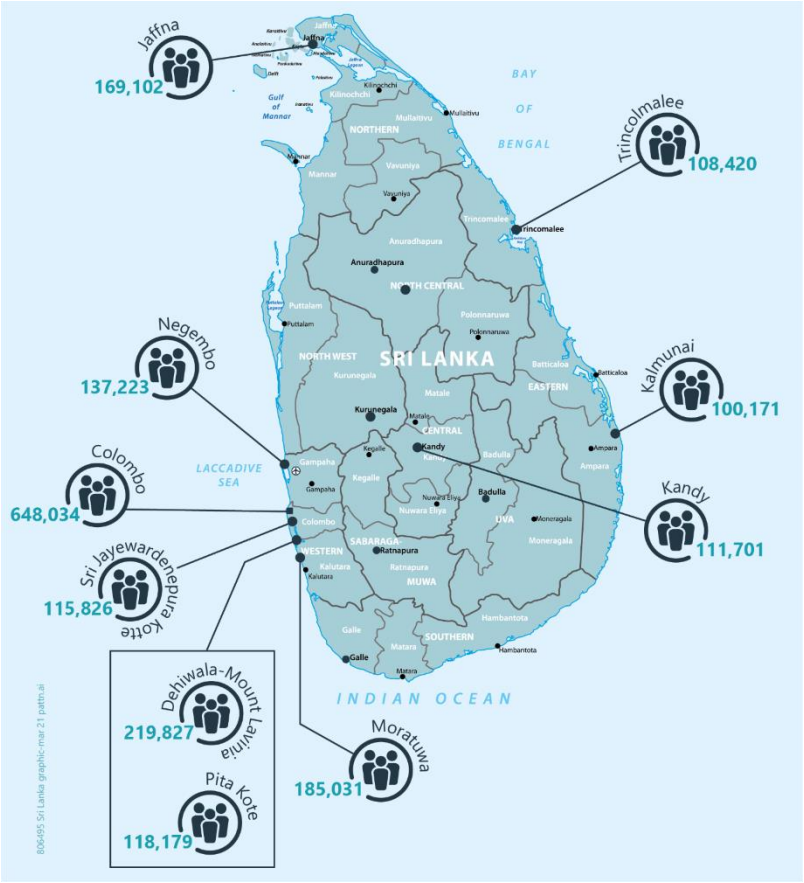

Figure 3-4 Population of the ten biggest cities of Sri Lanka in 2018/2019 (Mongabay, 2019).

3.4. Administration

Sri Lanka has four levels of administrative division:

1. Provinces
2. Districts
3. Divisional Secretary's Divisions - also referred to as Local Authorities (LAs)
4. Grama Niladhari Divisions.

There are 9 provinces and within these 25 districts:

- Northern – Jaffna, Kilinochchi, Mannar, Mullaitivu, Vavuniya
- North Western – Kurunegala, Puttalam
- North Central – Anuradhapura, Polonnaruwa
- Central – Kandy, Matale, Nuwara Eliya
- Eastern – Ampara, Batticaloa, Trincomalee
- Western – Colombo, Gampaha, Kalutara
- Sabaragamuwa – Kegalle, Ratnapura
- Uva – Badulla, Monaragala
- Southern – Galle, Hambantota.

Each district is further subdivided into a number of Divisional Secretary's Divisions (DS divisions). There are 335 DS divisions (also known as Local Authorities) within Sri Lanka, these are then further broken down into 14,022 Grama Nildahari divisions (GN divisions).

Sri Lanka possesses two parallel administrative divisions: The Central Government line and the Local Authorities (LA) line (JICA, 2016).

The Central Government administrative division falls under the Ministry of Public Administration and Home Affairs (MoPAHA). The District Secretariat implements, and monitors developing projects within the district level and assists in revenue collection and coordination of election for the district.

Sri Lanka has 335 LAs which are divided into 3 categories: 23 Municipal Councils (MC), 41 Urban Councils (UC), and 271 Pradeshiya Sabhas (PS). They are in charge of providing local public services such as roads, sanitation, drains, waste collection, housing, libraries, public parks, and recreational facilities. LAs are grouped into the nine Provincial Councils. The distribution of LAs by province is shown in table 3-2.

Table 3-2 Distribution of LAs by Province (Finance Commission of Sri Lanka, 2013).

Province	MC	UC	PS	Total
Central	4	6	33	43
Eastern	3	5	37	45
North Central	1	0	25	26
North Western	1	3	29	33
Northern	1	5	28	34
Sabaragamuwa	1	3	25	29
Southern	3	4	42	49
Uva	2	1	25	28
Western	7	14	27	48
Total	23	41	271	335

3.5. Economy

In 2019, the World Bank updated Sri Lanka's economic classification from lower middle income to high middle income. This classification is based on the Gross National Income (GNI), which was US dollars 3,741 per capita in Sri Lanka in 2019 (Central Bank of Sri Lanka, 2020)

The value of Sri Lanka's Gross Domestic Product (GDP) at current market prices was US dollars 3,852 per capita in 2019. The country's GDP has reduced when compared with 2018 when the GDP was US dollars 4,079 per capita. This is due to low economic growth, together with a severe depreciation of the Sri Lanka rupee. The annual GDP growth regression follows a steady trend that started in 2016 when the GDP growth was fixed at 4.5% (Central Bank of Sri Lanka, 2020).

The main drivers for each GDP approach (national output, expenditure and income) in 2019 are (Central Bank of Sri Lanka, 2020)

- Expenditure approach – Private consumption, with the expenditure on transport the main driver (6.8% growth, 69.3% contribution to expenditure GDP)
- Income approach – Gross Operating Surplus, which contributed to the income GDP by 63.1%
- Production approach – Wholesale retail trade has made Services the main GDP growth driver (2.3% growth, 57.4% contribution to production GDP)

The overall contribution from the industry sector to the GDP (production approach) was 26.4%, with a growth of 2.7%. The manufacturing activities are the highest contributors, followed closely by the construction sector.

The agriculture sector contribution was very low in 2019 due to the extreme weather conditions. It has suffered a drastic growth regression from 6.5% in 2018 to 0.6% in 2019.

As a consequence, the unemployment rate has decreased during the last year from 4.8% in 2018 to 4.4% in 2019.

4. Solid Waste Management in Sri Lanka

4.1. Governing bodies

Following the Sri Lanka Administrative divisions introduced in section 3.4, the government agencies related to waste management are also divided into 2 main groups: Central Government Agencies and Local Government Agencies. Table 4-1 and table 4-2 summarise the main characteristic of each Government Agency.

Table 4-1 - Central Government Agencies (JICA, 2016).

Agency	Description
Ministry of Local Government and Provincial Councils (MoLGPC)	Responsible for the implementation of policies and plans for LA through the nine Provincial Councils (PC).
Ministry of Environment (MoE)	Leading administrative guidance from the perspective of environmental protection.
Ministry of Megapolis and Western Development (MoMWD)	Ministry appointed by the Cabinet of Sri Lanka after August 2015 elections. It is responsible for assisting LAs with the improvement of SWM.
Ministry of Health, Nutrition and Indigenous Medicine (MoH)	Policymaking, monitoring, and management of medical waste. They prepared the Healthcare Waste Management National Policy.
National Solid Waste Management Support Centre (NSWMSC)	Established by the MoLGPC in 2007 to assist LAs to improve the solid waste management problem. Provide technical assistance, data gathering, support waste awareness projects and facilitate technical and financial support from NGOs and others.
Central Environmental Authority (CEA)	CEA was implemented by the National Environmental Act (NEA) under the MoMDE and is responsible for the supervision and management of solid waste.

Table 4-2 - Local Government Agencies (JICA, 2016).

Agency	Description
Provincial Council (PC)	There are nine PCs across the country. They provide substantial administrative guidance to the District and LAs of the region, economic and technical support.
Local Authority (LA)	Responsible for providing administrative services such as health and hygiene, waste disposal, regional environmental protection, and park management.

Due to the SWM problems within the Western Province, especially within the Colombo District, the Western PC founded the Waste Management Authority (WMA-WP) in 2004. The WMA-WP are the responsible agency for SWM in the Province and support LAs to improve their SWM, both technically and financially.

4.2. Legislation

4.2.1. Solid Waste Regulation

Legal Framework

At present, the basic legal framework for MSW management in Sri Lanka is provided under a collection of regulations and legislations overseen by Central Government, PCs and LAs. As well as the 13th amendment to the Constitution (1987), the following Ordinances and Acts are the key pieces of legislation pertaining to waste management in local authorities, stating that local authorities are responsible for proper removal of MSW and for providing suitable dumpsites:

- Provincial Councils Act-No. 42 of 1987
- Municipal Council Ordinance Act-No. 16 of 1980 - Section 129,130,131
- Pradeshiya Saba Act No:15 of 1987, Section 41, 93, 94, 95
- Urban Council Ordinance Act-No 61 of 1939 - Section 118, 119, 120

Each local authority sets the implementation rules for waste management and regulation within their jurisdiction and has the authority to impose penalties. The PCs oversee waste management within the local authorities.

In 1980, the then Ministry of Mahaweli Development and Environment devised the National Environmental Act No 47 (NEA) with the main purpose of preserving the environment and preventing pollution. It is an important regulation with regards to solid waste and was enforced with the aim of establishing a regulatory authority for environmental monitoring and regulation. The Act restricts the emission of waste materials

into the environment, and the CEA was established under the NEA to “make provision concerning the powers, functions, and duties of that Authority; and to make provision for the protection and management of the environment and matters connected therewith or incidental thereto” (Central Environmental Authority, 1980). Several waste management regulations have been set under the NEA including:

- **Gazette No. 1466/5 of 2006** ordered regulation for the prohibition of polythene or any polythene product of 20 micron or below in thickness.
- **Gazette No. 1534/18 in 2008** set regulations regarding the requirement for an environmental protection license for discharge, emission or disposal of waste, as well as a licence for the management of ‘scheduled waste’ as specified in Schedule VIII of the regulations (wastes from non-specific and specific sources).
- **Gazette No. 1627/19 in 2009** set regulations for MSW, prohibiting the dumping of MSW along national highways and any place other than places designated for such purpose by the relevant LA or those authorised on their behalf.
- **Gazette No. 34-38 in 2017** regulations were set for polythene and plastic management including prohibiting the manufacture of food wrappers, high density plastic bags, food containers, plates, cups, spoons from manufactured from polystyrene, the use of polyethylene products as decorations and the order also prohibited the burning of refuse and other combustible materials inclusive of plastic.
- **Gazette No. 2211/50 of 2021** stipulated that plastic items should be clearly marked with the Plastic Material Identification Standards symbol as specified in the Schedule.
- **Gazette No. 2211/51** prohibits the use of Polyethylene terephthalate (PET) or polyvinyl chloride (PVC) material for packing agrochemicals in any process, trade or industry, as well as plastic sachets having less than or equal to a net volume of 20ml / net weight of 20g (except for packing food and medicines), certain inflatable toys and cotton buds with plastic stems.

Illegal activities

In terms of open dumping, and the open burning of waste, the following rules and regulations prohibit these activities:

- National Environment Act
- Legislation / by laws under the Provincial and Local Authorities.
- Regulations under Marine Pollution Prevention Authority
- Public Nuisance Ordinance
- Irrigation Ordinance (as amended to address riverine protection)
- Flood Protection Act (to be amended - covers part of the rules and regulations related to riverine protection).

The National Environment Act, Irrigation Ordinance (riverine protection) and flood protection act (riverine protection) prohibits littering in river and water bodies, whilst the regulation under the Marine Pollution Prevention Authority prohibits marine littering.

4.2.2. Industrial Activities Legislation

The *'Quick Reference Guide to Relevant Industrial Standards of Sri Lanka'* (Environmental Foundation Limited, 2015) was published under the National Environmental Act N47 of 1980 (As Amended). It provides an overview of the Environmental Protection requirements and the standards to be met by every Enterprise.

Enterprises are required to obtain an Environmental Protection Licence (EPL) before commencing commercial operations. This is established in the National Environmental Regulations of 2008, under the NEA. EPL is issued by the Environment Management Department and the CEA.

The guide also stipulates the tolerance limits of chemicals for water (industrial and drinking), air and noise.

Main Regulations involved in industrial activities legislation are:

- National Environmental (Protection and quality) Regulations - Gazette No. 1534/18 of 01.02.2008
- National Environmental (Ambient Air Quality) Regulations - Gazette No. 850/4 of 20.12.1994
- National Environmental (Noise Control) Regulations - Gazette No. 924/12 of 23.05.1996 / Gazette No. 973/7 of 30.04.1997
- National Environmental (Municipal Solid Waste) Regulations - Gazette No. 1627/19 of 10.11.2009 87
- The Marine Pollution Prevention Act - Gazette No. 1709/15 of 07.06.2007
- Marine Environmental Protection (Issuance of Permits for Dumping at Sea) Regulations - Gazette No. 1816/37 of 28.06.2013
- Environmental Protection Areas specific regulations

Furthermore, Generators of scheduled waste must obtain the Scheduled Waste Management License (SWML) in addition to the Environmental Protection License (EPL).

Companies with SWML are obliged to report to the CEA about the types and amounts of their scheduled waste. 350 entities were identified as having obtained the SWML in 2016. Although the CEA has information about each of the entities, there are no updated statistics about the scheduled waste (JICA, 2016).

For the separation, storage, treatment, transportation and disposal of hazardous waste, there are the following rules and regulations:

- Hazardous Waste Management Regulations (1996)
- Hazardous Waste Guidelines (2012)

Licences and approvals have to be obtained from the CEA for handling and disposal of all hazardous wastes, under the Hazardous Waste Management Regulations.

4.3. National policies

The Ministry of Environment developed the National Strategy on Solid Waste Management in 2000 which recognised the requirement from generation to final disposal through a range of strategies, based on the 3-R principle (reduction, reuse, recycling). This was superseded by the National Policy on Solid Waste Management (NPSWM) in 2007 with the view to facilitate solid waste management in the country with more emphasis on municipal waste and an integrated solid waste management approach (Ministry of Environment and Natural Resources, 2007). It was prepared "to ensure integrated, economically feasible and environmentally sound SWM practices for the country at national, provincial and local authority level" managing wastes in accordance with the 3R principle with special emphasis on waste prevention. The policy objectives were:

- To ensure environmental accountability and social responsibility of all waste generators, waste managers and service providers
- To actively involve individuals and all institutions in integrated and environmentally sound solid waste management practices
- To maximise resource recovery with a view to minimise the amount of waste for disposal
- To minimise adverse environmental impacts due to waste disposal to ensure health and wellbeing of the people and on ecosystems.

The NPSWM emphasises that each LA is responsible for the collection and disposal of waste generated by residents who live in the region.

Following the 2007 national policy, the CEA initiated the 'Pilisaru' National Solid Waste Management Program in 2008 which provided funding of approx. 5.6 billion rupees (~£1 billion) to the LAs that implement solid waste management activities. To prioritise appropriate and sustainable SWM, in 2009, the Government devised the 'National Action Plan for the Haritha Lanka Programme' (2009-2016) to incorporate sustainable development within a range of areas including SWM, and a strategy was set for utilising appropriate infrastructure and/or alternative methods required for SWM in each LA.

In 2019, Sri Lanka updated its National Waste Management Policy with a more holistic approach to waste management to respond to the waste management problems experienced in the country (Ministry of Environment, 2019). It acknowledges that other waste streams need priority attention in addition to MSW. It is a revision and extension to the NWSWM devised in 2000 and the NPSWM in 2007. The policy is designed to "*provide more detailed focused directions for policy makers and implementers covering vertical and horizontal levels in the administrative and management structures of the country. The time span proposed is up to 2030*".

The policy covers all three types of waste; solid, liquid and gaseous, and includes hazardous waste streams (industrial waste, healthcare waste, radioactive waste). It addresses emerging waste streams such as packaging waste, construction and demolition waste, food waste and e-waste.

There are focused policy statements to offer guidance to the legally mandated institutions and other service providers. The policy reinforces that waste managers must perform their duties with the highest degree of responsibility and accountability throughout the country and that it is everyone's duty to protect the nature and conserve its riches.

The vision of the policy is '*managing waste for healthy life for all'* with a mission for development of an eco-friendly nation by promoting resource circulation.

The Policy acknowledges the overarching problems with regards to waste management within the country and hopes to rectify some of the problems and gaps but there is only 'guidance and directions' to achieve their objectives. There are general policy statements covering all forms of waste together, with specific policy statements relating to:

- Solid, liquid and gaseous waste
- Knowledge management and capacity building
- Institutional mechanisms, coordination and communication
- Monitoring, evaluation, feedback and reporting
- Legal and enforcement mechanisms
- Financial mechanisms and non-financial incentives
- Compliance with International treaties/conventions
- The way forward

The Policy identifies a responsible agency for each waste type, points to the application of market-based instruments to maximise resource and economic efficiency, requests performance should be reported annually with improved reporting by LAs through the creation of appropriate databases. Waste collection timetables should also be developed by LAs and there is responsibility on PCs to identify and provide suitable locations to LAs for the disposal of waste aided by clustering the LAs.

Healthcare waste treatment facilities have been established island wide and the Ministry believe appropriate clustering will be able to cater to the requirement of the government sector. Wider use of these facilities will be explored once specific and related sub-sectoral polices and strategies have been devised. The Policy states that current available disposal facilities are not adequate to deal with all the hazardous waste generated in the country (Ministry of Environment, 2019).

5. Waste generation

The NPSWM published in 2007 assumed that the total municipal solid waste generation in Sri Lanka was around 6,700 tons/day, and the daily waste collection by local authorities was estimated at 2,700 tons/day. Dharmasiri (2019) also used this figure when talking about the total solid waste generation, indicating the disparity within the data available. In 2009, the waste generation in Sri Lanka was reported to have increased to 10,786 tons/day due to economic growth after the end of the civil war. Moratuwa University and NSWMSC published SWM indicators in Sri Lanka in 2013, as shown in Table 5-1.

Table 5-1 SWM Indicators of Sri Lanka (JICA, 2016).

Provinces	Waste Generation (ton/day)		Collection Amounts (ton/day)		Collection rates	No. Final Disposal Sites
1. Northern	566	5%	178	5%	**31%**	16
2. Eastern	785	7%	347	10%	**44%**	40
3. North-central	616	6%	91	3%	**15%**	35
4. North-western	1,134	11%	187	5%	**16%**	45
5. Central	1,585	15%	304	9%	**19%**	47
6. Sabaragamuwa	835	8%	178	5%	**21%**	30
7. Uva	587	6%	116	3%	**20%**	24
8. Western	3,502	33%	1,793	52%	**51%**	52
9. Southern	1,158	11%	264	8%	**23%**	60
Total	10,786	100%	3,458	100%	**32%**	349

In comparison to the above, the CEA published the solid waste collection rates for each province as shown in Table 5-2. The collection rates are significantly lower than those in Table 5-1, in particular for the Eastern Province. This highlights the disparity of the assumptions being made by various organisations and emphasises the requirement for consistent and continual monitoring of data.

Table 5-2 Percentage of Solid Wase Collected by the LAs (CEA, 2015)**.**

Province	LA Collection rates
Western	**58.5%**
Eastern	**8.5%**
Central	**8%**
Southern	**7%**
North-western	**6%**
Northern	**3.3%**
Sabaragamuwa	**3.2%**
Uva	**3%**
North-central	**2.5%**

5.1. Baseline estimations

There appears to be a lack of centrally recorded waste data due to the irregular nature of waste management within the Country. This has meant that in developing baseline figures we have had to draw upon a range of sources to identify the potential arisings. Where there is a disparity in the waste arisings, we have attempted to highlight the differences and identify the most appropriate estimation to draw upon.

5.1.1. Municipal Solid Waste

There is a significant disparity between the nature of Urban and Rural properties within Sri Lanka and the nature and quantity of waste they produce. The waste generation for the urban areas are between 0.75 and 0.85 kg/day/cap and the rural area generates 0.4 to 0.6 kg waste/day/cap (Ministry of Environment and Natural Resources, 2007). In 2020 18.43% of the population of Sri Lanka lived in urban areas (Tradingeconomics, 2019). The population in Sri Lanka is estimated to be 21.41 million in 2020 (United Nations, 2019). Using the waste generation of 0.75 kg/day/cap to estimate the waste generation in urban areas and 0.6 kg/day/cap is used for rural areas (De Alwis, 2019). The total waste generation in Sri Lanka is therefore estimated to be 13,440 tons/day in 2020 or 4.9 million tons annually.

5.1.2. Waste Electrical and Electronic Equipment

The generation of WEEE in Sri Lanka has been estimated by De Alwis to be 20,000 tons per year with 4,500-5,000 tons of the collected WEEE exported annually (De Alwis, 2019). Gollakota *et al.* (2020) have made estimations of the production of WEEE at a continental level. It is estimated that on average the Asian population generates 4.2 kg WEEE per capita yearly (Gollakota, et al., 2020). Using the estimation by Gollakota *et al*. the generation of WEEE in Sri Lanka would be 89,936 tons in 2020.

The two different approaches to the calculation of WEEE arisings result in a difference of approximately 4.5 times. As the figure identified by De Alwis is a Sri Lankan specific figure we have used this estimation within our modelling, noting however the level is low compared to other areas which may indicate either an issue within the calculation or a potential for significant increase in WEEE waste arisings in the future.

5.1.3. Industrial waste and hazardous waste

No overall industrial waste data for Sri Lanka was nationally identified during the project. To attempt to estimate the national production of industrial waste we have used the assessment of industrial waste undertaken within Negombo industry by JICA. As the identification of industrial waste projections has been undertaken using a city-based assessment which will require extrapolation to a national level estimation we have considered 2 approaches:

- The first approach is a direct pro-rating of arisings based on the number of businesses in Negombo compared to nationally (this approach does not recognise the different natures of industries within different areas of the country)
- The second approach uses the proportion of the industrial landscape made up of the fishing industry in Negombo to attempt to account for the difference in the industrial landscape when scaling to a national level.

When considering the production of Industrial waste within Sri Lanka it is important to consider that the JICA report identified that non-hazardous industrial waste may not be recorded as industrial waste "*In Sri Lanka, industrial waste was considered as hazardous waste that requires special control and classified as "Scheduled Waste".* It was found in the report that industrial waste often is collected with the MSW (JICA, 2016).

Negombo Municipal Council's management of industrial waste in 2003 can be seen in table 5.3. These figures, along with the estimation of waste treatment routes have been used in the development of the waste treatment baseline. It is estimated that businesses in general are expected to dispose of their waste through municipal collection, onsite disposal or by recycling the materials.

Table 5-3 Distribution of Industrial Waste based in Negombo Municipal Council

	NMC Collection	Onsite disposal	Onsite composting	Recycling	Illegal disposal
Industry waste [tons/day]	38.8	9.6	0.1	6.4	0.2
Fraction	70.39%	17.43%	0.18%	11.63%	0.36%

Industrial waste based on businesses in Negombo

Using the ratio of businesses in Negombo and the industrial waste generation in Negombo as an indicator for the total industrial waste generation in Sri Lanka. The number of businesses in Negombo is 38 and the total number of businesses in Sri Lanka is 3,764 (LISTCOMPANY, 2020). The generation of industrial waste in Negombo was 55.22 tons/day in 2003 (Karunarathana, et al., 2019). Dividing the waste generation with the number of businesses in Negombo and multiplying it with the number of businesses gives a total waste generation in 2019 of 5,470 tons/day or 1,997,500 tons in 2019. It should be noted that this approach does not take the size and distribution of the 38 businesses in Negombo into consideration when compared to the 3,764 businesses in Sri Lanka. It is therefore possible that this approach underestimates waste production.

Industrial waste based on Negombo fishing industry

In 2010 5% of the fishing industry of Sri Lanka revenues was exported – a total of USD 171 million. The total fishing industry is therefore estimated to have generated USD 3.42 billion of the Sri Lankan Economy in 2010 (Export Development Board, 2012). The city of Negombo generates 16% of the income generated by the fishing industry in Sri Lanka. The Negombo economy is divided into three sectors, seen in figure 5-1. The income from the fishing industry in Negombo was therefore USD 547.2 million in 2010 and the total income in Negombo was USD 1.216 billion (Gampaha District Office, 2018).

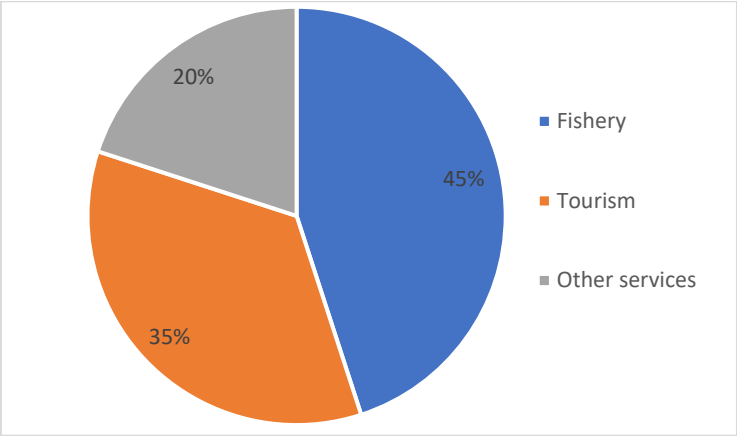

Figure 5-1 Economy of Negombo divided by sectors (Gampaha District Office, 2018).

The Sri Lankan GDP was in 2010 USD 56.726 billion and it was increased to USD 87.467 billion in 2019. Using the relationship between GDP and the Negombo Fishing industry, the industrial waste generation in 2003 in Negombo was found to be 55.22 metric tons/day (Karunarathana, et al., 2019). Using these figures to base the extrapolation of industrial waste arisings results in an estimation of 2,939 tons per day in 2019 or 1,072,735 tons in 2019. It should be noted that this approach does not take the distribution of sector for other areas into consideration. It is not defined where the industry waste generation in Negombo originates from thus, the waste generation from this approach may be an underestimation.

5.2. Waste Composition

5.2.1. Municipal Waste Composition

Municipal Solid Waste composition figures reported within assessments that have been undertaken have varied over time. However, all show similar values for biodegradable material and organic waste being the largest fraction. Figure 5-2 shows the waste composition in Sri Lanka as a whole, as included within the NPSWM of 2007 as well as by the CEA in 2014. It shows that biodegradable waste is 62% of the waste stream, glass represents the smallest individual fraction at 2% whilst “polythene and other plastic” constitute 6% of the waste.

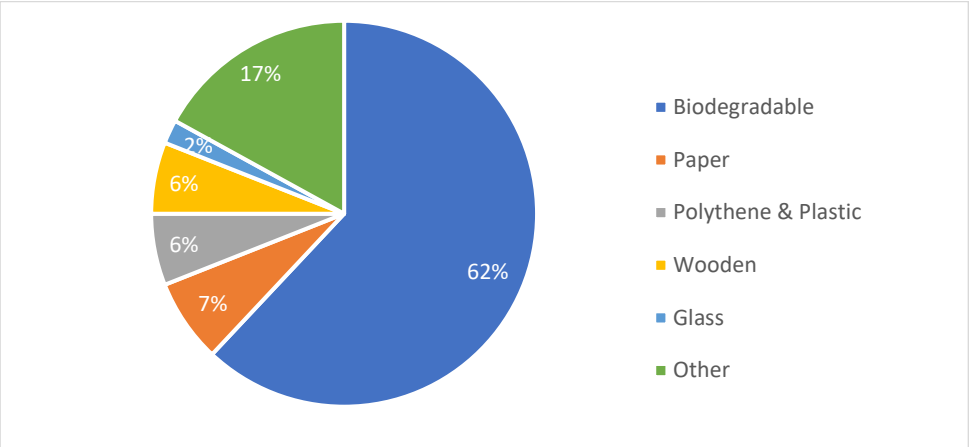

Figure 5-2 Waste Composition in Sri Lanka (Lal Mervin Dharmasiri, 2019).

The JICA, 2016 report however provides a more recent and detailed assessment of waste composition split between urban and rural areas. Wood have selected this study to represent MSW composition within this report as it was the most recent and detailed assessment that has been undertaken. Figure 5-3 shows that the waste composition in the rural areas consists of more bio-waste compared to the urban waste composition – 63.2% to 52.5%. It can also be seen that the urban area has a higher content of paper, hard and soft plastic, and metal. It accounts for a total of 24.8% of the urban waste stream whereas it only accounts for 11.4% of the rural waste stream.

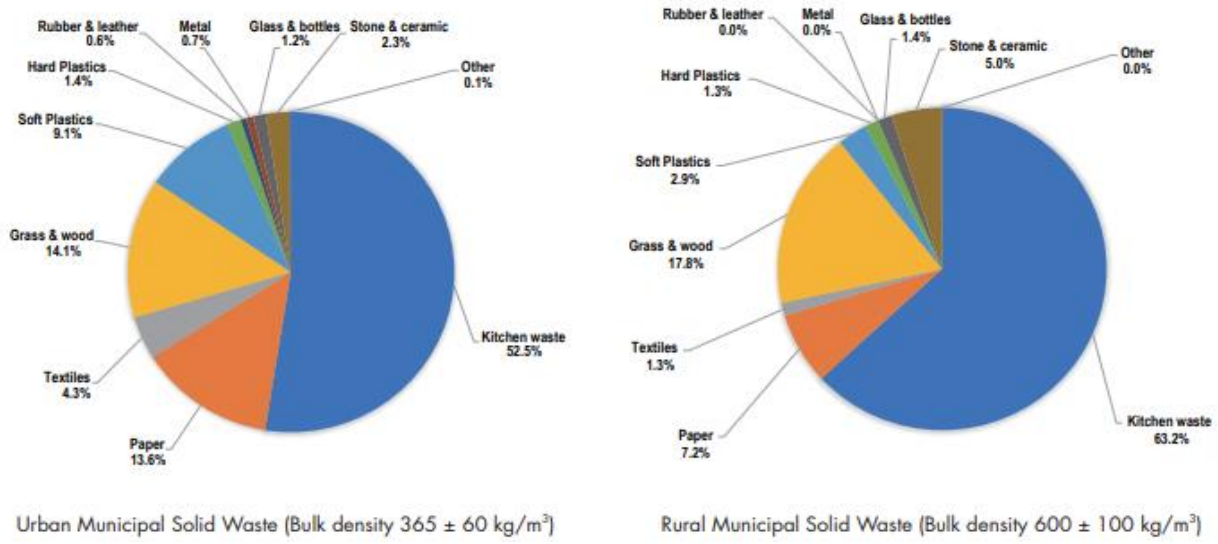

Figure 5-3 Composition of Municipal Solid Waste in Urban (left) and Rural (right) Areas of Sri Lanka (JICA, 2016).

5.2.2. WEEE

Eurostat (eurostat, 2020) subdivide WEEE into four sub-categories for the purpose of identifying their waste compositions:

- Cooling and heating white goods
- Small household appliances
- IT and consumer equipment, and
- Lighting equipment.

The distribution of these categories is based on the European distribution due to data availability. It is not expected to represent the distribution of WEEE in Sri Lanka correctly, but it may be used as a proxy to provide insight in the importance of monitoring this waste stream. The distribution can be seen in table 5-4 (eurostat, 2020). The material composition of WEEE in Europe can be seen in table 5-5, we see no reason to assume that the composition will differ globally.

Table 5-4 Distribution of WEEE in Europe (eurostat, 2020).

	Cooling and heating white goods	Small household appliances	IT and consumer equipment	Lighting equipment
Fraction [%]	52.7	10.2	29.4	8.7

Table 5-5 Material Composition of WEEE in Europe (Bigum & Christensen, 2011).

Material	Cooling and heating white goods	Small household appliances	IT and consumer equipment	Lighting equipment
Ferrous metal	43	29	36	-
Aluminium	14	9.3	5	14
Copper	12	17	4	0.22
Lead	1.6	0.57	0.29	-
Brominated plastics	0.29	0.75	18	3.7
Plastics	19	37	12	-

Lead glass	-	-	19	-
Glass	0.017	0.16	0.3	77
Other	10	6.9	5.7	5

5.2.3. Industrial Waste and Hazardous waste

Industrial waste and hazardous waste are generated from different sectors. The modelled distribution is based on the waste generation in Negombo (Karunarathana, et al., 2019) as seen in table 5-6. The industrial waste includes the commercial[1], tourist hotels, institutions, industries, pola (local markets) & markets, and public places resulting in 55.22 ton/day and the hazardous waste generation is 0.2 ton/day in Negombo.

Table 5-6 Waste Generation by Sector in Negombo (Karunarathana, et al., 2019).

Waste generator	Amount [ton/day]
Residential	100.77
Commercial	17.52
Tourist Hotels	7.29
Institutions	11.54
Industries	6.33
Pola & Markets	11.85
Public places	0.69
Drain Cleaning	1.2
Hazardous	0.2
Total	157.39
Industry	55.12

[1] The commercial waste generator covers hotel restaurants, groceries, pharmacies, and small & medium service industries.

6. Waste Projections

The waste projection for Sri Lanka has been modelled based on the baseline data set out in chapter 5. We have calculated the arisings for both municipal and industrial waste streams.

6.1.1. Municipal Solid Waste

The waste generation from 2020-2035 in Sri Lanka has been modelled based on the medium variance estimation population by the United Nations (UN). It is estimated that the population in Sri Lanka will increase from 21.41 million in 2020 to 22.17 million in 2035 (United Nations, 2019). It is anticipated that the urbanisation in Sri Lanka will continue increasing as it has been seen from 2015 to 2020 with 18.09% of the population living in urban areas in 2015 to 18.43% in 2020. It is estimated that the distribution of population living in urban areas will reach 20.09% in 2035. This estimation has been carried out using the following equation.

$$Cap_{Urban,year} \cdot \frac{Cap_{Urban,year}}{Cap_{Urban,year-1}} = Cap_{Urban,year+1}$$

The equation provides the coming year's urban population by taking the current year and multiplying with the percentage difference from the year before. The results from the population estimations can be seen in Table 6.1**Error! Reference source not found.** which shows that the urban population is estimated to increase with half a million from 2020 to 2035 while the rural population is expected to increase with a quarter of a million.

Table 6-1 Estimation of Population for every five year from 2020-2035 (worldometers, 2020).

	2020	2025	2030	2035
Urban population	3,945,488	4,130,500	4,298,934	4,453,590
Rural population	17,467,761	17,649,183	17,724,084	17,712,724
Total population	21,413,250	21,779,683	22,023,018	22,166,314

Based on the population estimation in table 6-1 the total MSW has been estimated using the waste generation of 0.75 kg/day/cap for urban areas and 0.6 kg/day/cap in rural areas (De Alwis, 2019). The MSW composition is modelled using the waste distribution for rural and urban areas, shown in figure 5-3. The estimation of the MSW flows can be seen in table 6-2 and depicted in figure 6-1. It should be noted that the two fractions which contribute most to MSW are the organic fractions 'kitchen waste' and 'grass and wood' which combined account for a total of 3,815,192 tons in 2020 increasing to 3,951,367 tons in 2035. The total waste generation in 2020 would be 4,905,600 tons and it would increase

to 5,098,320 tons in 2035. Soft and hard plastic waste is estimated to increases from 274,077 tons in 2020 (5.6% of the total MSW) to 290,935 tons in 2035 (5.7% of the total MSW).

Table 6-2 Estimation of the total waste generation in tons for the years 2020, 2025, 2030, and 2035.

	2020	2025	2030	2035
Kitchen waste	2,981,973	3,033,684	3,068,288	3,088,987
Paper	422,322	432,071	439,523	445,101
Textiles	96,174	98,868	101,064	102,852
Grass and wood	833,219	847,433	856,854	862,380
Soft Plastics	209,225	214,986	219,657	223,438
Hard Plastics	64,852	66,077	66,936	67,497
Rubber and leather	6,480	6,784	7,061	7,315
Metal	7,561	7,915	8,238	8,534
Glass and bottles	66,517	67,681	68,464	68,937
Stone and ceramic	216,114	219,265	221,146	221,995
Other	1,080	1,131	1,177	1,219
Total	4,905,517	4,995,895	5,058,408	5,098,257

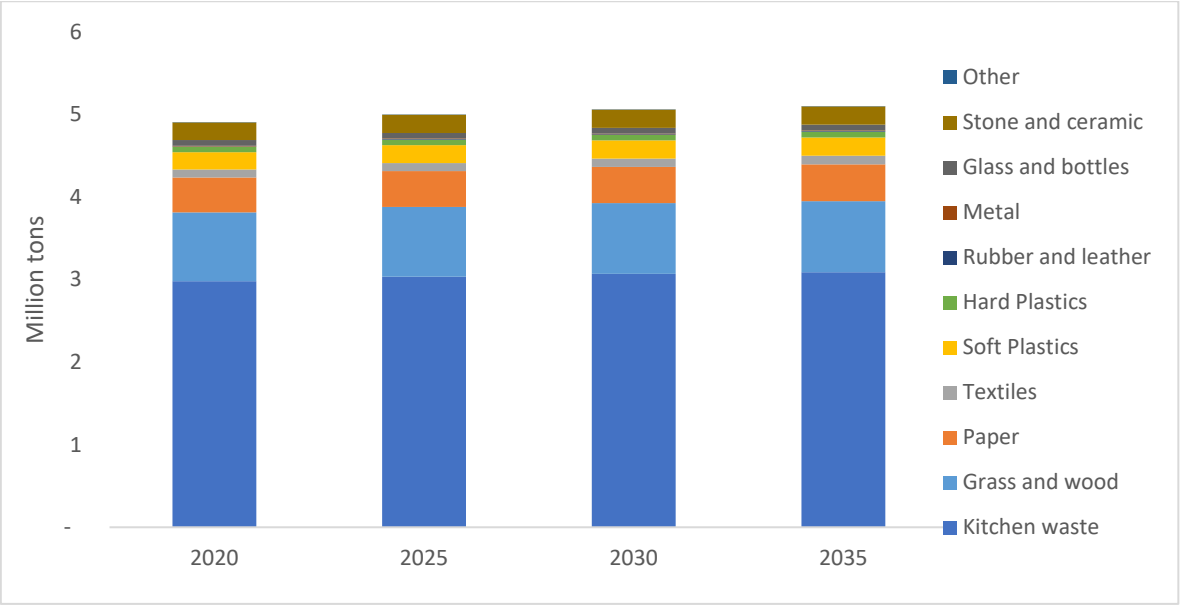

Figure 6-1 Depiction of the projection of the generation of MSW.

Wood recognise that there may be additional fiscal and legislative drivers that could affect the waste growth and waste composition over time (e.g., the recently approved ban on single use plastics such as cotton buds with plastic stick, small sachet, agrochemicals containers in PET and PVC and inflatable toys). The base data however has considerable uncertainties related to the monitoring and recording of tonnages and the age of the composition therefore trying to draw detailed analysis of waste projections risks leading to unsupported assumptions of accuracy.

The waste forecast model assumes that the national level composition shifts to reflect the changing balance of population from rural to urban areas but does not consider the potential impact of increasing GDP or potential future legislative impacts. Increasing affluence of the population may see the proportion of kitchen waste in the municipal waste arisings reduce (as seen in high GDP countries) alongside an increase in soft plastics associated with increased packaging. Rising GDP can also manifest in elevated waste arisings per capita as material consumption increases. Policy instruments can also drive positive behaviours around waste generation if implemented and enforced effectively which may act to counterbalance the potential waste increases inhibiting the use of certain materials or their collection for recycling.

6.1.2. Generation of electrical and electronic equipment waste

Based on a study for management of WEEE in Indonesia the yearly increase of WEEE is found to be 2.5% (Mairizal, et al., 2021). Using the average Asian WEEE generation and the annual increase of WEEE in Indonesia the WEEE generation for Sri Lanka is estimated to increase from 89,936 tons in 2020 to 130,254 tons by 2035. An estimation of the amount of metals, glass, and plastic that is disposed of with the WEEE, seen in table 6-3, is based on table values from Bigum & Christensen (Bigum & Christensen, 2011).

Table 6-3 Overview of ferrous metal, plastic, and glass generated from WEEE in tons for every five year from 2020 to 2035.

	2020	2025	2030	2035
Total WEEE [ton]	89,936	101,754	115,125	130,254
Ferrous metal [ton]	32,173	36,400	41,184	46,596
Aluminium [ton]	9,780	11,065	12,519	14,165
Copper [ton]	8,214	9,293	10,515	11,896
Lead [ton]	873	988	1,117	1,264
Brominated plastics [ton]	5,253	5,943	6,724	7,607
Plastics [ton]	15,401	17,425	19,715	22,306
Lead glass [ton]	5,024	5,684	6,431	7,276
Glass [ton]	6,127	6,932	7,843	8,873

The three fractions; metals (Ferrous metal, aluminium, copper, and lead), plastic and brominated plastics, and glass and lead glass represent 92.11% of the WEEE. Thus, if WEEE is not treated properly it may lead to debris of these materials entering into the environment. Beside these materials WEEE also consists of cadmium, mercury, silver, gold, and palladium (Bigum & Christensen, 2011). These materials have both an economic and environmental value which can be gained by recycling it and thereby preventing it from ending in the environment as pollutants.

6.1.3. Industrial Waste

The results from the two approaches both have a lower waste generation than expected. Model one generated one-third of MSW and the second generated less than one-fourth of the MSW. It is expected that the waste generation from industry is higher than MSW. For instance, the ratio of industry waste and MSW in United Kingdom is approximately 8.5 tons industry waste per ton MSW (OECD, 2020). With the limited data availability, the industrial waste projection is based on the model with the fishing industry. The projection of industrial waste for Sri Lanka is based on the GDP growth, seen in table 6-4. Estimations for the growth of GDP has been found from 2020-2025 and it is set to 4.5% from 2026 until 2035. Resulting in an estimation of the industrial waste ranging from 1,072,735 tons in 2019 to 2,016,260 tons in 2035.

Table 6-4 Industrial waste generation in Sri Lanka based on increase in GDP

	GDP [million USD]	GDP Growth1 [%]	Industrial waste [tons]
2020	83,484	-4.55%	1,023,894
2021	87,882	5.27%	1,077,832
2022	92,241	4.96%	1,131,304
2023	96,528	4.65%	1,183,875
2024	101,023	4.66%	1,239,008
2025	105,857	4.79%	1,298,295
2030	131,917	4.50%	1,617,912
2035	164,393	4.50%	2,016,213

Negombo Municipal Council's management of industrial waste in 2003 can be seen in table 6-5. Based on the distribution and the industrial waste generation from 2019-2035 Wood has modelled that the municipalities are going to manage 755,127 tons in 2019 which is estimated to increase to 1,419,250 tons in 2035, seen in table 6-6. This is under the assumption that all municipalities of Sri Lanka manage their industrial waste in the same way as NMC. It is estimated that businesses in general are expected to dispose of their waste through municipal collection, onsite disposal or by recycling the materials. The projection of the two approaches used for the estimation of industrial waste is depicted in figure 6-2. It can be seen that the waste generation differs with almost a factor 2 throughout the projection.

Table 6-5 Distribution of Industrial Waste based on Negombo Municipal Council

	NMC Collection	Onsite disposal	Onsite composting	Recycling	Illegal disposal
Industry waste [tons/day]	38.8	9.6	0.1	6.4	0.2
Fraction	70.39%	17.43%	0.18%	11.63%	0.36%

Table 6-6 Management of Industrial Waste based on the management in Negombo Municipal Council.

Year	NMC Collection [tons]	Onsite disposal [tons]	Onsite composting [tons]	Recycling [tons]	Illegal disposal [tons]
2019	755,127	187,030	1,946	124,752	3,892
2020	720,738	178,513	1,858	119,070	3,715
2021	758,707	187,917	1,955	125,343	3,911
2022	796,346	197,239	2,052	131,561	4,105
2023	833,352	206,405	2,148	137,675	4,296
2024	872,162	216,017	2,248	144,086	4,496
2025	913,894	226,354	2,355	150,981	4,711
2030	1,138,879	282,078	2,935	188,150	5,871
2035	1,419,250	351,520	3,658	234,469	7,316

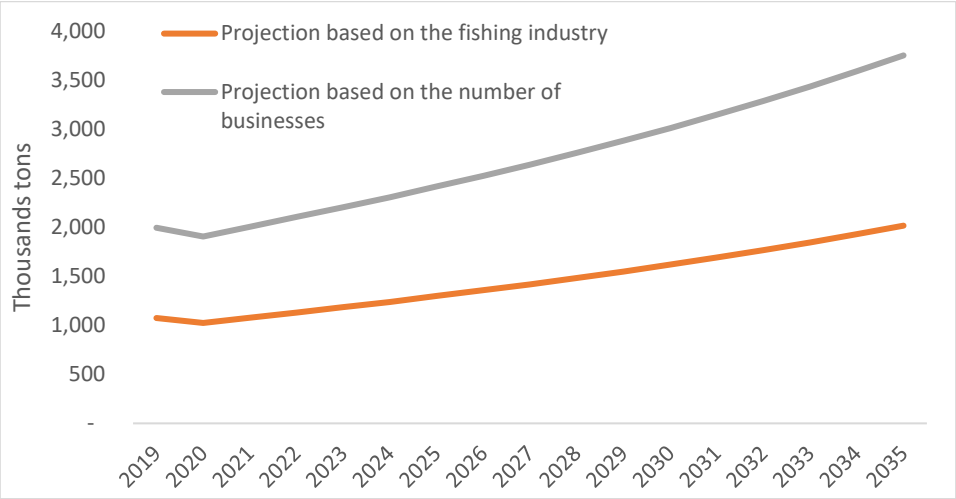

Figure 6-2 Depicting of the projections of industrial waste generation based on the two models.

6.1.4. Hazardous waste

The generation of hazardous waste is based on the same model used for the projection of industrial waste. This means that the baseline used for this estimation had a generation of 10.64 ton/day in 2019 which will increase to 20.01 ton/day in 2035 or 3,883 ton in 2019 which will increase to 7304 tons in 2035. The projection of hazardous waste is very susceptible to variation in the industries as it is based on the generation in Negombo. An overview of the generation of hazardous waste can be seen in table 6-7.

Table 6-7 Projection of hazardous waste generation.

	2019	2020	2021	2022	2023	2024	2025	2030	2035
Hazardous waste [tons/day]	10.64	10.16	10.70	11.23	11.75	12.29	12.88	16.05	20.01

6.1.5. Total Waste arisings

The projection of waste generation in Sri Lanka is depicted in figure 6-3. It should be noted that the hazardous waste contributes with 0.062% in 2020 and it is increased to 0.10% in 2035. Therefore, it is not visible in the figure and it may be an underestimation.

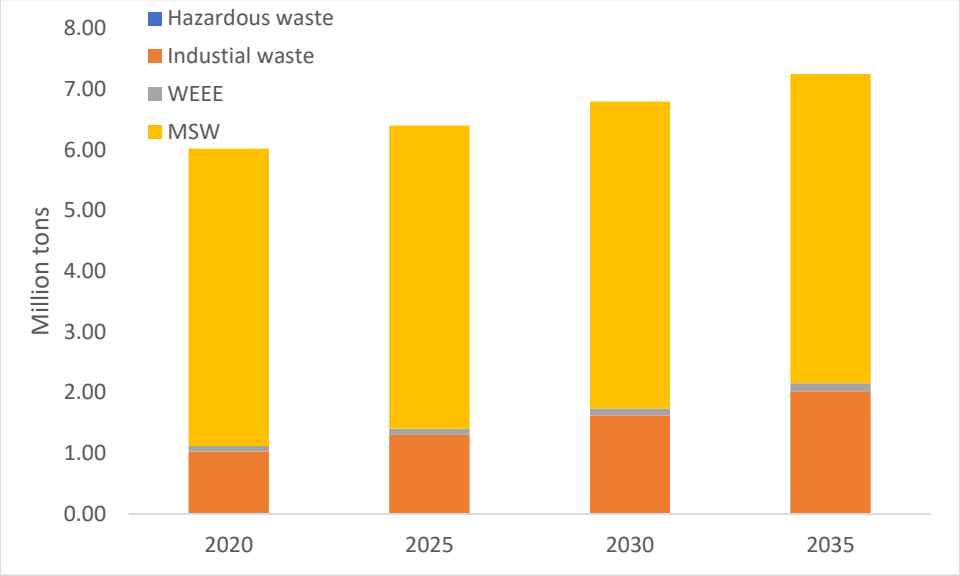

Figure 6-3 Waste projection of waste streams

There is a high uncertainty on the WEEE generation. The average Asian country generates 4.2 kg WEEE/cap/year, and according to the estimation by De Alwis (2019) the WEEE generation in Sri Lanka is 0.93 kg WEEE/cap/year. The estimation by De Alwis is 1 kg WEEE/cap/year lower than the average WEEE generation in Africa. The average WEEE generation by the Asian population is approximately 4.5 times higher than the estimated number by De Alwis. It is therefore a waste stream which has a big uncertainty to its generation. Additionally, there is also an uncertainty of the WEEE distribution as the composition is not monitored.

The MSW projection estimates the increase of MSW and the management of the MSW have not been considered in the projection. 32% of the MSW is collected by collection services. The remaining waste is then either managed privately, which could be incineration and or private landfilling, collected or sent to recycling, or illegal disposal. It should be noted that the estimate of illegal disposal of industrial waste in Negombo is 0.36% according to IGES (IGES, 2019). The estimate of illegal disposal of industry waste may very well be lower than the actual percentage. Both the onsite management and illegal disposal of waste are potential environmental issues as the waste may end up as environmental pollutants and or as marine debris.

The fact that the industrial waste is collected with the MSW - if it is not categorised as hazardous waste - means that data used for the projection of industrial waste is underestimating the waste generation. The industrial waste generation being approximately 25%-33% of the MSW indicates an underestimation of industrial waste. As the UK generate approximately 8.5 kg industrial waste per kg MSW as a comparison (OECD, 2020). The industrial waste collection is therefore an area where further studies are required before a management strategy can be designed.

6.1.6. Alternate Projection of Waste Generation in Sri Lanka

Another approach for the waste projection has been conducted using low, medium and high estimates for the waste generation in Sri Lanka. The baseline is from 2016 and it originates from an analysis conducted by the World Bank. Two approaches have been used resulting in a low and high estimate for the waste projections to 2035. The low estimate is based on the increase in population, while the high estimate is based on the increase in GDP (ceicdata, 2021). The GDP increase has been set to 4.5% from 2026-2035 due to the lack of available projections. The medium estimate is an average of the low and high estimate. The projection covers the waste fractions; MSW, Construction & Demolition (C&D), WEEE, Industrial waste, and Medicinal waste. It should be noted that the generation of WEEE in 2016 has been registered to 73 tonnes. Dividing this generation of WEEE means that the average Sri Lanka inhabitant generates 3.44 grams of WEEE annually (The World Bank, 2018). A generation of 73 tonnes of WEEE a year is lower than what can be expected for a country with the size population size Sri Lanka has. Additionally, the lowest average generation of WEEE is in Africa and it is 1.1 kg WEEE per person per year (Gollakota, et al., 2020). Thus, the generation of the low WEEE estimate is set to 74 tonnes in 2020 and the medium and high is not based on those numbers. The medium is set to 20,000 tonnes which is around 0.95 kg WEEE per capita and the high estimate is based on the average WEEE generation in Sri Lanka of 4.2 kg per capita (De Alwis, 2019). Resulting with the high estimate being 89,936 tonnes WEEE in 2020 (Gollakota, et al., 2020). Using the adjusted numbers for the WEEE generation the projection for the low, medium, and high estimates can be seen in figure 6-4.

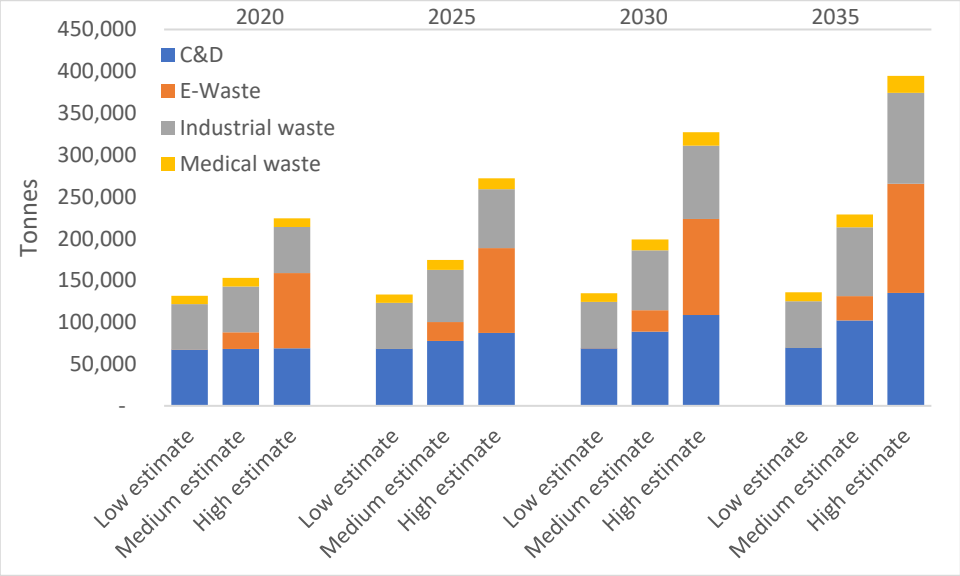

Figure 6-4 Projection of the low, medium, and high estimates for generation of C&D, E-Waste, Industrial waste, and Medicinal waste for every five years in the timespan 2020-2035.

The projection of MSW has been generated in the same way as the C&D, Industrial waste, and Medicinal waste, depicted in figure 6-5.

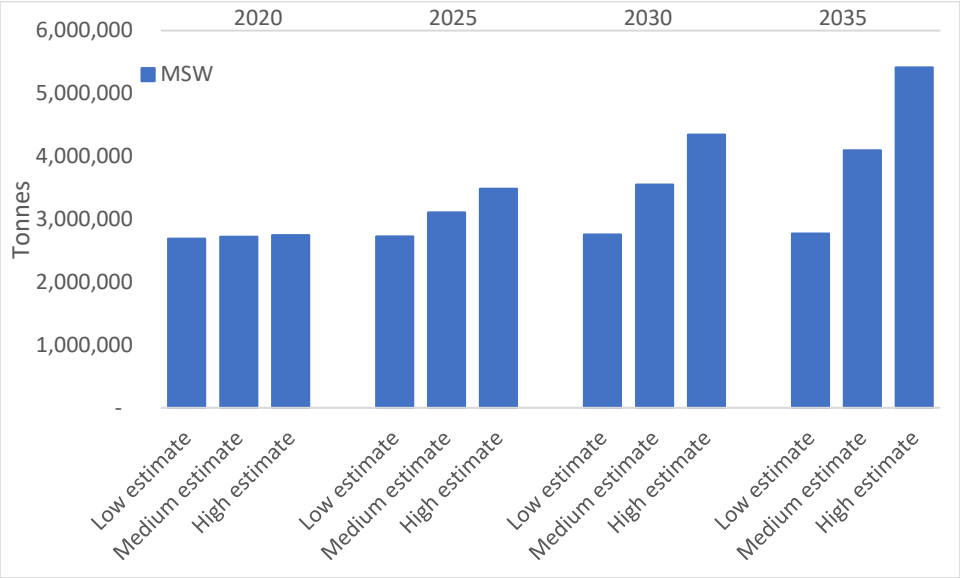

Figure 6-5 Projection of the low, medium, and high estimates for generation of MSW for every five years in the timespan 2020-2035.

It can be seen in the projections that the medium and high estimates increase over time. This is happening as the high is based on the increase in GDP which increases more than the increase in inhabitants over the timespan. The three fractions; C&D, Industrial waste, and Medicinal waste in figure 6-4 show that the medium and high estimates increases more and more over time. The same tendency can also be seen in figure 6-5 for the MSW. It is clear from figure 6-4 that the projection of WEEE is an area where the data availability is restricted.

7. SWM Systems within Sri Lanka

7.1.1. Waste collection

The LAs are responsible for collection and proper disposal of waste produced by the people within their region. The LA Public Health Department is responsible for SWM, but other responsibilities also include health and sanitation so SWM is not a priority and the budget allocation is limited (Bandara, 2011).

In general, waste collection rates are very poor apart from in three main MCs: Columbo, Dehiwala-Mount Lavinia and Kotte. It was estimated that in some smaller urban areas, only 5% of the waste generated is actually collected (Bandara, 2011). Data published by the Ministry of Forestry and Environment in 1999 showed that approx. 87% of LAs collect less than 10t/day and only five municipalities collect >100t/day.

A household survey conducted by the municipality of Moratuwa in 2007 estimated that only 56% of households have an MSW collection available to them. Approx. 20% of households dump their waste on the roadside, 8% dump waste in their own back yards and 7% compost their waste and practice recycling (Bandara, 2011). 65% thought the collection service was satisfactory whilst 30% thought it was poor.

Where a formal collection of household waste exists, waste is primarily collected by carts (door-to-door collection and sweep of the streets) (Figure 7.1), and larger collection vehicles. Waste generators, e.g., households, are required to separate waste as degradable, non-degradable, and recyclable waste. During the collection process, collection workers are allowed to pick up valuable (recyclable) items and sell them to buyers in the city. The different types of waste are usually collected on different days of the week.

Figure 7-1 NMC waste collection service provider fleet (Karunarathana, et al., 2019)**.**

The segregation of waste in households started in different years in every region, for example, Negombo City started their waste segregation at source in 2017 and they separate out into 3 fractions - organic, recyclable, and non-recyclable (Karunarathana, et al., 2019). Colombo MC have a comprehensive waste collection service in comparison to many other local authorities, and they too introduced the need for source segregation at household level in 2017. They have devised garbage collection timetables which are available on their website[2].

De Alwis reported on progress with regards to waste reduction, reuse and recycling; within the document they identified that 50-70% of households are segregating MSW at source in Sri Lanka (De Alwis, 2019). As the data on waste collection from properties (table 4.1) identifies that waste is collected from only approximately 51% of residences (as a maximum) we assume that this is a participation rate where collections from the household exist. This does identify a significant issue with the understanding regarding waste data for Sri Lanka as a whole with a lack of consistency in reporting.

Waste Electrical and Electronic Equipment (WEEE) collections are not typically undertaken separately so the items are usually dumped along with general garbage, but some authorities declare e-waste collection days/weeks and e-waste is collected in common places (De Alwis, 2019).

7.1.2. Residual Waste Disposal

There are 349 final disposal sites in Sri Lanka (JICA, 2016). Approximately 85% of total MSW generated in Sri Lanka is being disposed of in open dumps (Menikpura, et al., 2012), with these dumps often located adjacent to water bodies or close to residential houses or public institutions, as well as in environmentally sensitive areas such as wetlands, marshes and beaches.

From a study focusing on Negombo, the waste generated by all sectors (residential, commercial, tourist hotels, institutions, industry, pola and markets, public places, drain cleaning and hazardous), which totals an approximate 157.7 t/day (IGES, 2019), shows that approx. 45% of waste is collected by NMC and directly hauled to landfill, 38% is disposed of on site by burning or burying within generators premises, 7% illegally dumped in authorised places, 6% is sold or discharged to NMC collection for recycling by waste generators at source and 4% is composted on-site.

Dumpsites

The most common method for the disposal of waste in Sri Lanka is open dumping as it has been the easiest option for disposing of waste and has a minimal financial cost (Bandara, 2011). Open dumping or environment pollution is an offence under the Environment Act, but LA are often compelled to undertake open dumping due to resource constraints. Land

[2] https://www.colombo.mc.gov.lk/garbage-collection.php

scarcity, however, has made this option increasingly difficult over the past ten years. The land used for open dumps is generally low lying, degraded, state owned and used only for flood retention with no environmental protection measures in place (Bandara, 2011). Industrial waste, municipal waste, slaughterhouse waste, hospital and clinical waste are all disposed of in the same dump without any segregation. In Central Sri Lanka, waste is typically dumped along road embankments resulting in contamination of water streams at the bottom of the slope.

Dharmasiri (2019) reports that waste is dumped at final disposal sites in an unsystematic manner with minimal consideration for the disposal solution and the environmental impacts. Some of the disposal sites have a recycling/composting function but Dharmasiri (2019) states that these are not operated effectively.

In general, the majority of the dump sites have no environmental protection measures, aside from some compaction and topsoil coverage (IGES, 2019). This has resulted in environmental and public nuisance problems including litter dispersion, odour, flies, pests, smoke and leachate with nearby residents being adversely affected by the operations. Leachate may easily penetrate the underground water table contaminating groundwater resources, and the methane released from biodegradable fractions of the waste contributes to climate change. One report states that dumping of toxic waste also occurs at night (at the Kotikawatta site) as per eyewitnesses residing along the boundaries of the dump yard (Environmental Foundation, 2017). In many cases, dumping of waste continues many years after maximum capacity has been reached (Menikpura, et al., 2012). Some of the major dumpsites are located in wetlands and marshy land directly or indirectly connected to the coastal zone.

At the Kotikawatte site in the Columbo district, several drainage ways were blocked by the waste dump which previously had been a wetland that served to absorb water (Environmental Foundation, 2017) (see figure 7-2). Frequent flooding now occurs, with contaminated water presenting several potential diseases and issues to the nearby highly residential area and school.

Figure 7-2 Blocked drains within the Kotikawatta garbage dump (Environmental Foundation, 2017)**.**

Garbage from households and other sources enters rivers and water bodies, polluting waterways and blocking the drainage system in towns and cities creating breeding sites for mosquitoes and other vectors which spread diseases such as Malaria, Dengue and Filarial. It also facilitates the accumulation and flow of waste into the marine environment.

Figure 7-3 shows the open garbage dumping which occurred at the Meetotamulla landfill in Columbo. Operations here lasted several decades until 2017 when the dumpsite collapsed killing 32 people and causing damage to the residential properties at the bottom of the dump (Udara, et al., 2019). From the photos it is clear to see there is a lack of even basic environmental controls in place such as the use of daily cover to prevent pests or windblown littering. The waste had been dumped with steep angles of repose which increased the risk of the face slumping, in addition to the risks posed to staff and neighbourhoods, the collapse of the waste has the potential to entrain materials into the wider environment.

Figure 7-3 Garbage dumping site in Meetotamulla (Udara, et al., 2019).

Engineered Landfills

Whilst dumpsites are prevalent, engineered landfills are starting to be developed within Sri Lanka. A regional disposal site in the Ampara District of the Eastern Province was constructed by UNOPs, and the first purpose built sanitary landfill site was the Dompe final disposal site in Maligawatte, which was supported by KOICA and began operation in April 2015 (JICA, 2016). In May 2014 construction of four additional sanitary landfills was initiated for the cities of Anuradhappura, Kandy, Colombo, and Hikadduwa, with an anticipated four years construction time (JICA, 2016). However, media sources indicate these are severely behind timescales (Bandula, 2019).

The Moon Plains disposal site in Nuwara Eliya was converted into a sanitary engineered landfill in 2003, with the help of the JICA foundation (Dissanayake, 2012). Sited in a valley, the landfill was initially an open dump site used by the MC, with no environmental protection measures. The intention of the conversion into a sanitary landfill was to help reduce contamination of the nearby water stream and the reservoir and prevent further environmental and health care problems. The landfill is now isolated from the community, storm water is prevented from entering the surroundings with leachate collection and treatment and gas venting, with daily compaction and covering of solid waste.

Figure 7-4 Moon Plains Landfill (Dissanayake, 2012)**.**

A sanitary landfill has also been established in Arawakkalu in the province of Puttalam, with a capacity of 1,200MT per day, financed by the Asian Infrastructure Investment Bank. Once the transport infrastructure is complete, waste will be transported to the 30ha site from Columbo by railway. The facility faced protests and opposition from a broad civil society alliance, due to the impact on the environment and the livelihoods of the local community. Although the construction of engineered landfills is an environmentally sound option for the disposal of waste, where a more formal process is followed in setting up formal waste management sites and there is wider recognition of the proposed plans, e.g., through formal EIA and public consultation, there will likely be more issues at the beginning of the process, and this will likely be a regular occurrence for other developments. The Government state that public protest against the establishment of waste management facilities is a challenge for the implementation of environmentally sound disposal routes (De Alwis, 2019).

In order to better manage solid waste, a document was developed to provide guidelines on the development of new sanitary landfill sites, proposing development of pollution control and environmental restoration technologies at landfill sites which can be used by all LAs, implementors, regulators, managers and operators (JICA, JST, 2017). The document was created with funding from Science and Technology Research Partnership for Sustainable Development (SATREPS), a Japanese government assisted program that promotes international joint research targeting global issues. The program is a collaboration between JST and JICA.

Regarding waste disposal, LAs have been trying to divert waste from dumpsites by composting biodegradable waste (around the 60% of the total waste collected) and recycling paper and plastics.

Waste to Energy

The Ministry of Megapolis and Western Development are developing the “Waste to Energy” project in the Western Province, and there are three further proposed projects by the same Ministry. A summary of energy from waste projects in Sri Lanka is provided in Table 7-1.

Table 7-1 Waste to energy projects

Project	Operator / Agency	Waste type	Capacity	Latest status	Output
Kerawalapitiya, Muthurajawela (Western Province)*	Western Power Company	MSW	600 MT/day	Operational	10 MW (power supplied to the national grid)
Karadiyana W2E Project†	Fairway Holdings	MSW	500 Mt/day	Under construction	10 MW (national grid) Liquid and solid fertiliser Incinerator bottom ash
Kotawila (Matara District, Southern Province)‡	Unknown	Biodegradable	40 MT/day	Under construction	Electricity from biogas 400 kW (national grid)
Korathota, Kaduwela (Western Province)§	United Nations Development Programme and Kaduwela MC	Biodegradable	1 MT/day	Operational	Bio-gas fed into 5 kW generator (used by the MC to supplement the electricity requirement of the Waste Collection Centre)
Pilot project at Jathikapola in Narahenpita (Western Province)ǁ	Sustainable Energy Authority and Colombo MC	Market waste	Unknown	Pilot	Deemed to generate 26,280 kWh of electricity per annum

* (Ministry of Environment, 2021)
† (Fairway Waste Management, 2020), (Economynext, 2019)
‡ (Daily News, 2021)
§ (UNDP, 2016)
ǁ (Biodiversity Sri Lanka, 2016)

There are a number of challenges facing the development of Waste to Energy facilities within Sri Lanka (De Alwis, 2019):

- Financial impacts – the facilities are more expensive to construct and operate per tonne than alternative disposal routes
- Appropriate business model and conducive environment – the long-term investment required for the development is best supported by long term municipal supply contracts
- Technical capability – The facilities are complex to operate and require specific knowledge that is not readily available within the waste market
- Political pressure from local interest groups – Large scale facilities receive significant levels of interest and objection to their development
- Conflict between industry and environmental stakeholders

7.1.3. MSW Composting

The generation of compost from organic waste is well established internationally. The value of compost depends on its quality, which is determined by many factors including nutritional value, feedstock quality, applied technology, processing conditions, and storage conditions.

Sri Lanka had 112 compost facilities in 2015, with a total processing capacity of 542 tonnes/day as a result of the Pilisaru project and support by the NSWMSC (JICA, 2016) – the Pilisaru composting plants are owned and operated by LAs. Based on the available data, the processing capacities of the composting facilities ranged from an average of 3 t/day in the Central Province to 8 t/day in the Uva Province with the average across all provinces being 4.8 t/day. The Southern Province has 24 composting facilities which is the highest number of facilities in a province (JICA, 2016). The number of MSW compost facilities increased to 156 by 2019 (IGES&CCET, 2020). Sri Lanka established a compost quality standard (SLS 1243:2003) to improve the quality of compost to safeguard consumers and expand the marketing potential, although there is no obligation for producers to meet this standard (IGES&CCET, 2020).

The MSW compost generated from the composting facilities is generally made without proper sorting of waste feedstock at the origin and inappropriate operation at the facilities. The lack of source separation of the organic waste and the issues around the operation of the facilities results in poor quality compost particularly compared to the available alternatives. Therefore, commercial farmers, especially rice and vegetable farmers prefer compost from other sources. To overcome compost quality issues the Sri Lanka Land Reclamation and Development Cooperation (SLLRDC) have submitted a comprehensive project proposal on preparing a hybrid fertiliser using locally produced compost (CEA, 2017).

In Negombo, although the estimated organic waste collection is 30-40 Mt/day, only 20-25% of collected waste is taken to the composting facility – the remaining biodegradable waste is still disposed of at the local dumpsite (Karunarathana, et al., 2019). The disposal

of organic waste within the dumpsites and landfills results in the emission of methane a major contributor to climate change.

Study of large-scale Composting Facilities - Operational Modalities in Urban Areas

A study by the Institute for Global Environmental Strategies (IGES) Centre Collaborating with UNEP on Environmental Technologies (CCET) in partnership with the University of Peradeniya, looked at the management of centralised composting in Sri Lanka. Three case studies were analysed in the context of centralised large-scale composting facilities to reveal the factors and approaches that led to positive results under different types of operational modality:

- Large-scale composting case 1 - single municipal operation in Kuliyapitiya Urban Council (KUC)
- Large-scale composting case 2 - provincial operation in Kalutara District. Includes Kalutara PS (KPS), Kalutara UC (KUC)
- Large-scale composting case 3 - joint consortium operation (operated by two municipalities) in Kandy District. Includes Kundasale PS (KPS) and Pathadumbara PS (PPS)

In the case study of Kuliyapitiya UC the waste collection was managed by using music on the vehicle to announce its presence and thus having the garbage bins brought to the collection vehicle. The waste is managed in the Environmental Preservation Centre which has a waste generation of 10 MTPD, collects 9 MTPD and can produce 10 MTPD compost. The project in Kuliyapitiya reduced the waste disposal at the semi-engineered landfill site by 85% and it was proved that the value of the produced compost can recover 87% of the total expenditure (IGES&CCET, 2020).

In the Kalutara District, a composting facility was established in 2010 at the Pohorawatta dumpsite and the nearby LAs were responsible for collection and transport of the waste to the facility – none of the LAs segregated their waste which resulted in high labour costs to sort the waste and over half of the waste was landfilled. In 2014, the WMA-WP intervened to provide financial and technical input to upgrade the composting facility, now called Mihisaru facility, and they amended the waste collection policy so that the facility would only accept source segregated waste. A waste tipping fee was charged to all LAs except Kalutara UC. An effective source segregated collection system was rolled out by the WMA-WP for all involved LAs by 2015 through legal enforcement and public awareness activities. The Mihisaru Compost Facility has since become one of the best producers of compost in the market and has a capacity of 22-38 MTPD (IGES&CCET, 2020).

The joint consortium operation in the Kandy District operates the compost facility Kawashima which can produce 25 MTPD compost. In 2017, the two LAs generated 8 MTPD, and in order to meet the capacity of their compost facility they accepted biodegradable waste from other LAs for a tipping fee (IGES&CCET, 2020).

7.1.4. Recycling

The level of recycling across Sri Lanka varies considerably with urban areas more commonly separating out recyclables where a collection service exists. As there are limited collections in the more rural areas little information exists as to the amount that is recycled by scavengers and waste pickers. Within NMC, there is a well-established scavenging system operational which results in the recovery of a considerable portion of valuable resources (Karunarathana, et al., 2019). There are 3 stages where this process exists:

- NMC waste collecting employees remove valuable material such as metals, cardboard and plastics from the waste stream during the collection process itself
- at the resource recovery centres
- scavengers living in the vicinity of the Ovitiyawatta dumpsite sort the remaining valuable resources from the dumped waste.

Although it is not commonly stated in the literature it can be assumed that this type of operation will exist within other authorities within Sri Lanka.

According to a report on progress with regards to 3R (De Alwis, 2019), the recycling rate of paper, plastic, metal within the MSW stream in Sri Lanka, and e-waste is assumed to be 50-60% but construction waste is <50%. As the stated formal collection rate for MSW is at maximum 51% we assume that these figures relate to the capture rate for the individual waste streams rather than as the more typically reported % of municipal waste figure. The assessment also contradicts with the assessment made of recycling captured in Negombo as set out below.

Cardboard, paper, polythene, plastic, glass, coconut shells and metals are collected in Negombo's non-degradable waste collections and separated at a recycling centre in Negombo MC (Karunarathana, et al., 2019). The materials are generally low-grade recyclables such as contaminated plastics, polythene and paper since the valuable recyclables are segregated at source and also during collection by NMC labourers. Approximately 2.5MT/month of recyclable materials are recovered on average. The recycling centre is basic in set-up within an old municipal building with temporary shelters. Steel tables are used as sorting tables and there is one bailing machine (Figure 7-5). All non-degradable waste left after recovery of recyclables is bailed and subsequently used as supplementary fuel at a cement factory in Puttalam. The municipality pays the haulage costs, but no charge is levied to the cement factory as they have limited capacity to accept this residual waste.

Figure 7-5 Bailer and sorting table at Negombo recycling centre (Karunarathana, et al., 2019)**.**

Major recycling industries in the Country are plastic, paper, glass, CFL bulbs, batteries and metal (De Alwis, 2019). De Alwis (2019) states that 'sufficient' recycling industries are available in Sri Lanka but the collection mechanism of waste and sorting of waste needs to be improved.

For paper, plastic, metal and e-waste supportive policies/programmes exist for resource recovery but these can only be found in a few major cities. Electronic waste is mainly collected and exported for recycling. There are fifteen licenced e-waste collectors and exporters in Sri Lanka, and it is assumed that 22% of e-waste is collected and exported for recycling (De Alwis, 2019). Ceylon waste management private Ltd is the only Board of Investment (BOI) approved e-waste recycling factory in Sri-Lanka.

Plastics recycling

Plastic waste collection in Sri Lanka is currently a combined effort of its citizens, municipalities and private sector collectors. LAs have taken the initiative to integrate collection with processing of recyclable plastics into their waste management plans, with the support from national government (IGES&CCET, 2020).

Individual collectors informally collect recyclable materials from households and institutions and then sell the material on to junk shops or private entrepreneurs where it is cleaned and sold on to local industries or for export. The conventional door-to-door visits carried out by individual collectors has progressed in such a way that collectors now use small trucks and cover larger collection areas within a day. In the past, the plastic recycling industry in Sri Lanka mainly targeted export markets such as China and India in the form of granules, chips and flakes (IGES&CCET, 2020).

The National Post Consumer Plastic Recycling Project (NPCPRP) project started in 2002 with the objective to (IGES&CCET, 2020):

- Address the behaviour change necessary among consumers to ensure the proper disposal of plastic waste in such a manner that will not harm the environment and natural resources.
- Establish the necessary logistics to enable the collection and recycling of post-consumer plastic waste.
- Reduce the foreign exchange loss by enhancing the recycling of post-consumer plastic waste.

The project was initially funded via 1% tax imposed on imports of all plastic raw materials and finished goods in 2007.

In 2011, WMA-WP introduced the Sampath Piyasa Centres (SPC), where recyclables are bought, sorted, and sold. Sampath Piyasa was acknowledged by many other LAs outside the Western Province as an effective way of collecting recyclables from citizens as well as raising awareness as it demonstrates recyclables have a market value. Pilisaru (described in section 8.1) financially supported these LAs to establish Sampath Piyasa during 2008-2015. Most of the plastic that arrives at the SPCs is low quality plastic as waste collectors are allowed to sell the good quality plastic directly to buyers, before it reaches the SPC.

Thanks to the technical inputs from NPCPRP and financial support through the tax and the Pilisaru project, 12 plastic waste recycling facilities were established in Sri Lanka by 2018. Furthermore, LAs were equipped with non-degradable waste collection vehicles (IGES&CCET, 2020).

The number of plastic waste collectors and recyclers in the recycling business sector has steadily increased, from 37 in 2007 to 210 in 2015 (CEA, 2015). A few large-scale recycling businesses were established between 2010 and 2019. One of these has recently established a network of 125 collection points across the country, which ensures nearly 200-250 MT of PET waste is delivered to a factory every month. Most large-scale businesses were established as Board of Investment (BOI) industries, which receive capital investment to cater for demand for high quality recycled plastic materials such as yarn and high-grade pellets from international markets (BOI, 2017).

Currently, however, not all recycling facilities are fully operational owing to in-house management issues such as shortages of skilled labour, lack of market for low quality recycled plastics, and higher production costs (IGES&CCET, 2020).

Study of Plastic Recycling Operational Modalities in Urban Areas

IGES and CCET published a study called '*Effective Plastic Management in Sri Lanka'* in December 2020 (available at https://www.jstor.org/stable/resrep29012?seq=1#metadata_info_tab_contents). This analysis is based on 2 plastic recycling successful operational modalities: Kandy Municipal

Council (Single municipal operation) and Balangoda Urban Council and private company (PPP-Based Operation). It includes waste tonnages and the percentage of recyclable plastic for each location. It also defines the main characteristics of the site, how plastic is recycled (processing activity), and the financial analysis of the system. The main conclusions are (IGES&CCET, 2020):

- When a LA operates a Plastic Recycling Centre (PRC), the LA could stabilise the plastic recycling market by introducing a fixed rate agreement to plastic waste buyers for a certain period. This incentivises the buyers to make a profit when the fixed price is higher than the market price.
- When a private company operates a PRC, the private operator can focus on extended collection even outside the concerned LA, proper and efficient operation of the PRC, development of value-added products, and marketing, whereas LA can focus on the reinforcement of segregated waste collection and awareness-raising to support the private operation. However, due to the profit-seeking and market-based operation, the low-value plastic items tend to be uncollected.

Alternative technologies to treat plastic waste are in process, with one pyrolysis plant established and another two facilities pending (Ministry of Environment, 2021). The product of these plants is furnace oil.

8. SWM programmes and initiatives

The literature illustrates that Sri Lanka are addressing SWM issues with efforts in more recent years focused on composting, resource recovery and more environmentally sound disposal. LAs and Districts have also developed and implemented projects to improve the management of solid waste and these are listed below.

8.1. Pilisaru program

The Pilisaru program was developed by CEA in 2008, under the NPSWM and is one of the most relevant programs launched in Sri Lanka to solve the solid waste problem at the national level, with the notion of maximising the reuse of resources collected in the waste stream before final disposal. It started with an initial budget of 5.675 bil LKR, funded by the Central Government (IGES&CCET, 2020) and provided technical and financial assistance on SWM to the local authorities. The five main objectives of the Pilisaru program were:

- Development of a national policy on SWM
- Development of a national strategy on SWM
- Effective education and awareness for all stakeholders on SWM including training and capacity building
- Facilitation for LAs for implementation of SMW projects
- Legal reforms to strengthen effective law enforcement.

The objectives of the Pilisaru program included the provision of the necessary facilities for the implementation of solid waste management projects and programs, and the provision of training and awareness programs on effective solid waste management. The Pilisaru program achievements up to 2014 include (Bandara, 2014) (CEA, 2017):

- 133 compost sites have been established covering 136 LAs and military/educational institutions
- 109 of these are operational; construction has finished but compost production not started at one site; construction works have not been completed for ten sites; and thirteen sites are inactive with critical issues.
- 22 Biogas plants for hospitals and other government institutions
- Compost bins at a low cost for local authorities
- Conducting of education and awareness programs.
- Project Coordination, Monitoring, and Evaluation.

The program was meant to last until 2014 but it was finally extended until 2018.The 3R progress report indicates that this program is still operational and will continue as three sanitary landfills are in construction as part of the program, as well as continuing to facilitate composting, biogas generation and waste recycling programmes (De Alwis, 2019).

8.2. Environmental Remediation Programme (ERP)

ERP was implemented by UNOPS with the CEA as a counterpart. The program was initiated in 2007 and it lasted until 2013 with a total budget of 12.64 million euros. ERP was implemented in Ampara District (Eastern Province) and its main achievements were (JICA, 2016):

- Capacity training for waste management officers and public awareness activities in 12 municipalities
- provided seven disposal sites, five recycling centres, five compost plants, and one transfer station. It has been noted by JICA (2016) that there is a risk that these facilities could be left alone without actually carrying out any operations due to lack of technical and financial capacity within the LA. There is no cooperation between the MoLGPC, who oversee the LAs, and the CEA.

8.3. Volume Based Bag (VBB) System – Pilot Project. KOICA

In October 2015 KOICA started a pilot project with the WMA-WP and introduced the VBB system. Under the VBB system citizens have to pay 40Rs for each plastic bag (20L) of mixed waste they produce. The money collected is used to the improve the waste management system, but the main barriers are that citizens have been getting this service for free and they are unwilling to pay (JICA, 2016). As there has been no legislation to support this system it is unlikely the pilot project has been widely implemented.

8.4. Sustainable actions and initiatives

In terms of reducing the quantity of MSW and implementing sustainable practices, the Ministry of Environment have:

- In 2017, in collaboration with all stakeholders, revised “Doing Away with Dumps” which is the sustainable waste management segment of the Haritha Lanka Action Plan (National Environmental Action Plan).
- In 2019 revised their national policy (see section 4.3), also approving the National Environmental (Stationary Sources Emission Control) Regulations No. 01 of 2019 (Ministry of Mahaweli Development and Environment, 2019)
- Introduced the concept of “Zero Waste”, as well as green procurement, green accounting, green reporting
- Drafted a Sustainable Consumption & Production Policy.
- In 2019 banned coloured water bottles and plastic wrappers (Outlook, 2019); manufacturers have been instructed to manufacture transparent plastic bottles
- Devised National Action Plans on Plastic Waste Management and Electronic Waste Management (Ministry of Environment, 2021).

- In 2020 they launched the “Surakimu Ganga” project (Protect Rivers) a holistic project to take action against activities which cause damage to the environment within river basins. Legal action will be taken against those who engage in such activities under the ‘Surakimu Ganga’ project. It is expected to cost around Rs.32 billion and will be one of the largest development projects being implemented under the present government (Daily News, 2020).

Other government initiatives that may have an impact on the generation of solid waste either in terms of quantity, composition or destination of material have included:

- A National Policy on Cleaner Production with sectoral policies formulated for Tourism, Fisheries, Health, etc.
- From September 2017 certain plastics were banned including HDPE, Lunch sheets, carry bags and expanded polystyrene lunch boxes, as well as the use of Polythene for all festivals/ election campaigns.
- In 2017, the Ministry of Provincial & Local Government made it compulsory for all local authorities to collect only segregated waste and they are in the process of establishing mega scale composting facilities “Kawashima Composting Machines” in all nine provinces – they have been established in six provinces to date with a capacity of 50MT/day (Ministry of Environment, 2021).
- The National Colour Code has been reduced from five categories (bio degradable/glass/plastic& polythene/paper & cardboard/ Metal) to three categories for local authorities (Food waste/ Recyclable items clean/ Landfill waste).
- Colombo Municipal Council is distributing home composting bins for free in order to minimise domestic organic waste with the intention to compost all biodegradable wastes and has initiated construction of waste to energy project for residual waste for the western province (Construction of one project is in progress).
- The MoMWD supported by the Food and Agricultural Organisation (FAO) and the International Water Management Institute (IWMI), launched in June 2019 a project on “innovative approaches to reduce, recycle and reuse food waste” to run through to 2021 (FAO, 2019). The food waste reduction project bought together key stakeholders: wholesalers, supermarkets, hotels, restaurants, hospitals, schools, consumers and the waste management system with the aim to raise awareness, collect data and draft an evidence based national strategy for food waste prevention.
- The landfilling of non-degradable and non-recyclable wastes with capacity of 100MT/day in Dompe has been initiated by CEA.
- The Ministry of Megapolis & Western Development are progressing implementation of a waste to energy project in the western province, as well as building a landfill site with modern technology and recycling solid waste (1,200 MT per day) in Arawakkalu (Puttalam district).
- Action plans have been developed for Colombo Municipal Council, WMA-WP, CEA, Ministry of Environment.

- There are Island wide ‘Green Productivity’ programmes by the National Productivity Secretariat to promote community learning and development on 3R and sustainable waste management.
- The government encourages industry to adopt cleaner production and resource efficient technologies through a range of awards, e.g., green productivity award, national cleaner production award.
- The Sri Lanka institute of Development Administration includes modules on 3Rs for the government officers training programmes.

There are National Steering Committees convened by MoE and other Ministries, on waste management and encouraging cooperation between Government, scientific and research institutions and the private sector in 3R areas. The following government bodies and organisations co-ordinate 3R actions and movements:

- Ministry of Environment
- Central Environment Authority (Pilisaru Project)
- Ministry of Provincial & Local Government
- Solid Waste Support Centre
- Ministry of Megapolis & Western Development
- Solid Waste Authority -Western Province
- National Cleaner Production Centre
- Provincial Councils and Local Authorities
- Ministry of Megapolis and Western Development
- Ministry of Agriculture, Rural Economic Affairs, Livestock Development, Irrigation and Fisheries & Aquatic Resources Development
- Ministry of Health

There is, however, no healthy collaboration among institutions (De Alwis, 2019).

There is a ‘Student Based Pro Active Environment Education Project’ (CITYNET, 2019) in the City of Columbo under the financial support of CITYNET, a non-profit international organisation based in Yokohama, Japan. CITYNET’s mission is to promote cooperative links and partnerships throughout the Asia Pacific to improve the sustainability of cities. The main objective of this project is to educate the young students to understand, love and protect the environment. Resource efficiency and the 3R principles are also included within the school curriculum, as well as university level education (environment related degree programmes) and post graduate level. The University of Colombo, University of Moratuwa, University of Peradeniya and University of Sri Jayawardenepura offer higher education programmes in the areas of 3R and resource efficiency.

The government plans to introduce Extended Producer Responsibility (EPR), an economic instrument for the management of e-waste and to strengthen waste recycling through PPP and they plan to develop a Sustainable Consumption and Production Policy in the near future.

8.5. Data

In terms of data availability and monitoring, there is very limited data on material flows, cyclical use, direct disposal to water and e-waste generation (De Alwis, 2019). The only data type with good data availability and monitoring is that with regards to the export of recyclables. De Alwis (2019) states that all other data types are ‘moderately’ recorded, e.g., waste generation, disposal to land.

9. Plastics in the marine environment

Plastic consumption per capita is about 6 kg per annum, and plastic waste accounts for 10% of total waste in urban areas. Regarding plastic waste generation, about 1 million sachet packets (sauce, jam, shampoo) are dumped every month, together with 20 million yogurt cups, 15 million lunch sheets, and 20 million grocery bags every day (IGES&CCET, 2020).

Sri Lanka is ranked as the 5th most significant contributor to marine plastic pollution, it is estimated that 84% of the waste generated in Sri Lanka is mismanaged which contributes to plastic litter entering the marine environment. Out of the mismanaged waste plastic accounts for 1.59 MMT and it is estimated that this amount of plastic waste contributes to 0.24-0.64 MMT per year of plastic marine debris (Jambeck et al., 2015). Studies show that more than 90% of the litter on Sri Lankan coasts originates from the land (Mafaziya, et al., 2020), with the accumulation mainly in river mouths and urban beach areas.

As well as inland based sources, it is important to recognise there are sea-based sources (fisheries sector, merchant ships, cruise liners, recreational activities) that also include transboundary pollution.

Improper SWM is considered to be a major factor accounting for debris accumulation on both land and sea (Mafaziya, et al., 2020). Table 9-1 shows the amount of solid waste collected by municipalities in coastal districts, with the majority collecting very little of the total district waste generated and is likely a contributing factor to marine litter generation.

Table 9-1 Amount of solid waste collected in municipalities in coastal districts (Ministry of Mahaweli Development and Environment, 2018).

District	Gross weight of waste collected per day (ton)	District percentage (%)
Puttalam	97	3.4
Gampaha	313	11.0
Colombo	1,257	44.3
Kalutara	93	3.2
Galle	103	3.6
Matara	68	2.4
Hambantota	28	1.0
Ampara	57	2.0
Batticaloa	119	4.2
Trincomalee	56	2.0
Mullaitivu	09	0.3
Kilinochchi	01	0.0
Jaffina	71	2.5

The total marine litter status of Sri Lanka has not been evaluated to date but results from two beaches in Negombo revealed that packaging materials were the primary source (55%), as well as consumer products (26%). Plastics composed 79% of the total materials, which is comparable to the worldwide situation. Surveys from 2018 also found that 60% of sand samples and 70% of surface water contained an abundance of micro plastic (Koongolla, 2018).

Figure 9-1 Beaches polluted with plastic debris at Mirissa (top) Gurungar (middle) and Kudawella (bottom), Sri Lanka (Mafaziya, et al., 2020)**.**

The impacts of marine litter are vast including:

- Reducing quality of the marine environment reducing fishery stock
- Damaging fishing gear and vessels, increasing costs and effort for fisheries while reducing productivity
- Causing potential harm to human health and safety,
- Severely impacting the environment and marine organisms in particular
- Affecting recreational activities and damage boat engines, and
- Reducing the value of the marine industrial sector as well as tourism.

The following policies, regulations and activities are in place to address the issue of plastic wastes in coastal areas and the marine environment:

- As of September 2017, four commonly used polythene products were banned to reduce the plastic /polythene waste generation, and at the end of March 2021 the use of Polyethylene terephthalate (PET) or polyvinyl chloride (PVC) material for packing agrochemicals in any process, trade or industry will be banned, as well as plastic sachets having less than or equal to a net volume of 20ml / net weight of 20g (except for packing food and medicines), certain inflatable toys and cotton buds with plastic stems.
- The Department of Coast Conservation and Marine Pollution Prevention Authority conduct waste management programmes to conserve the coast and the sea.
- In 2020 a national programme on the management of pesticide containers was introduced to minimize the plastic waste added to coastal and marine areas.
- The Coast Conservation Department have placed garbage bins on the beach and introduced a ‘cleaning beach’ concept.
- Frequent beach clean-up programmes are conducted; there was an island wide beach clean-up organised by MEPA to commemorate the National Coastal and Marine Resources Conservation week.
- As well as plastic recyclers collecting plastic waste, Samurdhi recipients are employed to collect waste from beaches.
- Some zones of the beach are cleaned and maintained by the Sri Lankan Navy, as well as other zones maintained by private companies, villagers, government organisations (Ministry of Tourism), NGO s etc.
- The government have implemented the Sustainable Development Goals (SDG) of the United Nations to aid in addressing the marine litter issue.
- The government plan on incorporating a filtering mechanism in the water ways to collect plastic waste that enters the sea.
- EPR for the management of PET bottles and yoghurt cups to be introduced to reduce the flow of plastic waste entering the coastal and marine areas.

The National Aquatic Research Centre (NARA), National Aquaculture Development Authority, Marine Environment Protection Authority (MEPA), the Coast Conservation and Coastal Resource Management Department and IUCN – Sri Lanka, are developing research programmes to address the impacts of micro-plastic participles (<5mm) on coastal and marine species. Actions plans have also been developed by these organisations to tackle the marine plastics issue.

The Government acknowledge that marine litter is a problem within Sri Lanka and have taken steps to address the issue. However, challenges to implementation include the following (De Alwis, 2019):

- There is insufficient infrastructure to protect public health and ecosystems, including freshwater and marine resources.
- Community and local government institutions play a vital role in protecting public health (from open dumping/littering) but due to inadequate human resources, knowledge capacity gaps and lack of financial resources, it is difficult to obtain immediate results from programmes and activities.

- In terms of protecting public health, current legislation requires revising /strengthening in order to address all possible shortcomings, and there needs to be simplification of the mechanisms to implement change.
- There are political interferences when it comes to regional cooperation and multi-stakeholder partnerships. There is also limited technical capability, unsuitable business models and negative environments.

10. Gap Analysis

Although there are programs and projects being implemented in Sri Lanka to improve the waste management system, there is still a significant percentage of waste that is not being disposed of correctly. There are many governmental bodies and organisations involved with waste management within the country, however collaboration between organisations appears to be limited and infrequent and there is a lack of commitment by all governmental parties. This is shown in a lack of financial assistance for the system and low awareness from the public on how to appropriately deal with their waste. Most LAs pay little attention to solid waste problems hence there is no proper collection system of recyclables. The issues at the LAs originates from lack of political will and political conflicts at the local level (Bandara, 2014).

The management of solid waste is haphazard, with the dumping of solid waste in unsuitable locations affecting the environment. There are many impacts including water pollution, air pollution, odour problems, uncontrolled release of landfill gasses from dumps / non-engineered landfills as well as health and safety issues. The lack of accountability for proper waste management, the dumping of waste near watercourses and environmentally sensitive areas combined with the physical geography of Sri Lanka is resulting in an increasing amount of litter escaping into the marine environment. In addition to the potential consequences for the health of the surrounding fisheries, environment and human health are the loss of aesthetic values and scenic beauty, a selling point for tourism in Sri Lanka.

There are a number of gaps within the waste management system which are hindering efforts to improve the situation. These are based around seven core areas, as shown in Table 10-1.

Table 10-1 Gaps within the waste management system.

Area	Gaps
Policy & legislative framework	• Lack of coordination between national level strategy, provincial level policies and strategies. • Support from political leadership is missing, especially in terms of regulatory enforcement. • Limited priority is given to SWM within LAs and there is lack of or improper implementation and monitoring of waste management plans and policies, for instance the Pilisaru project has not been implemented country wide. • Lack of policy and attention for specific waste streams including WEEE, healthcare waste, construction and demolition waste, and other hazardous waste, which are damaging to the environment – noted revised policy includes these streams.

	• Often lengthy delays to making changes, negotiations, progressing 3R movement due to political debate. • No adoption of green procurement policies by the ministries and government agencies (noted draft guidelines have been developed by the National Procurement commission). • Absence of mandatory guidelines, finance, time and a lack of sustainable procurement knowledge within Government.
Waste collection	• Absence of formalised MSW collections (leads to residents dumping or burning wastes). • Lack of co-operation between LAs and waste management contractors. • Non-comprehensive collection mechanisms for recyclable items. • Local removal of valuable fractions reduces economic benefits for LAs. • Lack of separation by households, businesses for reuse and recycling. • Poor collection and sorting of e-waste. • Lack of adequate resources from the Local Government to support waste management activities.
Data recording, reporting and monitoring	• Lack of data on waste types, quantities and sources – without this data the Government cannot understand the underlying causes/sources of waste generation and thus how to promote resource efficiency and circular initiatives. • Inadequate data monitoring and record keeping for most waste types (partly due to informal disposal routes as well as changes in management). • Weak or total absence of monitoring (of hazardous waste) by authorities and society.
Economic situation	• Limited funds within LA impacts on SWM budget and actions, e.g., for operations relating to separation, composting, recycling and disposal of waste. • Insufficient enforcement with small fines and low probability of prosecuting offenders. • Lack of government guidelines and procedures on PPP which limits the effectiveness of dialogue Central Government has with stakeholders, NGOs, industrial associations etc. • Only private sector participation on paper recycling, due to the daily fluctuations in plastic and paper values.
Stakeholders	• Poor commitment from the relevant authorities to encourage private sector participation in MSW management. • Poor private sector investment on recycling due to low return.

	• Limited market availability for products such as compost and recyclables.
Education and engagement	• Limited public awareness programmes about solid waste management, sustainable production and consumption and resource efficiency. • Limited waste separation by the public and knowledge on organic waste management. • Lack of public awareness on hazards associated with e-waste. • Lack of public awareness on the damage marine plastic pollution does to the environment, human health and economy. • Lack of technical capacity in LAs, e.g., around how to collect, dump, recycle and compost solid waste. • Lack of technical knowledge in LAs to advise consumers and producers to promote use of sustainable consumption and production through 3R and other SWM techniques.
Waste management facilities (WMF)	• Deficiencies in SWM infrastructure in the Country results in plastic waste entering the marine environment. • Lack of separation of waste types at the dumps, hazardous mixed with non-hazardous waste etc. • Lack of technology for efficient and sustainable landfill design and management. • Limited suitable land to establish waste management facilities. • Lack of technology for recycling plants and recovery facilities. • Lack of facilities to dispose of certain categories of hazardous waste. • Insufficient number of, and inadequate e-waste collection centres. • Limited resource and technical capacity within LAs to plan, design, establish and operate proper waste management plants as well as limited infrastructure such as machinery and equipment. • Lack of data capture by the WMF (partly due to informal disposal routes). • Lack of data hinders planning and design of WMF - planners cannot determine the different recycling modes and processes that could be used, therefore WMF cannot be designed fit for purpose.

11. Recommendations

This chapter outlines a range of recommendations to channel that ambition into policies and practices to improve SWM and to minimise the environmental impact of SWM across the country.

Table 11-1 outlines a range of recommendations for consideration. Where relevant, each recommendation is supported by evidence where the intervention has delivered success across other countries.

Table 11-1 Recommendations to improve SWM in Sri Lanka.

Theme	Recommendation	Summary	Timescales and predecessors
Baseline	Legislative review	Current SWM legislation requires revisions and strengthening to address shortcomings, and mechanisms to implement change need to feed down to the local level. There needs to be consistent political support to enforce the regulations and penalise where necessary. There needs to be healthy collaboration between organisations with lessons learned, with progress driven by continual monitoring an improvement against actions.	Immediate action
	Education and awareness	To address the lack of technical capacity within local government, training should be given to the staff involved in SWM, so they know how to collect, dump, recycle and compost solid waste, as well as advise consumers and producers on sustainable consumption and production. To ensure implementation of the national strategy for SWM, there should be awareness programmes targeted at the general public with training on how to segregate waste as public participation is necessary for tasks such as waste segregation at source. Residents needs to be engaged with the wider aspirations. People's attitudes and behavioural patterns has led to plastic waste entering the marine environment so there needs to be behavioural change through effective and targeted communications and an understanding of the implications their actions are having on the environment and economy.	Immediate action

Theme	Recommendation	Summary	Timescales and predecessors
		The raising of awareness can be effectively supported by the use of NGOs and 3rd sector organisations considered below.	
	Data management	In order to plan, prepare and act on waste management issues there needs to be efficient data management. There should be accurate data recording for waste types, waste quantities and waste sources with the ability to trace accountability through the whole chain of waste management, from waste producer, e.g., household or business through to final disposal site. There also needs to be understanding of the waste composition and this should be monitored at periodic intervals. WMFs need to be recording the type and quantities of waste they receive, by whom and the final fate of the waste. A weighbridge should be installed at all WMFs to record this information. There needs to be efficient waste duty of care practised for waste transfer movements within the country in order to protect the environment, and this should be enforced. Monitoring of waste practices should be established to ensure all responsible parties are doing the right thing. Databases should be created to record waste data information at the LA level, with WMFs also accountable for accurate data recording and reporting. Only at this point can programs be correctly developed and targeted to reduce waste as well as ensure waste is disposed of correctly and legitimately.	Short - Medium term

Theme	Recommendation	Summary	Timescales and predecessors
		With robust data, appropriate WMFs can be designed for the waste types and quantities.	
Collections	Comprehensive Residual Waste Collections	At present approximately half of properties receive formalised waste collections. In order to prevent waste materials being released into the environment ensuring all wastes are captured to be managed effectively is essential. Providing collections of waste to all households will disincentivise the dumping or burning of wastes taking and ensuring that the materials can be disposed of in an appropriate manner. Implementing this requirement may require the implementation of additional regulation and the provision of funding or governmental loans to support the development of the necessary infrastructure by the LAs.	Immediate action
	Deposit Return Schemes	Deposit Return Schemes are common features of a circular economy. DRS are utilised to capture high quality reusable or recyclable material. The use of DRS financially incentivises residents to use the scheme increasing participation. The use of DRS allows for the implementation of recycling collections whilst avoiding the development of municipal collection schemes passing the cost of collection back to the producers rather than the municipality. DRS are common in over 40 nations, including Canada, multiple US states, Belize, Germany, Denmark, Italy,	Short-Medium Term

Theme	Recommendation	Summary	Timescales and predecessors
		Morocco and Australia. DRS are being considered in Scotland, England and Wales.	
	Use of the third sector to support waste collections	LAs could consider introduce collaborative measures between waste collection authorities and the third sector. Malaysia has extensively used NGOs and charity organisation in the provision of waste collection and recycling. This has been effective in improving collection rates and raising awareness. These organisations collect waste for free and sell material to waste processors, thus raising money for their benevolent causes. This approach can also create secure employment (with improved health and safety practices) for informal workers of scavengers. Similar schemes are also in operation in Kerala with local groups being provided with formal training and PPE to undertake waste collections, this is often combined with schemes for collecting fees from the waste generators to support the 3rd sector groups aims. In Bangladesh BD Clean aims to raise environmental awareness and drive cultural change in waste management.	Short Term
	Take-back schemes for local manufacturers	Take back schemes can be introduced using regulatory requirements for manufacturers to collect spent items from consumers. Take-back schemes encourage manufacturers to design items that can be durable and, when spent, disassembled and components recovered for use in their operations. Take back schemes are common for electrical items, vehicles etc and support adoption of a circular economy. Such schemes are in place across most	Short Term

Theme	Recommendation	Summary	Timescales and predecessors
		of the world including the European Union, America, Asia, and Africa.	
	Waste charge for specific collections	Collection charges can be introduced for specific, or problematic, wastes. Collections of e-waste, food waste, garden waste or specific recyclable items, should incur specific charges to fund the collections and management of these materials.	Medium - Long Term - Once comprehensive collections are in place
	Polluter Pays Principle	The generators of waste should be responsible for the cost of managing it. The implementation of this principle may choose to focus on the companies producing packaging or could be extended to individual property level. If property level implementation were to be introduced household waste collections could be charged subject to household income. Such a flexible approach may overcome the cultural objection to paying waste collection costs. A variable fee could bring waste collections within the budget of households. Such an approach is offered in Rwanda where household income determines the fee any household pays for collection, funding door-to-door collections and communal collection services.	Long Term - Once comprehensive collections are in place
Reduce	EPR schemes	EPR schemes place the financial burden of waste collections upon manufacturers of the materials. EPR schemes can be introduced for problematic materials such as chemicals, industrial materials and plastic items. EPR schemes are common across the world; the European Union operates EPR schemes for batteries, packaging,	Short-Medium Term

Theme	Recommendation	Summary	Timescales and predecessors
		tyres and other materials. A scheme operator can be deployed to oversee the administrative, monitoring and enforcement elements of the schemes. In Bangladesh Unilever is working with local authorities to support the collection of plastics for recycling to generate the plastic cullet required for its products. Coca Cola are working with NGOs to facilitate beach clean-up activities with volunteers.	
	Tax on imported problematic materials	Plastic materials are a common component of onshore and coastal litter. Sri Lanka could consider a phasing in of taxes upon imported materials. This approach would reduce the tonnage of problematic materials entering the nation, whilst also supporting local manufacturers. Import taxes are a common element of waste management practices. Morocco has introduced a plastic Ecotax which raises of 1% ad valorem of all raw plastic imported.	Short-Medium Term
	Limits per company (permits, quotas etc)	Quota systems are in operation across Europe and fall under the category of EPR schemes. Quotas (or credits) are sold by the government or scheme operator, to manufacturers in Sri Lanka, to set limits on the amount of problematic materials that can be introduced to the marketplace. Credits can be purchased from other manufacturers or sold back to the government. The overall annual availability of credits can be reduced to phase in gradual improvements across the sector by incentivising innovation. Credits are commonly used with limits upon carbon emissions. These are commonly used	Medium – Long Term

Theme	Recommendation	Summary	Timescales and predecessors
		– either voluntarily or via regulation – across the European Union, Asia and America. Sri Lanka should adopt a robust, and thoroughly enforced, approach to non-compliant businesses. For example, in Malaysia, the government shut down illegal waste processors and returned waste imports to origin based on the newly initiated permit system.	
Disposal	Prevent Illegal/Informal Dumpsites	Identify illegal dumpsites and enforce closure to prevent additional waste being deposited. Levy fines on those operating and using illegal dumpsites at a level that ensures that the benefits are outweighed by the risks. The income from the fines/levies should be ringfenced to support remediation activities on existing sites and development of properly engineered landfills. Preventing the further uncontrolled dumping of wastes will reduce the potential for further pollution of the environment and send positive message on the nation's intended direction of travel.	Short Term – Requires linking to development of replacement infrastructure.
	Remediate existing dumpsites	It is not feasible to retrospectively implement engineering control measures in all dumpsites within Sri Lanka, but risk assessments should be undertaken, and measures developed for individual sites to identify measures that can be implemented to minimise the potential for the escape of pollutants into the environment. As a minimum this should include measures to prevent site collapse,	Medium Term – Following on from site closures.

Theme	Recommendation	Summary	Timescales and predecessors
		discourage scavengers and to prevent the movement of materials by the action of wind, water and animals. Waste types should also not be mixed with technical feedback sought on the best approach to alleviate this issue.	
	Develop engineered landfill sites	A series of landfill sites should be developed. The number, size and location of these sites should be assessed at a strategic level nationally. The facilities should be developed with leachate management and gas capture systems. Through the implementation of correct operating procedures these sites will significantly reduce the potential for waste and pollutants to be released into the environment.	Immediate Action
	Disincentivise landfill (landfill tax)	Sri Lanka landfills operate without charge to users. This makes landfill an economically convenient disposal method with no incentive to adopt more sustainable practices. Sri Lanka can introduce a tax for each tonnage of material disposed to landfill. Landfill taxes are common across the world and can be found in Rwanda, Bulgaria and Morocco. In the United Kingdom, landfilling of waste can incur a charge of £96.70 per tonne (SLR 26,428). Landfill tax can generate significant funds for government and waste infrastructure. In the UK, the landfill tax generated £641M in 2019/2020 (SLR 744,856,964.79).	Medium – Long Term – Needs to be implemented following transition to use of engineered landfills to avoid negative impact and disincentivising use of correct facilities.
Plastics	Taxes on problematic plastics	Taxes can be introduced on problematic materials as an incentive to manufacturers to design and produce alternative materials. Taxes are common on specific items	Short-Medium Term

Theme	Recommendation	Summary	Timescales and predecessors
		such as single use plastic bags. Taxes have been introduced to incentivise the reduction of bags in the environment across in a range of countries across the globe. A suitable “lead in” phase is recommended, and specific exemptions may be required for food and drink production, or medical reasons.	
	Bans on problematic plastics	An outright ban on problematic materials can eradicate the issue almost entirely. Bans prohibit the import, manufacture and use of materials but also generate new industries and employment opportunities as manufacturers adopt alternative materials. Whilst Sri Lanka has introduced Bans on certain single-use plastics (sachets, cotton buds, etc.) there is the potential to extend the coverage to include items such as single-use plastic carrier bags as have been introduced in a number of countries including Fiji, Tanzania and Morocco.	Implementation dependent on materials and ability to replace.
	Industrial policies / standards	The government of Sri Lanka could instil standards that determine the qualities and composition of problematic materials, or items. This could improve waste management practices by issuing stipulations that ensure items are durable or recoverable, that hazardous components are phased out of use etc. The introduction of these policies or standards would need to be developed in consultation with industry stakeholders. Tanzania is in the process of introducing standards for plastic packaging/bags and Malaysia has introduced	Medium term – Legislative change to follow attempts to introduce voluntary schemes

Theme	Recommendation	Summary	Timescales and predecessors
		standards for bioplastics. In Bangladesh the textile industry is using Leadership in Energy and Environmental Design (LEED) certification to help reduce its environmental impact.	
	Subsidise alternative materials; textile, hemp, paper bags etc	Levies and subsidies can be used to incentivise the private sector to use alternative materials – or manufacturing processes – than current problematic practices. By incentivising alternative materials, manufacturers can see lower tax bills, or greater income from subsidies, by innovating their processes. In Bangladesh there has been research into the use of bioplastics developed from locally available Jute, this material can be used in place of soft plastic packaging but biodegrades. Across Rwanda, to support the ban of single-use plastic bags and single-use plastic items, new industries to develop reusable items using textiles, hemp and bamboo among other materials have developed. Subsidies were also in place across Morocco to support single-use plastic bag manufacturers in advance of the single-use plastics bag ban. Morocco also provides financial support to new cooperative movements which design and manufacture reusable bags such as textile bags.	Medium – Long Term – subsidies to be funded by ringfenced income.

Table 11-1 has outlined a range of potential recommendations for Sri Lanka with evidence from other nations to demonstrate that these recommendations are credible and workable to improve SWM practices in Sri Lanka. A suggested roadmap in 4 steps (from step 1 to be implemented as soon as possible and step 4 to be realised over the long term) is therefore included here according to the actions listed in Table 11-1. An indication of the timeline over which period these activities could be introduced is included, as well as the level of difficulty to implement the actions. Depending on the number of resources available to assist and the level of expertise, several actions could be implemented simultaneously.

Table 11-2 Step 1 actions

Action	Indicative timeline	Level of difficulty
Conduct a legislative review to ensure consistent political support to enforce the regulations and penalise where necessary. There should be a healthy collaboration between organisations and monitoring of actions.	Year 1	Easy Involve policy teams and higher education institutions.
Increase education and awareness in the general public on waste segregation. Programmes should also include training for the staff involved in SWM and advice to consumers and producers.	Year 1	Easy Involve LAs, higher education institutions, NGOs and third sector.
Understanding what gaps (legislatively and operatively) need to be addressed to organise a comprehensive residual waste collection for all households and to develop engineered landfills. Listing possible opportunities for funding or loans to start developing the necessary infrastructure.	Years 1-3	Difficult Involve LAs and waste collection authorities. Need experts who are familiar and understand these operations and landfill infrastructure.
Increasing training opportunities to build capacity for data management related to waste management (e.g. data recording for waste types, quantities and sources). Tools such as weighbridges should be installed at all WMFs.	Years 1 - 4	Medium Need experts in data management in waste industry
Create databases for waste data information at the LA and WMF level	Years 1 - 4	Medium

ensuring accurate data recording and reporting.		Need experts in data management in waste industry

Table 11-3 Step 2 actions

Action	Indicative timeline	Level of difficulty
Expand range of materials included within the existing ban (currently limited to few single-use plastics) to include items such as single-use plastic carrier bags. Requires stakeholder engagement to determine lead-in times and exemptions.	Years 1-3	Easy-medium (dependent on alternative materials and ability to replace). Involve higher education institutions, food & drink sector, and industry including manufacturers.
Involving the third sector to support waste collection which is led by LAs.	Year 2 onwards	Easy – medium Involves co-operation between waste collection authorities and NGOs and charities.
Implementing take-back schemes for local manufacturers to collect spent items from consumers.	Year 2 onwards	Easy – medium Requires regulatory measures and engagement and commitment from manufacturers. Possibly also capital for start-up costs.
Introduce waste management/disposal charges for specific or problematic wastes (e.g. e-waste) to fund their management. *Comprehensive collections must be in place.*	Year 2-3	Medium Difficulty will be with acceptance from public
Mapping illegal dumpsites with a view to close them through imposing levies to users (to be used for landfills development) and through sending positive message to the citizens	Year 2-3	Medium Requires local knowledge and regulatory measures.

Address the need for duty of care for waste transfer and for monitoring of waste practices	Years 2 - 4	Medium Need experts in data management in waste industry
Introducing financial and logistic arrangements such as Deposit Return schemes to capture high quality reusable or recyclable material through financially incentivising citizens; EPR schemes to share the financial burden of waste collections upon manufacturers of the materials; taxes on imported problematic materials, to incentivise the design and production of alternative materials. *A suitable "lead in" phase and the identification of specific exemptions should be considered.*	Years 2 – 7 (Full implementation)	Medium – difficult Requires regulatory measures, engagement with all stakeholders – producers, manufacturers, and governance, and tendering for Scheme Administrator as well as procurement of infrastructure (Reverse Vending Machines, counting centres etc).
Tax on problematic plastics and imported problematic materials.	Years 3 - 5	Medium – difficult Requires regulatory measures and governance.

Table 11-4 Step 3 actions

Action	Indicative timeline	Level of difficulty
Remediate existing dumpsites, undertaking risk assessment of existing sites to minimise the possibilities of pollution events, site collapse and to discourage scavengers and the mixing of waste types.	Year 4 onwards (links to closing of dumpsites)	Difficult Requires remediation experts
Subsidise alternative materials or manufacturing processes to incentivise their use/adoption (lower tax bills, income from subsidies, use of public procurement portals to incentivise bidders using alternative materials by setting minimum standards for bidders).	Year 4 onwards	Medium - difficult Financial mechanisms to provide subsidies should be based on ringfenced income.

Introduce industrial policies and standards for problematic materials or items (e.g. packaging/bags or bioplastics). This will stipulate the quality and composition of problematic materials and items (increasing durability or phasing out hazardous components).	Years 4 - 6	Medium - difficult Requires regulatory measures following attempts to introduce voluntary schemes. Consultation with industry stakeholders is needed.
Deter landfill through the introduction of landfill usage taxes). Transition away from dumpsites must have happened to avoid disincentivising use of correct facilities.	Year 5 onwards	Medium - difficult Requires regulatory and fiscal measures.

Table 11-5 Step 4 actions

Action	Indicative timeline	Level of difficulty
Limit the amount of problematic materials that can be introduced to the marketplace through use of permits, quotas or credits under EPR schemes.	Year 6 onwards	Medium – difficult Requires governance and industry engagement.
Implement the Polluter Pays Principle to charge costs of waste management to generators of waste (companies producing packaging or individual properties charging households). *Comprehensive collection must be in place.*	Year 6 onwards	Medium Requires governance and industry engagement.
Enforce legislation through a robust approach to non-compliant businesses. Enforcement officers should be in place undertaking site inspections and penalising non-compliance (seizing non-compliant materials, issuing fines etc) to ensure adherence with the laws and rules. It is important to ensure that border control measures are also in place to prevent illegal imports, or materials being brought in by tourists.	Year 6 onwards	Medium – difficult Requires governance and resources to monitor industry.

Underlining the success of each recommendation are key principles that should also be considered by Sri Lanka should it opt to adopt any of these recommendations:

1. Stakeholder engagement is essential to ensure the effective design of any policy and to ensure consensus among stakeholders. Stakeholders should be engaged early in the design of any policy to ensure valid concerns are incorporated into the final design, whilst generating a sense of stakeholder “buy in” to the final implemented policy;
2. Enforcement is imperative to ensure that stakeholders are educated on how to follow the policy correctly, identify where wrongdoing occurs and to penalise non-compliance. Enforcement in the countries signposted above include site inspections, fines, imprisonment and the closing down of non-compliant businesses;
3. Data management is essential to record and monitor the impact of each policy before, during and after implementation. This will allow the Government to identify any need for further interventions or investment, whilst providing valuable data upon which to evaluate the policy and inform future initiatives.

Consideration of the above policies can support Sri Lanka to embed sustainable and economically viable practices across their SWM processes, whilst generating valuable opportunities for the local economy.

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