# Microplastics and You

Ministry of Environment & Sri Lanka Medical Association

# MICROPLASTICS AND YOU

**Ministry of Environment**
**&**
**Sri Lanka Medical Association**
**2021**

CM 034618 -  500 (11/2021) Dept. of Govt. Printing, Sri Lanka

**Ministry of Education**

**Licence No. : EPAB/2020/27086**

**Name of the Book—Microplastics and You**

**Author—Dr. Sajith Edirisinghe**

Approved as a school library book by the Director General of Education In terms of Para 19/A of the code of regulations for assisted vernacular, Billingual and English Schools , published in the Government Gazette of 29th February 1952.

**Pushpakumra Vithanage**
Secretary,
Educational Publications Advisory Board.

27-10-2020
Ministry of Education, "Isurupaya", Battaramulla.
Date of Expiry : 2025-10-26

**Dr. Sajith Edirisinghe**
Assistant Secretary
Sri Lanka Medical Association 2020/2021
Lecturer and Clinical Geneticist
Faculty of Medicine, University of Sri Jayewardenepura

**N.S. Gamage**
Deputy Director General (EMA)
Environmental Management and Assessment Division
Central Environmental Authority

**Dr. H.M. Palitha Kithsiri**
Director General / Research and Development
Project Coordinator Norway-Sri Lanka Bilateral Project
EAF-Nansen Program Coordinator - Sri Lanka
National Aquatic Resources Research and Development Agency (NARA)

**W. R. W. M. Ashoka Priyaweerakoon**
Scientist
National Aquatic Resources Research and Development Agency (NARA)

Microplastics and You



First edition: December 2021

ISBN 978-955-9386-51-3
The authors are responsible for all articles contained in this book.

**Cover design and graphic design**
Chamid Mudalige - Faculty of Medicine, University of Sri Jayewardenepura.

**Photography support**
Varuna Abeyratne - Faculty of Medicine, University of Sri Jayewardenepura.

**Contributions to the English version by:-**
Dinul Doluweera - Faculty of Medicine, University of Sri Jayewardenepura.
Anagi Kottahachchi- Faculty of Medicine, University of Sri Jayewardenepura.
Shamal Gunawardhana - Faculty of Medicine, University of Sri Jayewardenepura.
Amalka Chandraratne - Faculty of Medicine, University of Sri Jayewardenepura.
Anjana Gurusinghe - Faculty of Medicine, University of Sri Jayewardenepura.
Kasunika Perera - Faculty of Medicine, University of Sri Jayewardenepura.
Kasuni Kumarasinghe - Faculty of Medicine, University of Sri Jayewardenepura.

**Editor**
Dr. B.J.C. Perera – Specialist Consultant Paediatrician, Medical Editor and Past President, Sri Lanka Medical Association

**Publication**
Ministry of Environment & Sri Lanka Medical Association -2021

## Dedication

To all of you who simply love the environment and are committed to creating an environment free of polythene and plastic.

# Preface

The day when the menace of plastic will take over the earth is not far off. At such a critical juncture, the efforts of the authors of this book to open the eyes of a generation of Sri Lankan readers to an unprecedented aspect of plastics are extremely timely.

The damage to the environment caused by the excessive amount of microplastics that are constantly being produced and released into the environment is heart-breaking. This poses a huge threat to the survival of humankind and other species alike. We are already experiencing the effects of declining biodiversity, impacts on natural cycles, increased natural disasters, and cancer. Unfortunately, Sri Lanka is one of the countries that produces much plastic waste, while lagging behind in terms of reuse and recycling.

Even as an individual, the contributions one can make towards minimizing the use of plastics and recycling and the impact on their generation, country, and the world, are immense. It is also important to know the legal background of the manufacture and use of plastics. Not knowing them will not be an excuse. It is not generally appreciated that various products contain small particles of microplastics. Their release into the environment has a devastating effect on human health, which is the last link in the food chain and network. Such particles are also potent carcinogens.

Dr. Sajith Edirisinghe is the Assistant Secretary of the Sri Lanka Medical Association for the year 2020/2021 and serves as a Lecturer in the Department of Anatomy, Faculty of Medicine, University of Sri Jayewardenepura.

Coinciding with the 133rd Annual Medical Conference, the Sri Lanka Medical Association (SLMA) successfully conducted a workshop on 'Impact of Microplastic Condition on Human Health in Sri Lanka' on 10/07/2020 on a concept brought to light by Dr. Sajith Edirisinghe. This book is the next step in his mission, to educate the public through his press conferences, articles, radio, and television programmes, aimed at rescuing the Sri Lankan people from the menace of microplastics.

Mr. N. S. Gamage, Director, Central Environmental Authority; Dr. H. M. Gamage, Director, National Aquatic Resources Research and Development Agency (NARA);

Mr. Palitha Kithsiri and Mr. W. R. W. M. Ashoka Priyaweerakoon have done and continue to do a lot of research on the environment. The diverse range of knowledge of all these authors has helped to build-up the scope of this work.

This book explains what microplastics are, their importance and adverse effects, how they are added to the environment, as well as the history and current use of plastics, worldwide use and status in Sri Lanka, plastic classification, correct use, disposal, recycling and related institutions.

I'm much grateful to Dr. Anil Jasinghe, Secretary, Minister of Environment for the support given to bring this valuable book to the publication level by providing the necessary guidance and financial support for printing.

You, the intelligent reader, should reap the maximum benefits of such a book. It cannot be achieved simply by reading this. I think this book will be a great help to prevent future generations from being destroyed by the plastic menace.

**Prof. Indika Karunatilake**
President,
Sri Lanka Medical Association,
2020

**Special Thanks goes to**

**Dr. Anil Jasinghe**,
Secretary

**Mr. M.G.W.M.W.T.B. Dissanayake**
Additional Secretary (Environment Policy & Planning)

**Mr. A.H.L.D. Gamini Wijesinghe**
Additional Secretary (Environment Projects & Education Training)

**Mr. R.S.K. Doolwalage**
Director (Education Training & Research)

**Mr. Mahinda Werahera**
Director (Environment Pollution Control & Chemical Management)

**Mr. Ranjith Rajapakshe**
Assistant Director (Communication and Public Relations)

**Ms. S.T.K. Fernando**
Assistant Director (Environment Pollution Control & Chemical Management)

**Mr. A. H. T. Tharindu Vidumini**
Environment Management Offer

**Ms. Sajani Sulakkhana**
Development Officer

of
Ministry of Environment, Sri Lanka
for the unconditional support given.

# Table of Contents

# Table of Figures

## List of Tables

# Abbreviations

| | |
|---|---|
| ABS | Acrylonitrile Butadiene Styrene |
| EEZ | Exclusive Economic Zone |
| GPGP | Great Pacific Garbage Patch |
| HDPE | High-Density Polyethylene |
| HIPS | High Impact Polystyrene |
| LDPE | Low-Density Polyethylene |
| LLDPE | Linear Low-density Polyethylene |
| NAFTA | North American Free Trade Agreement |
| OPP | Oriented Polypropylene |
| PET | Polyethylene Terephthalate |
| PP | Polypropylene |
| PS | Polystyrene |
| PVC | Polyvinyl Chloride |
| UN | United Nations |
| UNCLOS | United Nations Convention on Law of the Sea |

# Chapter 01 – Plastic – Past and Present

**Dr. Sajith Edirisinghe**

Plastic, although an essential component of today's world, has become a massive threat to Mother Earth. The English term "plastic" is derived from the Greek word "Plastikos", which roughly translates into 'mutable without fracture'.

The world's first molecule of plastic was synthesized by Alexander Parkes in 1856 in Birmingham, England and he also obtained the patent for it. The World's first type of plastics was named "Parkesine", now called nitrocellulose. Parkesine is synthesized by chemically combining cellulose (the main substance of the plant cell wall) with nitric acid and alcohol.

Figure 1: The blue plaque at the Birmingham museum in Memory of Alexande

According to the website "Statista", large scale production of plastics was commenced in 1940 (STATISTA 2020. ). Today the industry is growing rapidly, not sparing any nook and corner of the world. Plastic production in just the year 2017 reached 350 million metric tons. Calculations predict that it will rise 3-fold by 2050. China tops the world in plastic production, reaching 31% of total production in the world. Countries belonging to the North American Free Trade Agreement (NAFTA) was the second largest plastic producing region in the world after China, and accounts for 19%. The rest of the Asia accounts for 17%  contribution to world plastic production (Tiseo 2021).

The graph below shows the worldwide distribution of plastic production from 1950 to 2015. It is evident that plastic production is growing exponentially. In the year 2000, the worldwide production was 213 million metric tons and by 2010 it has increased up to 313 million metric tons. Within 10 years the production has increased by 100 million tons. By 2015 the numbers would reach 381 million metric tons.

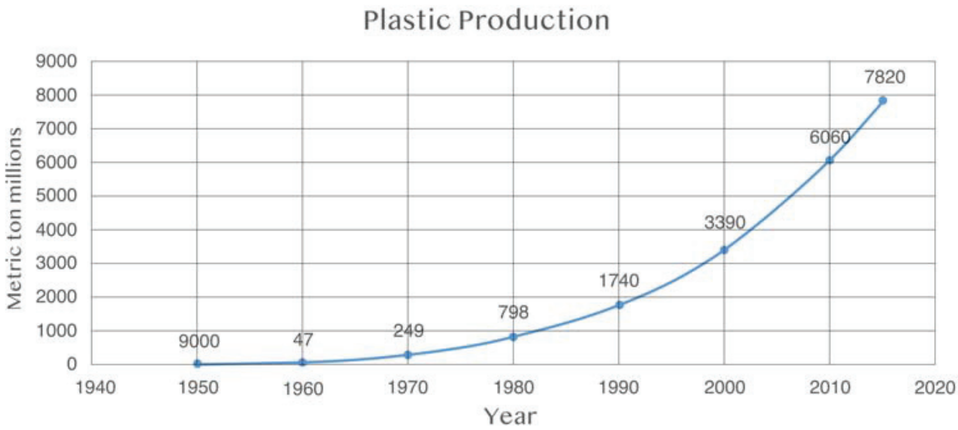



Figure 2: Worldwide plastic production 1950 -2015 (Geyer et al., 2017)

## 1.1 Why plastic became a pollutant?

Currently plastics are one of the most easily available products in the world. It is easily affordable, cheap, easy to manufacture and durable as well, as it can be just discarded easily. These qualities together lead plastic to become one of the major polluters in the world. In the end, plastics harm the environment in many ways. When plastics are burnt, it pollutes the air. Once used for landfills, it pollutes the soil. If it is dumped into the water sources, it pollutes the marine environment. With the increase of the population, people demanded for cheap and readily available materials. In most of the urban waste, plastics account for a significant proportion. Most of the household plastic products are lightweight with a small user time. Most are single use plastics (plastic water bottles, straws, food containers, plastic bags and wrappers). The plastic molecules have a strong bond complex. It takes many years to break down the complex chemistry between the molecules. A simple grocery bag takes at least 50 years to break down while some complex plastic products take 600 —1000 years to decompose.

Not only the production of plastics but also the misuse of plastics has exponentially increased over the last few years; the greatest contribution to it being provided by the East Asia Pacific region (more than 60%). Unfortunately, the South Asian region, where Sri Lanka belongs, marks the second-highest in plastic misuse. In 2010 the rate was 11% and by 2015 it has increased up to 12.5%. The rate of plastic misuse remains

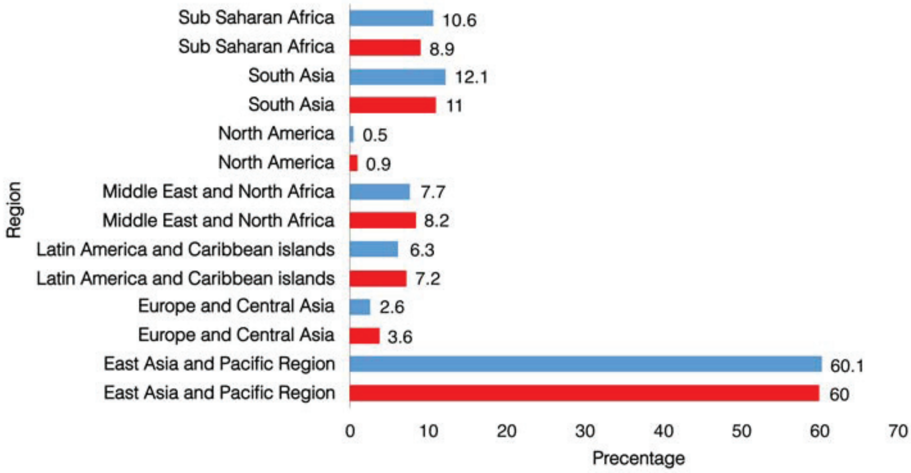



*Figure 3: Plastic misuse in 2010(red) and predicted value in 2025(blue) as a percentage (Jambeck et al., 2015)*

considerably low in European countries even though the region claims the second-highest rate of plastic production, after China. These statistics pinpoint the fact that a major attitudinal change towards plastic use and disposal is needed in the Asian region.

Only less than 20% of plastics worldwide were being recycled by 2015, which leaves a vast majority, more than 80% (nearly 304.8 metric tons), being released, without any controls to the environment. Needless to say, this unfolds a huge number of environmental issues.

Even though the following graph shows a decline in the percentage of plastics released, the production has massively increased, dwarfing the reduction of the percentage of release. In 2015, 19.5% of plastics were recycled, 55% released to the environment unprocessed and 25.5% were burnt.

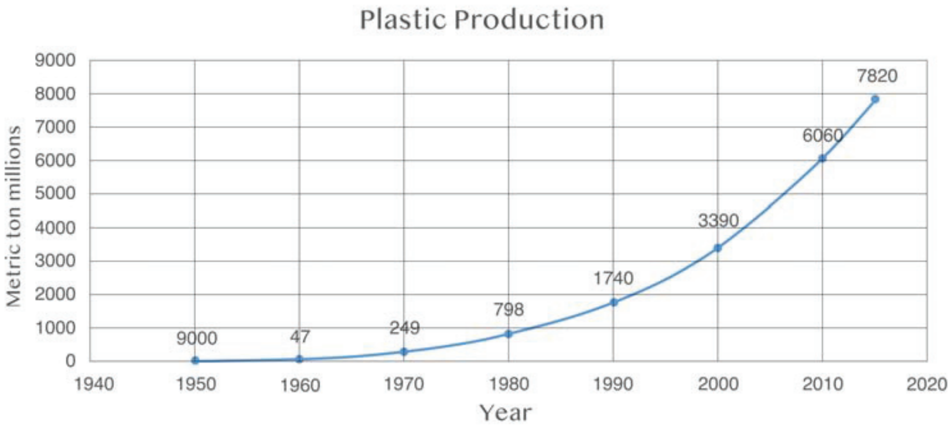



Figure 4: Fate of plastics produced (Geyer et al., 2017)

### 1.2 Great pacific garbage patch

Currently, the world's offshore, uncontrolled waste plastic is being carried by waves and ocean currents and piled up as islands in five major oceans around the world. As shown in the figure below, these plastic islands are formed in 5 oceanic regions. Its specialty is that the location of the archipelago changes depending on the prevailing weather conditions such as the wind speed and the nature of the waves.


Figure 5: Offshore plastics

The Great Plastic Island in the Pacific Ocean (Zone 1 in the figure above) was calculated to cover an area of 1.6 million square kilometres in the 2018 census. It is twice as large as the state of Texas in the United States, three times as large as France and 20 times as big as Sri Lanka. According to reports in *Nature*, one of the world's leading scientific journals, it is estimated to have more than 1.8 trillion pieces of plastic and an estimated weight of over 80,000 tons. Around 94% of the estimated floating plastic pieces here are microplastics or nanoplastics. More than three fourth of it consists of pieces of plastic larger than 5cm; 46% of them are fishing nets.

If the amount of plastic here is distributed among all the people in the world, one person gets 250 pieces of plastic. Such a large amount of plastic has accumulated in this place alone.

The plastic concentration in the central part of the island is about 100 kg per square kilometre (kg/km²) and the plastic concentration in the periphery is about 10 kg per square kilometre (kg/km²).

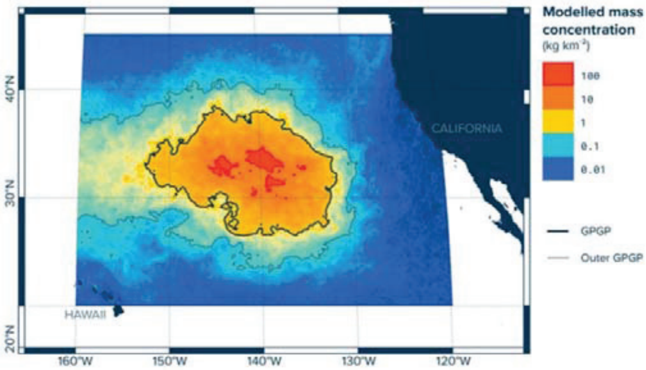



Figure 6: Plastic concentration in parts of the island (CLEANUP 2013)

Research on this plastic island has been on-going since the 1970s, and the light blue in the chart below shows the size of the microplastic/nanoplastic inside the island, while the dark blue indicates the gradual growth of the microplastic/nanoplastic size around the island.

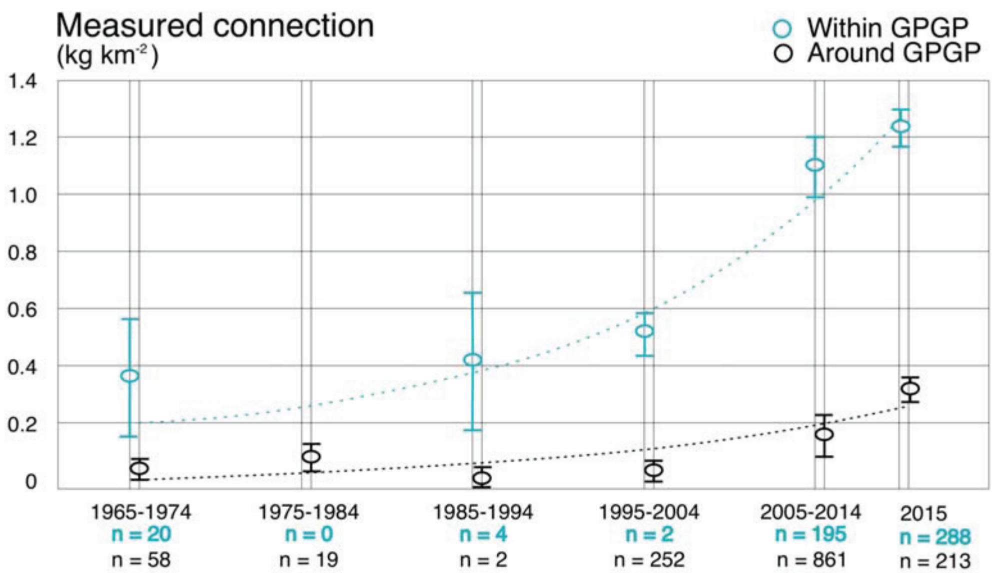



Figure 7: Microplastic / nanoplastic scale in and around the great plastic island of the Pacific Ocean. (CLEANUP 2013)

The indisputable fact is that the problem of plastics will only get worse day by day, if the release of plastics into the environment does not stop.

## 1.3 Current Situation in Sri Lanka

According to the report of reference PER/B/2019/01, issued by the Environmental Audit Division of the National Audit Office, in the year 2020, 3,353.9 million kilograms of plastics were imported to Sri Lanka during the 7 years from 2012 to 2018. The value is 184,300.90 million rupees. The plastics thus imported are imported under four main categories. They are raw materials, finished goods, furniture and toys. In 2018, 64% of the total amount of imported plastics was imported as raw material for the plastics industry. This is an increase of 3.65% over 2017.

According to the audit report, only about 30% of imported plastic is properly recycled. That means 70% is discharged directly or indirectly into the environment. A study conducted to analyse the future trends of plastic recycling in Sri Lanka showed that out of 310,000 tons of plastics consumed, around 220,000 tons (70.99%) would be wasted by the year 2025 (Gunaratna 2012). Since Sri Lanka is a small island, such a big percentage of plastic waste has a significant environmental impact. Western Province generates around 3500 metric tons (MT) of solid waste every day and out of that solely 2400 MT is collected (Amarasinghe, Bandara et al. 2020). Out of this waste nearly 15% is converted to compost, 10% sent for recycling and 75% thrown into open dumps. Sri Lanka is within the first 10 places in plastic pollution around the world. If you visit the nearest beach, it provides you all the proof you need. This rubbish issues are combined with natural disasters like floods and landslides at times. The most recent example of inadequate and ineffective waste management was the devastating waste yard collapse at Meethotamulla. When it comes to Sri Lankan industries, they manufacture varied forms of plastic waste that is typically disposed of directly while not being processed because handling plastic waste is troublesome, time consuming and costly. The industries continue to use plastics because there is no material that will replace plastics in terms of characteristics and functions.

Given below are the total quantities of plastics imported into Sri Lanka from 2012 to 2018. A rapid growth of importation of plastics is noticeable. The total amount of plastic brought to Sri Lanka in the past 7 years is 3,353,896,078 kg.

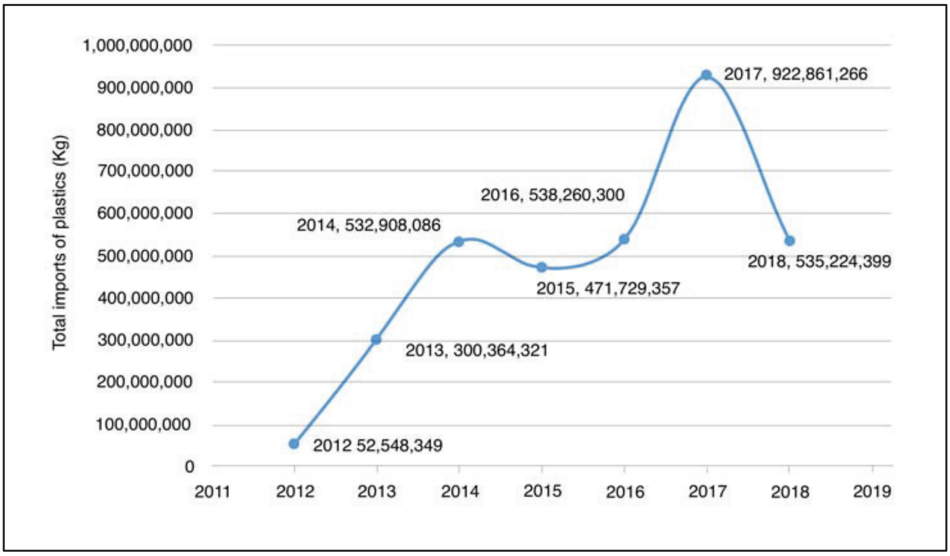



Figure 8: Total amount of plastic imported into Sri Lanka

(Source - National Audit Office, Environmental Audit Division - Report No. PER / B / 2019/01)

The chart above shows the extraordinary growth in plastic imports in 2017. As mentioned earlier, according to the classification of plastics entering the country, the amount of plastics arriving as furniture in 2018 has decreased significantly, when compared to 2017.

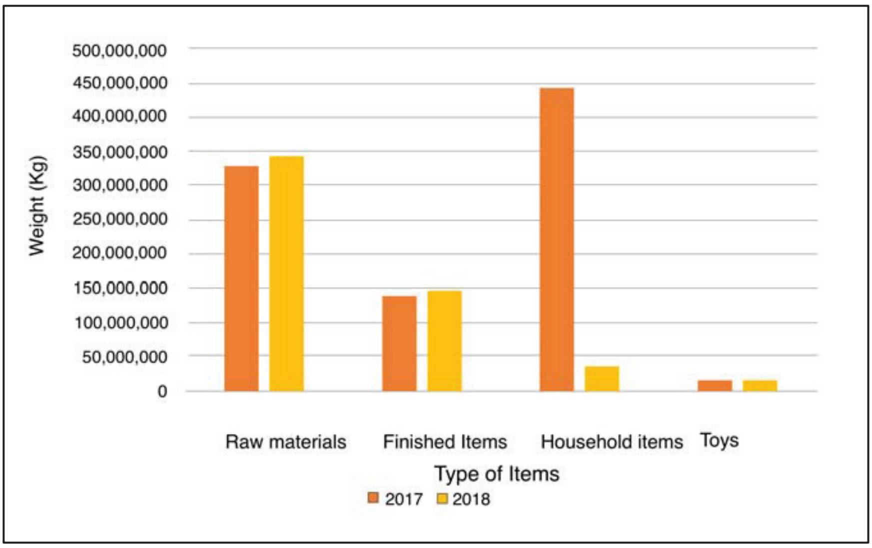



Figure 9: Plastic import classification 2017-2018

(National Audit Office, Environmental Audit Division - Report No. PER / B / 2019/01)

According to the Sri Lanka Export Development Board, there are about 400 companies involved in the plastics processing process in Sri Lanka, and the plastics industry processes about 140,000 metric tons of plastics annually. This is expected to grow by 10-12% per annum in the future.

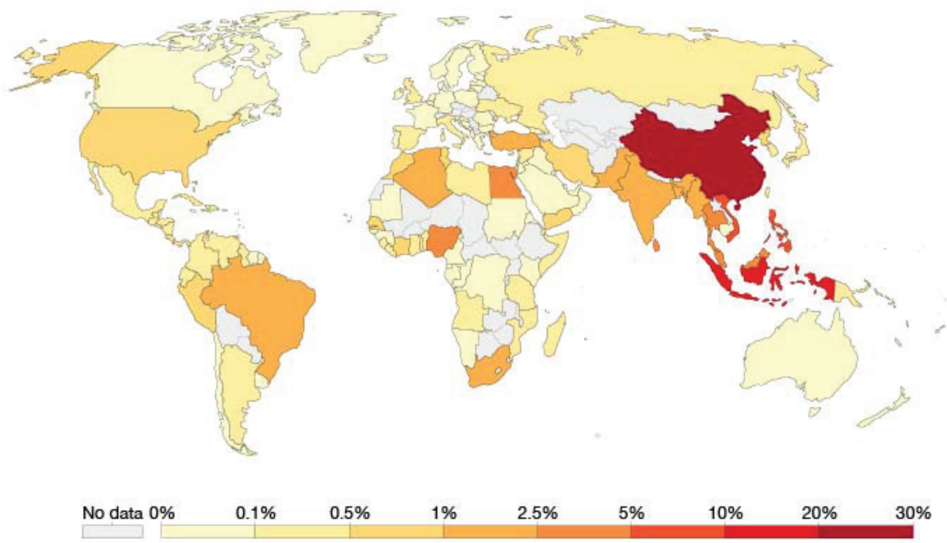



Figure 10: The amount of uncontrolled Release of Plastic into the Environment per Day by an Individual (Jambeck, Geyer et al. 2015)

Sri Lanka, as a percentage of the global share of the world's misused plastics, contributes 4.9%. Neighbouring India contributes even less than us, which is 1.8%. Sri Lanka is preceded by Indonesia (10.1%), Vietnam (5.7%), the Philippines (5.9%), and China (27.7%). This means that Sri Lanka is the 5th largest polluter of the environment by plastics in the world (Jambeck, Geyer et al. 2015) even though there is no large-scale plastic production in our country.

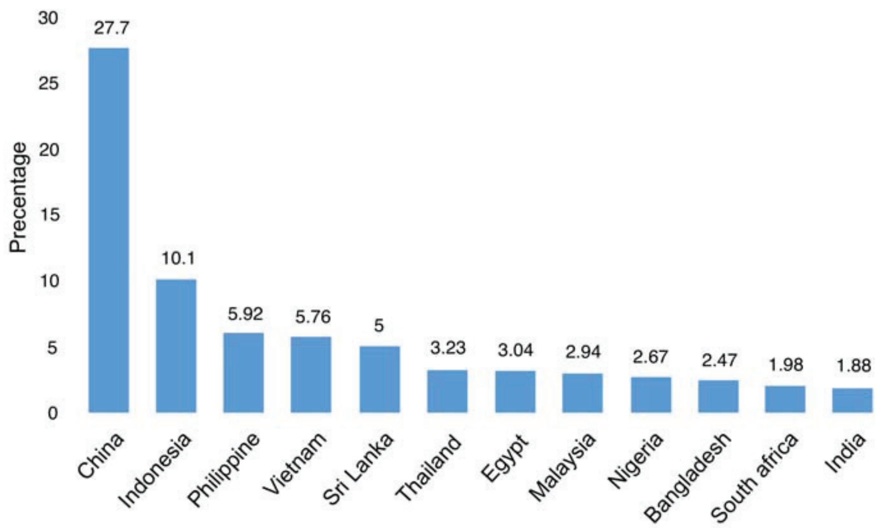



Figure 11: Percentage of the global volume of plastic misused in the world (Jambeck et al., 2015)

According to a survey conducted by the Institute of Policy Studies of Sri Lanka, the PET raw material required for the production of plastic products in Sri Lanka in 2003 alone (further details on PET are given in Chapter 2) is 1337 metric tons. Imports of PET-based raw materials have been growing at 28% per annum since 2000, while the production of all plastics products has grown by 7.5% per annum. According to the data of a garbage sorting company in the city of Colombo, about 3 kg of PET related plastic waste is discharged from one house per year, while the entire Western Province alone emits about 736 metric tons of PET related plastic waste per year.

# Chapter 02 - Situation of marine environment and microplastic waste in Sri Lanka

**Dr. H. M. P. Kithsiri and W. R. W. M. Ashoka Priyaweerakoon**

The Sri Lankan coastline is one of the most productive and fertile areas in the Indian Ocean because of its geographical location between the Arabian Sea and the Bay of Bengal. Sri Lanka is a party to the United Nations Convention on Law of the Sea (UNCLOS) acceded to on December 10, 1982 and exercises jurisdiction over the territorial sea, contiguous zone, continental shelf and the exclusive economic zone in keeping with the definitions laid down in that convention. The territorial waters of Sri Lanka extend 22km (12 nautical miles) [nm] beyond the coastline and cover an area of about 21,500 $km^2$. The contiguous zone is the band of water extending from the outer edge of the territorial sea to up to 24 nautical miles. In addition, the country enjoys rights to a un-mandated 'Exclusive Economic Zone' (EEZ) that extends outward 370km (200nm) from its shores and covers an area of about 510,000 $km^2$. Besides having sovereign rights to resources in the water column, seabed and subsurface, Sri Lanka also has the exclusive right to authorize, regulate and control scientific research within this zone. This sea area is very important due to the eruptions caused by monsoon winds and the biodiversity associated with marine corals and other ecosystems.


*Figure 12: Sri Lanka's territorial sea area*

Pollution has a direct impact on the quality of marine resources around the world. Arguably, human activities create more deadly threats to the marine habitat than natural forces, including climate change and natural disasters. Industrial waste and debris have a direct impact on the survival of fish, corals and other marine life. Therefore, it is important to provide information on the water quality, cleanliness of the marine environment, importance of coastal and shallow water eco system conservation for future sustainable development. This has necessitated worldwide research and data collection to provide an analysis of trends and changes in the marine environment.

Over the past decade, plastic waste has become an emerging problem around the world due to major ocean and coastal waste dumping. Over the past six decades, the use of plastics without proper recycling and massive increment of plastics production for various purposes have resulted in dumping of large amounts of plastic waste into natural streams, rivers, coastal environments or to the ocean worldwide. Since there is a failure to introduce a permanent replacement for plastics, marine and coastal areas and their associated sensitive ecosystems continue to be polluted.

These contaminants have several chemicals and physical properties that determine their breakdown which impact on the composition of various ecosystems. This waste is generated from various sources such as industrial wastes, used as coverings and personal care products. Several accepted methods are used to classify plastic waste. Those wastes can be mainly classified according to how they are generated or by their physical or chemical parameters.

Physical parameters used to classify plastic waste, are the hardness, colour, shape, surface texture, and physical size. Many studies around the world take physical size of the particles into account. The physical size of the pollution particles are measured for its length & width in mm. Particles smaller than 5 mm are also known as micro-plastics. Particles between 5 and 25mm are known as meso-plastics and particles between 26 and 100 mm are known as macro-plastics. Particles larger than 100mm are known as mega-plastics.

Out of the above types, special attention is paid to very small particles called microplastics. The increase in microplastic pollution in the oceans has become a serious problem and various research projects are being carried out in different parts of the world on the possible impact on the marine ecosystems. Microplastics as well as other plastics are scattered throughout the ocean under the influence of various factors. The plastic wastes that are deposited in the ocean as sediments have the potential to persist for many years.

Once the plastic waste is added to the ocean, it does not decompose easily. Unlike other wastes, plastic wastes are less likely to become broken down because they are man-made. During the decomposition (breakdown) of this large plastic waste, very small particles, such as microplastics, are formed.

## 2.1 Current research

National Aquatic Research Agency began its study of plastic waste in the oceans and coastal areas around Sri Lanka in 2016. The main objectives of this project was to conduct a systematic study of various plastic wastes in the ocean and coastal environment around Sri Lanka.

The research venture, which was conducted continuously for 4 years, analysed the plastic contaminants present in the ocean surface water and beach sand using an internationally accepted method. These studies were conducted during the period 2016 -2019 to fully cover the coastal areas of Sri Lanka to determine the seasonal variations of the plastic pollutions of the Sri Lankan coast.

The above explorations were carried out with the help of small motorboats, the Marine Research Ship and the research vessel with Dr. Frijoff Nanson who arrived in Sri Lanka for research work.

In many Sri Lankan coastal areas and ocean surface water is contaminated with microplastics. The research project was designed to identify several types of plastic waste, including microplastics, and their chemical-physical properties.

Figure 13: Collecting water samples from the sea around Trincomalee using the NARA ocean research ship.

Most of the surface water contaminants found in the seawater around Sri Lanka were fragments. The second major type was string-like plastic fibres mainly from fishing nets. The survey found the least numbers were of thin fibres and films, and the third most common group of microplastic contaminants were foams. A large number of particles were reported from the Eastern and North-Western regions.

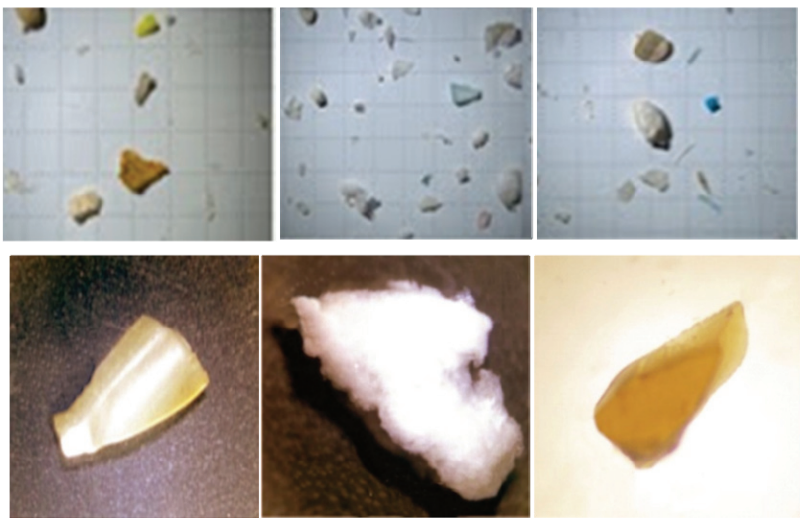


Figure 14: Several microscopic plastic waste samples observed under a microscope

## 2.2 Colour composition of microplastic particles

The majority of microplastic particles are blue while white, green, transparent, and brown plastic particles are abundant in various regions.

The average size of small plastic particles is 1.26 mm. This reveals the size variation of the microplastic particles. According to the available data, the majority of microplastics were having a width of 0–0.5 mm and a length of 0–4 mm. In the study there were plastic particles belonging to mesoplastics (5-25 mm), and macroplastics (>25 mm) category as well.

## 2.3 Surface properties of microplastics

At the time of observation, most of the microplastics were particulate matter. Many particles had a rough surface. The particles in film form had a smooth and shiny surface.

## 2.4 Hardness of microplastic particles

Microplastic particles have a hard or soft structure, which depends on the chemical polymer composition of the waste product and its density. Rigid plastic (plastic products that do not get compressed easily when squeezed) that have a rigid structure tend to be debris belonging to the high-density plastic category. The soft structural plastics have fragile or partially brittle structures.

## 2.5 Geometric shapes of microplastic particles

The majority of the plastic particles found so far were irregularly shaped, accounting for 74.13%. Very few plastic particles with other geometric shapes were found in the analysed samples. Many plastic particles took on three-dimensional shapes in their geometric contours.

During the four years of the study, from June to September, the Western part of the island, especially the North-West coasts, had high levels of all plastic waste, which is much higher than the amount of waste found in the Northern, Eastern and Southern seas. The largest amount of plastic debris accumulating along the coast, especially from Chilaw to Kalpitiya, was seen in the year 2018. The fragments included plastic waste from a variety of sources, including beverage packaging, medical waste, drinking water bottles, fishing gear, nets, cosmetics bottles and personal care products. During the study period, large amounts of microplastics were also found in the surface layer of the sea water near the West coast.

Over the past few years, large amounts of plastic waste have been found from time to time in several areas along the Western and Eastern coasts, and further research is underway as their origins cannot be determined at once. As it is a tidal region, this contaminant may also have come from other parts of the world. Active currents at different times of the year have the potential to transport such plastics to other seas and oceans off the coast of Sri Lanka, but no such studies have been identified yet, and further studies are being conducted by NARA.


*Figure 15: Large-scale plastic debris found on the northwest coast.*

## 2.6 Chemical composition of microplastics

The chemical compositions of the currently identified microplastic particles were assessed by laboratory analysis. The type of plastic waste which were commonly found in the ocean surface water and on the beach were chemically analysed. The results revealed that the majority of plastic contaminants in surface water include Polypropylene, Polyethylene, Psolystyrene and Nylon.

The raw material (primary plastics) was the least observed in all samples. This indicates that the vast majority of micro-plastic waste belongs to the secondary plastic category and that most of it is are generated from packaging materials from various industries, and fishing gear, as well as nets, from the fishing industry.

According to the above research endeavour, plastics used in the packaging of various items in daily life and emissions from various industries are the most harmful pathways of plastic contamination in the seas and beaches around the island. Therefore, further research, projects and policy formulations, are essential to minimize the discharge of this waste into the ocean and coastal environment.

# Chapter 03 - Plastic classification

Dr. Sajith Edirisinghe

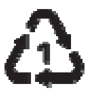
Most of the plastics we use are made from petrochemicals from crude oil. In the manufacture of plastics, it is used to produce plastics of various properties by mixing various chemicals, pigments, stabilizers and fillers.

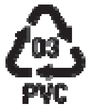
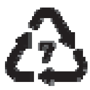
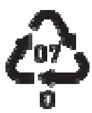
According to the International Resin Identification Coding System (RIC) published by the American Society for Testing and Materials, plastics are divided into seven main categories according to the raw material used to manufacture the plastics. This classification was initially introduced by the Society of the Plastics Industry in 1988. Subsequently, in 2008, it was administered by the American Association for Internationally Recognized Research Material. The main purpose of this number was to make it easier to identify them for recycling after use.

Furthermore an extraordinary gazette notification (No. 2211/50) has been issued by the Sri Lankan government (Regulations made by the Minister of Environment under Section 32 of the National Enviornmental Act, No. 47 of 1980) regarding the "Plastic Material Identification Standards" on 21st January, 2021.

The symbol used here is a triangle in the form of three arrows rotating clockwise, with the corresponding number in the centre.

Table 1: International resin detection and coding system

| Number | Symbol options | | | Description |
|---|---|---|---|---|
| | Image 01 | Image 02 | Image 03 | |
| 1 |  |  |  | Polyethylene Terephthalate (PETE or PET) |
| 2 |  |  |  | High-Density Polyethylene (HDPE) |

| Number | Symbol options | | | Description |
|---|---|---|---|---|
| | Image 01 | Image 02 | Image 03 | |
| 3 |   |   |   | Polyvinyl Chloride (PVC) |
| 4 |   |   |   | Low-Density Polyethylene (LDPE) |
| 5 |   |   |   | Polypropylene (PP) |
| 6 |   |   |   | Polystyrene or Styrofoam (PS) |
| 7 |   |   |   | Miscellaneous plastics (includes: Polycarbonate, Polylactide, Acrylic, Acrylonitrile butadiene, Styrene, Fiberglass, and Nylon) |

## 3.1 Polyethylene Terephthalate (PETE or PET)

Figure 16: PET plastic bottles

These PET plastics are widely used for packaging food. The special feature of this PET plastic is that it prevents the spoiling the content in side by stopping Oxygen come in and trap the carbon dioxide in carbonated soft drinks.

The danger here is that it contains antimony trioxide. It is a chemical that can cause cancer. It can also affect the body's endocrine system. The longer the food or beverage in pet plastics lasts, the more likely it is that this chemical compound will be released into the food. Also, rising temperatures accelerate the release of this chemical. For this reason, doctors advise not to store water, especially in plastic bottles and not to keep it in vehicles parked outdoors.

But reports from people say that PET bottles contain less of the antimony trioxide chemical that is harmful to the human body. Very little scientific research has been done on the effects of PET / Antimony trioxide on the human body. Therefore, it is in the best interest of our body to be careful when using it.

## 3.2 High-Density Polyethylene (HDPE)

This is a thicker, stronger material than PET plastic and is widely used to store chemical materials. Furthermore, it is used to store milk and to make bins. Chromium or silica crystals are used to make this type of plastic. HDPE is also used in about one third of the world's toys. According to current reports, the production of this HDPE plastic worldwide, in 2007 alone, exceeded 30 million metric tons.


Figure 17: HDPE plastic bottles

## 3.3 Polyvinyl Chloride (PVC)

Polyvinyl Chloride is used to make the PVC pipes we all know. In addition to that, bottles containing cleaning agents are recycled and used to make plastic binders, which are then used to bind books. These PVCs also contain ingredients that are harmful to the body. It contains bisphenol A (BPA), lead, mercury and dioxins (released when burning).

Some of the chemical compounds mentioned here can even cause cancer. By minimizing its use, this type of plastic can be prevented from being released into the environment.

Figure 18: PVC pipes

## 3.4 Low-Density Polyethylene (LDPE)

This type of plastic can be manufactured at a very low cost. The cellophane covers we often find belong to this category. This is a very thin and very easy to handle plastic. In addition to cellophane covers, it also produces food storage containers and even plastic bottles that can be squeezed to get the fluid inside to the outside. These plastics have also been found to impair the hormonal activity of the human endocrine system. Usually, this type of plastic can be used to store food. By minimizing the use, this type of plastic can be prevented from being released into the environment.

Figure 19: LDPE polythene bags

## 3.5 Polypropylene (PP)

This type of plastic is stronger and more resistant to heat conditions. They are commonly used to store hot food. It is also used in the manufacture of sanitary napkins. This type of plastic is suitable for storing food or beverages and according to some research reports it can impair the hormonal activity of the human endocrine system and contribute to the exacerbation of asthma in some people. By minimizing the use, this type of plastic can be prevented from being released into the environment.

Figure 20: Polypropylene plastic bottles

## 3.6 Polystyrene or Styrofoam (PS)

Figure 21: Various rigid-foam products

This is the rigid-foam in containers that we all know. It is widely used to pack food and goods. When this type of plastic comes into contact with a hot liquid or an oily liquid, it releases styrene, a toxin that affects the human nervous system. This chemical also causes serious damage to the liver, lungs, and immune system. The danger is that this chemical can also mutate in humans. By minimizing the use, this type of plastic can be prevented from being released into the environment.

## 3.7 Miscellaneous plastics

This type applies to any of the plastics which does not belong to RIC classification 1-6 or maybe a mixture of several types of plastics. Polycarbonate sheets and acrylic sheets that we use frequently, belong to this category. It is widely used and is a carcinogen. These plastics are very difficult to recycle. By minimizing the use, this type of plastic can be prevented from being released into the environment.

*Figure 22: Plastic products belonging to category 7*

According to the report PER / B / 2019/01 issued by the Environmental Audit Division of the National Audit Office in the year 2020, it was observed that there has been an increase of importing the types of polyvinyl chloride (PVC) plastic by 21.19%, polystyrene plastic by 44.67%, polypropylene plastic by 39.24% and the different category plastic by 160.79% in the year 2018 compared to the year 2014.

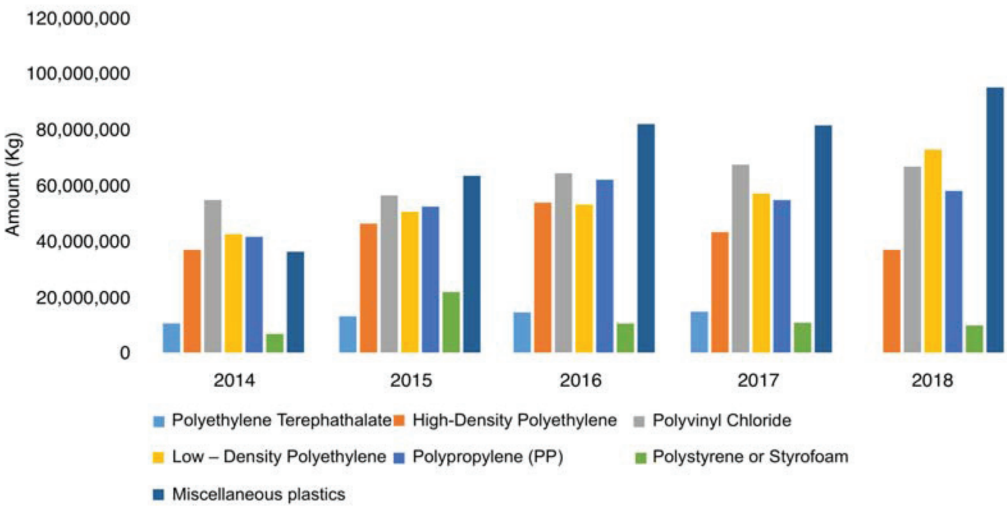



Figure 23: Different types of plastic quantities imported to Sri Lanka during the years 2014-2018 (National Audit Office, Environmental Audit Division - Report No. PER / B / 2019/01)

# Chapter 04 - Microplastics

**Dr. Sajith Edirisinghe**

From our childhood, we have heard of how plastic pollutes the environment. We have studied it for examinations and even written essays on it. However, that was only about the plastic we find on the beaches, in drains and in rivers. Did you know that the plastic we see and talk about accounts only for about 15% of the world's total plastic content? So, what is the remaining 85%? These are called microplastics/ nanoplastics.

Microplastics refer to the fraction of plastic that is released into the environment, either properly or otherwise, through various environmental or human processes. These particles range from 1 micrometre ($10^{-6}$ m) to 5 millimetres and those that are smaller than that (in the order of $10^{-9}$ m) are called Nanoplastics.

Figure 24 : Microplastics / nanoplastics

## 4.1 How do microplastic/nanoplastic materials get added to the environment?

There are several ways in which these microplastics / nanoplastics can be added to the environment. For the study purpose, we will divide the microplastics into two categories. These are primary microplastics and secondary microplastics.

### 4.1.1 Primary microplastics

Primary Microplastics are plastics that are manufactured in sizes less than 5mm and released to the market.

For example, small plastic beads used in textiles, tiny plastic beads found in Face washes/Toothpaste/Shower Gels, belong to this category. Without your knowledge, they flow through waterways and eventually into the sea. In one wash alone, between 94,000 and 100,000 microplastic molecules are released into the environment.

Figure 25: Primary microplastics in face Soaps

Figure 26: Primary microplastics in toothpaste

### 4.1.2 Secondary microplastics

This category includes plastics that are released to the environment after being used once (plastic drink bottles, straws) or several times (plastic pans).

These plastics get continuously broken down into very small pieces (eg:- as they get caught in vehicle tires, collide with rocks as they cross rivers and streams, or get exposed to rain/sun)

Furthermore, the nylon clothing you wear release these secondary micro-plastic fibres into the environment.

Research from around the world has shown that most of these are released into the environment from fabrics made from acrylic fibres.


Figure 27: How secondary microplastics are produced

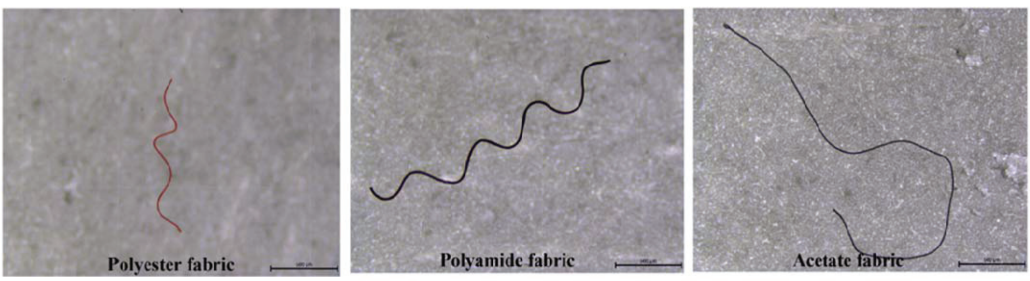



Figure 28: Secondary microplastic fibres released into the environment during washing (Yang et al., 2019)

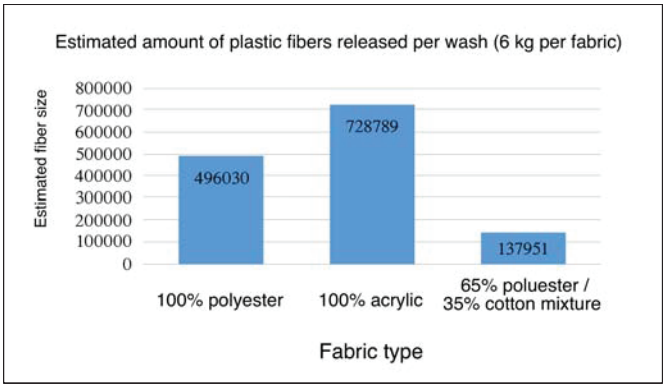



Figure 29: Quantitative amount of plastic fibres released in one wash

(Napper and Thompson, 2016)

## 4.2 Situation worldwide and in Sri Lanka

According to available research results, more than 75% of the plastic waste in the oceans is microplastics/nanoplastics.

From the image below, it is evident that most of the microplastics/nanoplastics in the coastal belts of Sri Lanka are from plastic waste from land-based activities.

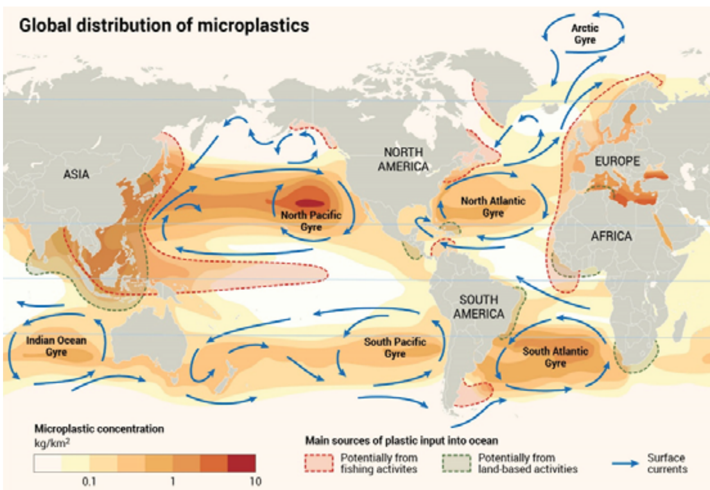



Figure 30: Microplastics / nanoplastics in the seas around

Sri Lanka.

(Linkages, 2019, Van Sebille et al., 2015, Jambeck et al., 2015)

# Chapter 05 – How do microplastics / nanoplastics enter the human body and what are their adverse effects?

**Dr. Sajith Edirisinghe**

There are various methods by which microplastics / nanoplastics enter the human body. The main ways of entries are discussed below.

## 5.1 *Via* contaminated food

Plastic that joins the environment is washed away by rivers and streams. When being washed away and due to various environmental reasons, these plastics break down into small pieces and eventually end up in the ocean. Microplastics / nanoplastics that are released into the sea are eaten by tiny invisible animals. Thus, these small animals take part in food chains by being eaten by larger animals and the concentration of microplastics / nanoplastics molecules in larger animals gradually increases during this process. These microplastics / nanoplastics enter the human body in large quantities due to the consumption of these animals at various stages of the food chain.

The diagram below shows a simple food chain. No. 1 shows marine living beings that are rarely visible or are mostly invisible to the naked eye. Once they eat those parts, the particles get trapped in their bodies. A large group of creatures in Group No. 1 is eaten by a larger single fish, represented by No. 2. Then a large number of fish belonging to group No. 2 are eaten by a larger single fish, represented by No. 3. In the end, man consumes all three types (1, 2, and 3) in his various diets. In this way, these microplastics / nanoplastics accumulate on a large scale as they move up the food chain and at the end of the food chain, get into the human body).

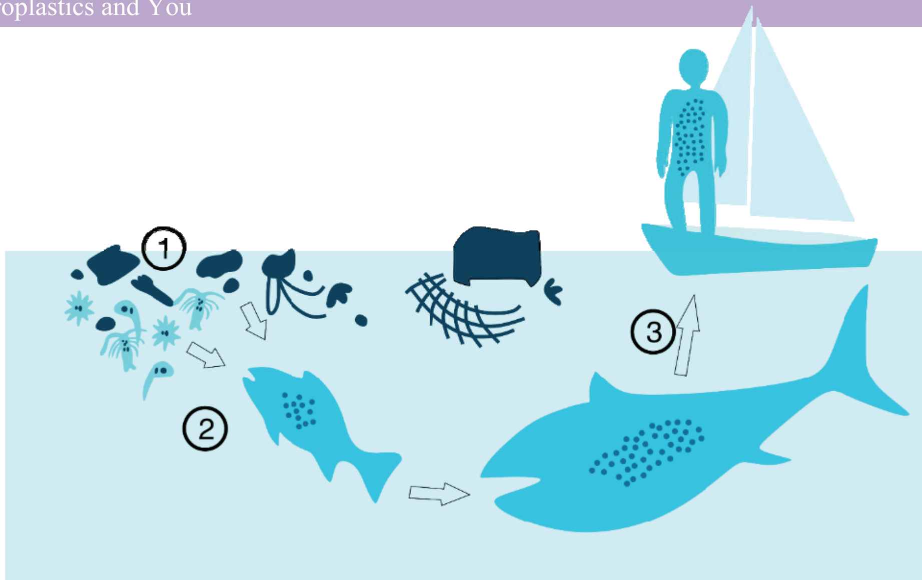



Figure 31: Microplastic / nanoplastic traveling through the food chain. 1. The microplastics up taken by the microscopic animals, 2. Large quantity of microscopic and small fish will be eaten by medium size fish, 3. Large quantity of medium size fish will be eaten by bigger fish and ultimately human eat them all.

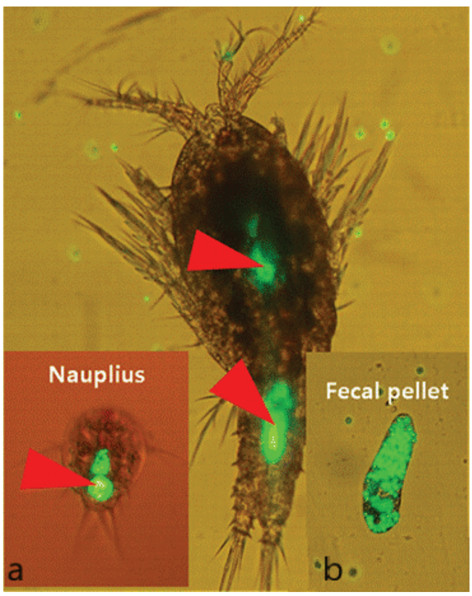



Figure 32: Microplastic / nanoplastic fragments ingested by microscopic animals (a) and (b) pieces of plastic excreted as feces (Luminous Green) (Lee, Shim et al. 2013)

When we observe creatures that are barely visible or mostly invisible to the naked eye as shown in Figure 1, with the help of a microscope, the luminescent green appears to be microplastics / nanoplastics ingested by these microscopic animals.

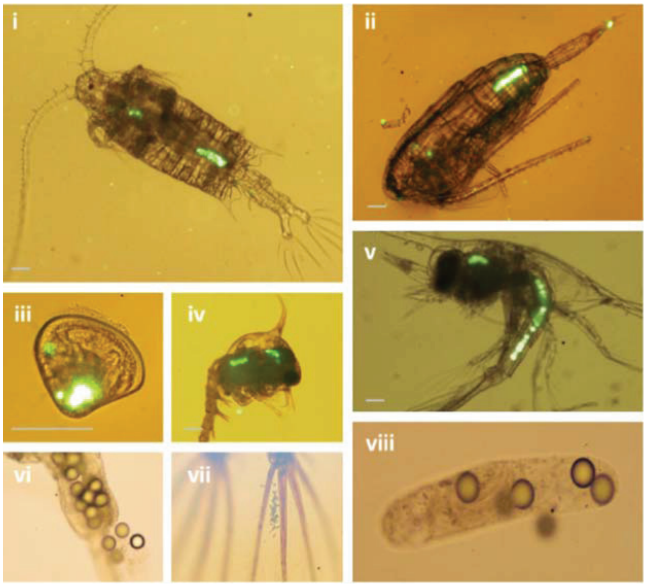



Figure 33 : Microplastics / nanoplastics ingested by microscopic animals (Cole, Lindeque et al. 2013)

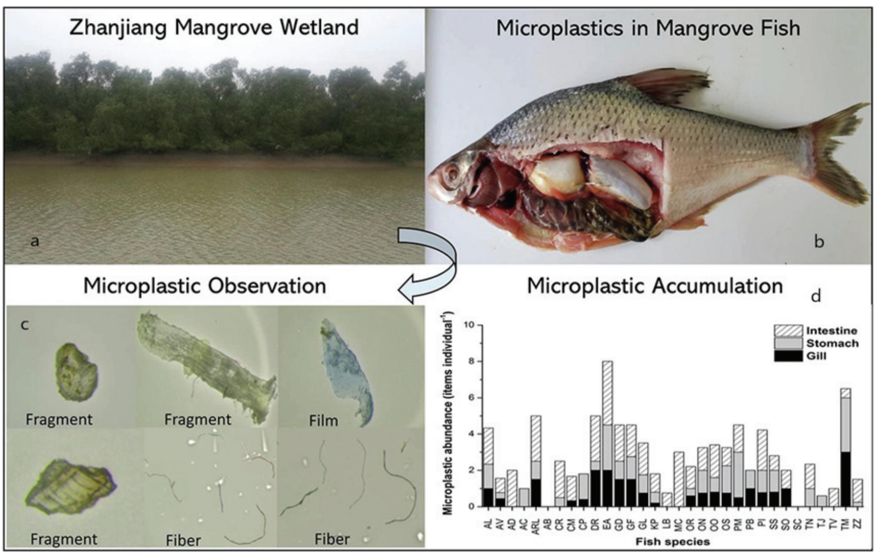



Figure 34: Xinjiang Mangrove Environment in Southern China (a) Microplastics (b) of Microscopic Fish (c) and the Number of Microplastics accumulated in Various Parts of Fish Bodies (d) (Huang et al., 2020)

Not only seafood, other food articles prepared using contaminated water also contribute towards microplastic/nanoplastic material entering the human body. These microplastics/nanoplastics are available in the soil and are deposited on grass. The farm animals being raised for the meat industry (cattle, goats, chicken etc.) come into contact with these plastic particles. Therefore, when humans consume these meats there is a possibility of microplastics/nanoplastics entering into the human body.

## 5.2 *Via* drinking water

Research around the world has found that microplastics/nanoplastics can be found in table salt, drinking water bottles, and tap water that is used for everyday household chores. Research done in the United States, by using drinking water bottles of one of the world's leading international brands which has a high demand in the world has revealed that more than 93% of the 259 water bottles used in the research project contained microplastics (Mason, Welch et al. 2018). It is estimated that the average concentration of microplastic molecules per litre of water (MPP/L) is about 325 MPP/L in these water bottles. Further studies have found that the concentration of molecules larger than 100 microns (>100µm) was about 10.4 MPP/L and the concentration of molecules between 6.5-100 (6.5-100µm) micrometres was 315 MPP/L. Another special finding is that the microplastic concentration of water in glass bottles is less than the microplastic concentration of water in plastic bottles (Mason et al., 2018).

In 2019, the World Health Organization (WHO) issued a 125-page report (ISBN: 978-92-4-151619-8) confirming the severity of microplastics in drinking water.

The report can be downloaded from the following website.
(http://www.who.int/water_sanitation_health/publications/microplstics-in-drinking-water/en/ )

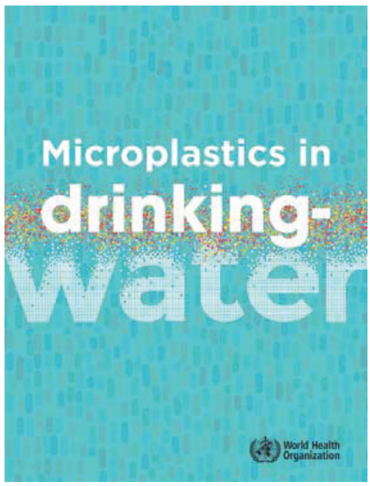



Figure 35: WHO report on microplastics in drinking water published in 2019

They are also present in the air we breathe, so they enter our body through inhalation as well.

## 5.3 *Via* inhalation

Several sources can contribute to the release of microplastics / nanoplastics into the air, including the synthetic fabrics from clothing, tyre erosion (especially from automobiles and trucks), household objects, waste incineration, building materials, sewage sludge, landfills, abrasive powders, 3D printing, and the resuspension of polymer fragments in urban dust (Kershaw 2016). The most commonly reported form of MPs in the atmosphere is synthetic fibres with the length > 5 μm, and diameter around 3 μm (Cai, Wang et al. 2017). The increasing use of synthetic fibres with a diameter of 1–5 μm by the textile industry has contributed directly and indirectly to textiles as a source of fibrous microplastics / nanoplastics (Gasperi, Wright et al. 2018).

Scientists estimate that between 74,000 and 121,000 of these microplastics / nanoplastics molecules are ingested by a person in a week in various ways (food, drinking water, beverages and air). In other words, you ingest 5 grams of plastics per week. That means, within a week, we ingest a quantity of plastic equivalent in size to a bank ATM card that we use to withdraw money.


Figure 36: 5 Grams of plastic per week into the body

These microplastics / nanoplastics were found in stool samples taken from 7 countries around the world including the United States, Japan and Great Britain.

The adverse effects of microplastics on the human body can be divided into two main categories. They are the complications caused by the physical properties of the plastics and complications caused by the chemical constituents contained in the plastics. The physical properties of microplastics are defined in terms of size, shape and concentration.

## 5.4 Chemicals in plastics and health risk

When considering the chemical constituents, they can be divided into two main parts. They are the raw materials used to add different physical properties to the plastic product and the chemical constituents that absorbed into the plastic molecule from the environment.

In plastic manufacture, it is blended with various chemicals to have colour, transparency, different energy levels, thermo-tolerance, heat resistance, malleability, and to keep the finished product intact without getting oxidized. These chemicals include carcinogens and heavy metals.

As mentioned earlier, different sized molecules enter our body in different ways (through food, drinking water, beverages and by inhalation through breathing contaminated air). These plastic molecules that enter have various types of chemical constituents in various proportions. That means through these plastic molecules, various chemicals enter the human body as a cocktail.

These toxic chemicals can affect a single cell, a group of cells, an entire organ, or the entire body. The serious issue here is that certain chemicals cause mutations in the human body that can sometimes lead to cancer.

As shown above, these toxins accumulate in high concentrations as they travel to the upper links in the food chain. As a result, in addition to cancer, certain high doses of the chemicals severely affect the human endocrine system and lead to reproductive health issues.

These chemicals most commonly affect the liver, kidneys, heart, reproductive organs, brain and nerves. Some chemicals have already been identified and proven to be carcinogens.

The majority of these chemicals used in plastic manufacture are harmful to the human body. Of these, bisphenol A (BPA) is a main chemical compound that has been clinically proven to damage the endocrine system of the human body when ingested through food or taken in by inhalation.

These compounds also impair the growth hormone responses towards its related organs in the human body. Some of these chemicals impair the responses by actions such as mimicking the natural hormone produced in the human body, inhibiting its action, impairing the natural production process or impairing the release of the receptors that activate the hormone.

### *5.4.1 Bisphenol A (BPA) – $C_{15}H_{16}O_2$*

This is used to manufacture Polycarbonate sheets and plastic food containers. Since plastic made with the use of BPA is heat resistant and strong, they are used as storage containers and microwavable dishes. Furthermore, BPA is used as a substance in the protective layer applied to the inner side of Aluminium cans.

But even though BPA has all the above-mentioned uses, research shows that BPA in plastic is in an unstable form that causes it to gradually leak out of the plastic. Some clinical research has also shown that BPA causes obesity, heart disease, reproductive disorders and breast cancer. It is found that there are 1 -729.9ng of BPA in 1g of microplastic molecules.

Some research work has shown that this BPA which causes diseases is the BPA that has been added to the plastic product to obtain different properties of plastics and not caused by the absorption of free BPA in the environment.

BPA can mimic oestrogen to interact with oestrogen receptors α and β, leading to changes in cell proliferation, apoptosis (programmed cell death), or cell movement. Therefore BPA contributes to the development of ovarian, breast and prostate cancers and its progression (Gao, Yang et al. 2015).

### *5.4.2 Heavy metals*

Heavy metals are naturally occurring elements with a density greater than $5g/cm^3$ or an atomic mass greater than 23 daltons. The table below lists the heavy metals used in the manufacture of plastics and the clinically confirmed diseases caused by them.

*Table 2: Heavy metals used in the manufacture of plastics and clinically confirmed diseases arising due to them*

| Heavy Metal | Use for | Plastic type | Effects on humans |
|---|---|---|---|
| Antimony (Sb) | Used as a Flame retardant and as a catalyst | PET bottles<br>1 PETE | Breast cancer |
| Aluminium (A1) | Used as a stabilizer, pigment and flame retardant | Used for PVC, PET plastics<br>1 PETE 3 V | Breast cancer |
| Bromine (Br) | Used as a flame retardant and pigment (Unlike in the case of chlorine compounds, there are only a few bromine containing organic pigments used in plastics) | PE, PS, PP<br>5 PP 6 PS 2 HDPE 4 LDPE | Can cause gene mutations |
| Cadmium (Cd) | Used as a Heat and UV stabilizer and a pigment | PVC<br>3 V | Impairs the metabolism of calcium and phosphorus in the body therefore increases the chance of bone fractures. It is also a carcinogen and can cause genetic mutations |

| Heavy Metal | Use for | Plastic type | Effects on humans |
|---|---|---|---|
| Murcury (Hg) | Used with various other chemicals in manufacturing of plastics (biocide - a substance that destroys living things, especially a pesticide, fungicide, or herbicide) | PU -Polyurethane (use to make sponges and seat covers) | Deforms the nervous tissue in the brain. It is also a carcinogen and can cause genetic mutations |
| Aresnic (As) | Used with various other chemicals in manufacturing of plastics (biocide) | PVC, LDPE, and polyesters   | Birth defects, Cancers of the lungs, liver, kidneys, bladder, and digestive system. |
| Tin (Sn) | Used with various other chemicals in manufacturing of plastics (biocide)and as a heat and UV stabilizer | PU - Polyurethane (sponge) and PVC   | Can result in skin rashes, gastric ulcers, vomiting, diarrhoea, abdominal pain, and genetic mutations. |
| Lead (Pb) | Used as a heat and UV stabilizer and a pigment | All types of plastic including PVC   | Anemia, high blood pressure, nervous system disorders, infertility, miscarriage. It is also a carcinogen |

| Heavy Metal | Use for | Plastic type | Effects on humans |
|---|---|---|---|
| Titanium (Ti) | Used as a heat and UV stabilizer and a pigment | PVC<br>3 V | Toxic to cells in the lungs and large intestine |
| Cobalt (Co) | Used as a pigment | PET<br>1 PETE | Can cause neurological disorders, hearing and vision impairment, and heart disease. |
| Chromium (Cr) | Used as a pigment | PVC, PE, PP<br>2 HDPE, 3 V, 4 LDPE, 5 PP | May cause allergies, wounds in the nasal cavity, lung, esophageal, circulatory, kidney and liver disorders. It is also a carcinogen |

What we have to understand here is that the complications arising due to heavy metals depend on the concentration, duration of exposure to the heavy metals, the patient's age, gender, the strength of the immune system and the genetic background of the person.

## 5.5 Evidence that microplastics cross the placenta and enter the unborn babies

For the first time in history scientists have shown that these microplastics can cross the human placenta and enter the body of the baby. That, the research work was published in a much reputed peer-reviewed scientific journal covering environmental science and health called "Environment International" (*Impact factor 7.577 in year 2019*) Volume 146, in January 2021. Normal placenta weight is between 500-600g. The scientific experiment was done using a small portion of the placentae (~23 g with respect to a total weight of ~600 g). The scientists have found that 12 microplastic fragments in four placentae out of the total of six placentae used for the study. Out of the 12 fragments 5 microplastic fragments were found in the foetal side, 4 in the maternal side and 3 in the chorio-amniotic membranes, indicating that these MPs, once inside the human body, can reach placental tissues at all levels (Ragusa, Svelato et al. 2021).

Since the research team had used only a small segment (23g /600g) to analyse, it leaves an obvious hypothesis that the number of MPs within the entire placenta is much higher.

## 5.6 Risk to wildlife

The plastic issue has affected not only humans, but also the wildlife and the surrounding environment.

Plastic pollution has a direct and deadly effect on wildlife. Thousands of land animals, birds, turtles, seals and other marine mammals die each year after ingesting plastic or by getting entangled in it.

Figure 37: The wild animals eating garbage

The Figure 37 shows elephants looking for food in a garbage dump in Oluvil in the Ampara district (*Photograph aid - Mr. M.N. Niroshan & Mr. L.L.S Priyankara*). The animals get addicted to the taste of the food in the garbage. Therefore, the animals in the surrounding areas have completely changed their lifestyle. When the elephants smell food, it does not matter whether it is covered in plastics. They swallow everything together. The waste is then trapped inside the intestine of the animals. None of the animals have an ability to digest plastics. Therefore, the digestive tracts of these animals get blocked, leading to a painful death.

# Chapter 06 - Legal regulations pertaining to microplastic and single-use plastic waste control

**N. S. Gamage**

The use of plastic products and packaging has been around the world since the 1950s, with an estimated global production of plastics reaching 368 million metric tons, with 57.9 million metric tons of that amount produced in Europe alone in 2019. It is estimated that 9% of the waste is recycled to develop other products and 12% is destroyed by combustion. It has also been revealed that a large amount of other plastic waste has been released into the environment. These products and packaging materials are added to the environment and to the oceans after use, accounting for 9.5 million tons each year.

Pollution from plastic waste is most severe in marine environments. Nylon nets used in the fishing industry join the ocean and a large amount of land based plastic waste is discharged into the ocean through river mouths. This pollution has been reported to have a number of adverse effects on marine biodiversity. Meanwhile, birds, reptiles, fish and mammals are most at risk because large animals being trapped in these nets and plastic parts, misunderstood as plastic food and used for feeding the young. Albatrosses, whales, dolphins, turtles, and seals are among the most endangered species in these cases. This type of plastic pollution is known as 'large scale plastic pollution'.

Total waste generation in Sri Lanka is approximately 10,768 tons /day while the average composition of plastics in collected wastes is 5.9% of total waste. It is estimated that about 635 tons of plastic waste is generated daily in Sri Lanka and about 180 tons of which has been identified as plastic packaging waste. About 20 million polythene food wrappers and 15 million plastic bags are dumped into the environment every day. Also, more than 300 tons of PET bottles are released into the environment daily. It has been reported that around 0.56 million tons of plastic (as primary forms) have been imported to Sri Lanka during 2015 to 2019. Considering these factors, the management of single-use plastic waste and microplastic waste has become an urgent need.

The National Environmental Act (NEA) contains the legal provisions required for the control of plastics. The National Environment Act was enacted by Act No. 47 of 1980 and subsequently amended by Act No. 56 of 1988 and Act No. 53 of 2000 and included provisions under Section 23W, empowering the Minister in charge of the environment, to publish orders in a Gazette to;

(a) Prohibit the use of any materials for any process, trade or industry;
(b) Prohibit whether by description or by brand name the use of any equipment or industrial plant, which endanger the quality of the environment.

Accordingly, a number of orders were enacted in September 2017 to control the single-use plastics and address the subsequent secondary microplastic issue currently raising its ugly head in the country.

The items prohibited were polythene lunch sheets, high density polythene shopping bags, polystyrene foam food containers, plates, cups & spoons. The polythene bags less than 20 micron in thickness were also banned. Also, it prohibited the use of polythene for any kind of decorative purpose. Implementation of these orders commenced in January, 2018.

The implementation methodology of the regulations was two fold i.e. the issuing of administrative orders and direct enforcement through the judicial process. All political parties, national and local level government and non-governmental organizations concerned have been informed about the regulations imposed on the use of polythene for decoration and accordingly, the use of polythene for decoration is at a very low level at present. The manufacture of food containers, plates, cups and spoons made of polystyrene foam has been suspended with the enforcement of the order.

It is a positive development that all concerned, including the relevant governmental, non-governmental and political parties, are aware of these laws and the Central Environmental Authority (CEA) has set the stage for the successful implementation of these laws throughout the island. The Authority's Head Office and 09 Provincial Offices and 16 District Offices are in a commendable quest to rapidly enforce these laws. The Consumer Affairs Authority and the Sri Lanka Police are the other agencies that assist in this process.

From 2018-2019 a total of 20,869 raids were conducted island-wide, and 1534 (7.35%) violations were detected. Prosecution actions were taken against the accused person in the respective magistrates' courts. Among these violators, 42 wholesale traders and manufacturers operate their illegal activities from the Western province. Also, it was detected that certain violators continue the same offence even after the first prosecution, indicating the punishment's lower effectiveness.

The major limitations encountered during implementation of the orders are;

(a) The NEA neither empower the CEA to seize stocks of such illegal products i.e. polythene lunch sheets nor seal any facility where polythene lunch sheets are manufactured, stored or sale in bulk;

(b) In most of the cases, the penalty for the accused manufacturing companies and wholesale traders are not effective to discontinue their activities;

(c) Any of the offences under the NEA including the offence in discussion are not cognizable and as such the violators could not be arrested even either through the Police.

The existing provisions of the National Environmental Act are not sufficient to successfully control this menace. Therefore, the Central Environmental Authority is working to add new amendments to the National Environmental Act. Among those amendments, it is expected to increase the fine from the current value of Rs 10,000/- to Rs. 100,000/- and to impose a fine of Rs. 200,000 for a second time offender, which is double the first fine, and to obtain the power to close the relevant institution.

The Authority is also in the process of incorporating legal provisions into the National Environmental Act on the basis of "Extended producer responsibility" to facilitate further private sector support on the fight against plastic pollution in the future.

Sri Lanka has focused attention on plastic pollution through legal provisions as well as through plastic waste recycling and has handed over the task of constructing and operating the required recycling centres to a number of local government bodies in the country. These Recycling Centres operate under the supervision of the Local Government Institutions of Kaduwela, Badulla, Jaffna, Kurunegala, Matara, Balangoda and Kandy. Two private sector companies have assisted in the construction of such recycling centres in Horana and Puttalam. The CEA has also taken steps to register private sector companies that recycle plastic waste.

The CEA is taking systematic steps under the guidance of the Ministry of Environment to control the pollution of single-use plastics and micro-plastics and is receiving overwhelming public support. In the near future, Sri Lanka will be able to make a significant contribution to the resolution of this recently identified global environmental problem by working together more and more positively.

*Table 3: Single-use plastic waste control regulations imposed under the National Environmental Act*

| Order No. | Prohibited items and activities |
|---|---|
| **2211/51** | With effect from March 31st , 2021, prohibit the use of<br>a) Polyethylene terephthalate (PET) or polyvinyl chloride (PVC) material for packing agrochemicals used for any process, trade or industry; and<br>b) Any plastic item specified herein for any process, trade or industry: - Sachets having less than or equal to a net volume of 20ml/ net weight of 20g (except for packing food and medicines).<br>Inflatable toys (except balloons, balls, water floating/pool toys and water sports gear). Cotton buds with plastic stems (except plastic cotton buds used for medical/clinical treatment). |
| **2211/50** | Any manufactured plastic item shall be marked clearly in accordance with the Plastic Material Identification Standards specified in the Schedule. (more details are in table 01) |
| **2034/33** | The manufacture of polythene or any polythene product of twenty (20) microns or below in thickness for in country use; or the sale, offer for sale, offer free of charge, exhibition or use of polythene or any polythene product which is twenty (20) microns or below in thickness within the country; Provided that polythene or any polythene product of twenty (20) microns or below in thickness may be permitted to be used with the prior approval of the Authority for the purposes specified in the schedule hereto. Use of the following material for the purpose of laminating were permitted - Polythene Terephthalate (PET) whether or not metalized or holographic PET film; Polypropylene film whether or |

| Order No. | Prohibited items and activities |
|---|---|
| | not metalized or pearlised; Nylon; Cast polypropylene (CPP) or metalized Cast Polypropylene (CPP) Polyvinyl Chloride (PVC); Polyethylene Terephthalate Glycol (PETG). Also, use for medical or pharmaceutical purposes in the absence of any other suitable alternative were permitted. |
| **2034/34** | Manufacture of food wrappers from polythene as a raw material for in country; and the sale, offer for sale, offer free of charge, exhibition or use of food wrappers manufactured from polythene as a raw material within the country. |
| **2034/35** | Manufacture of any bag of high-density polyethylene as a raw material for in country use; and<br>Sale, offer for sale, offer free of charge, exhibition or use of any bag manufactured from high density polyethylene as a raw material within the country.<br>However,<br>1. Garbage bags of the following dimension or above,<br>length 600 mm, width 260 mm wide, height 900 mm and;<br>Textile bags of the following dimension or above; length 400 mm, height 500 mm are exempted. |
| **2034/36** | No one shall burn openly or cause to be burnt, allow or permit the open burning of refuse or other combustible matters inclusive of plastics. |
| **2034/37** | Prohibit the use of all forms of polyethylene, polypropylene, polyethylene products or polypropylene products as decoration in political, social, religious, national, cultural or any other event or occasion. |
| **2034/38** | Manufacture of food containers, plates, cups and spoons from expanded polystyrene for in country use; and<br>The sale, offer for sale offer, free of charge, exhibition or use of food containers, plates, cups, and spoons manufactured from expanded polystyrene within the country. |

Sri Lanka currently imports virgin plastic raw materials for varying applications which amounts to 300,000 MT/annum. Municipal solid waste collection by local authorities accounts for only 3,458 MT/D, in which over 50% of uncollected waste, containing valuable plastics, goes to open dumps and the surrounding environment. The inflow of plastic packaging including unaccounted packaging of other goods is increasing. Polythene bags and large amounts of single use plastics have become a key issue.

The Ministry of Environment has developed, through stakeholder consultations, the National Action Plan Plastic Waste Management (NPPWM) 2021– 2030 for Sri Lanka to address the challenges in management of plastic waste in the country and establish a financially sustainable and environmentally sound national plastic waste and resource recycling management system. The primary objective of the Action Plan is to assist in achieving the National Waste Management policy's vision – enabling a "Healthy life and Cleaner Environment for all".

The NPPWM has been prepared based on a preventative approach and using 3R (Reduce, Reuse and Recycle) related waste hierarchy. The actions in this plan cover the entire lifecycle of plastic waste management from importation, processing, final use or collection and disposal. NAPPWM includes a comprehensive list of goals and actions to be achieved under short-term, mid-term and long-term targets, and also includes the key organizations responsible for their implementation. The approach conforms to the National Policy on Waste Management and the National Policy on Sustainable Consumption and Production Policy. (National Action Plan Plastic Waste Management (NPPWM) 2021– 2030, www.env.gov.lk)

# Chapter 07 - How do we minimize the microplastic / nanoplastic problem?

**Dr. Sajith Edirisinghe**

Here we can analyse this problem under several main sections. These streams are interconnected and the answer to the motion of one section can be found in another stream. They are…

## 7.1 Reducing plastic usage

The main solution to this plastic issue is reducing the usage of plastic. How do we do that? Some small steps that we could implement may add a huge value to the environment. Listed below are some steps with few simple examples.

* Banning the usage of plastic straws to consume beverages - Cardboard straws can easily be used as an alternative for this. Some restaurants have already shifted to cardboard straws and that can be seen as a positive trend. These straws can be used easily with drinks on-the-go. It is possible to substitute traditional plastic straws with reusable, corrosion-resistant steel/glass straws and it will be similar to using plates, cups, knives and forks, over and over again in the restaurants. These can be cleaned just like plates, spoons and cups.

* When you buy rations from a fair or a supermarket you can always use a cloth bag or a reed basket instead of a plastic bag.

* We can substitute plastics, polythene and styrofoam used in decorations of schools, places of worship and universities with environmental-friendly substances.

* We have to stop consuming bubble gum, as it causes a huge, unprecedented damage to the environment

* We have to choose washing powder, fresh milk, flavoured food items that are packed in recyclable packing, instead of taking above items packed in plastic bottles or polythene bags.

* When buying rice or grains, try to buy in bulk quantities and try storing them with dry "Kohomba" leaves as it will act as an insect repellent. This way, you will be able to save money and effort plus it will also reduce the amount of plastic added to the environment.

* Cafeterias can switch to using glasses instead of plastic cups when selling beverages whenever possible.

* When selling food items in cafeterias, owners can use paper bags. It is a positive trend that can already be seen in some food outlets.

* Always try to use match sticks to start a fire, instead of using lighters.

* Avoiding frozen food items can be a good move as they are usually wrapped in plastic packaging. Since they are not healthy for the body too, avoiding it would be an added advantage.

* Reduce household usage of plastics. Try using recyclable material instead, as much as possible.

* Try to buy clothes made of cotton whenever possible.

* Use a razor with switchable blades. This way, you can reduce the amount of plastic disposed of.

* When taking your lunch to school or office, use a banana leaf wrapping or use a lunch box. Minimize usage of lunch sheets.

* When holding meetings or conferences, offer water to participants in glasses and avoid buying mineral water bottles made of plastic.

* When preparing tea, avoid using tea bags and try to use tea powder and a sieve. This way you can contribute to reducing the dumping of plastic into the environment.

## 7.2 Reusing and minimizing new purchases

* Carry the necessary bags when shopping at a grocery store.

* Carry reusable containers to store items such as fish/meat when purchasing.

* Use disposable plastic bottles to store dry rations at home. In empty bottles, grains can be stored without wind exposure.

* Start a small garden using disposable plastic bottles. It can also provide non-toxic foods.

* Plastic bottles/cans can be rearranged in a variety of designs and use as tills to save money.

* Disposable plastics can be used to make various toys and home appliances to create self-employment opportunities.

* Carry a bottle of water with you when you leave the house. Minimize buying outdoor plastic water bottles.

## 7.3 Recycling

At present, the world's plastic recycling percentage is at a very low level (10-20%). Disposal of plastics after use can be minimized by releasing them to the correct recycling system (Chapter 3) and handing them over to the relevant recycling agencies (Chapter 8).

## 7.4 Rejecting

Rejection is refusing to take the plastic material you receive for free. That is, by not asking for plastic spoons/straws when buying yoghurt/milk if it is to be consumed at home. Instead, use the spoons/cups you have at home.

## 7.5 Think twice before buying or using

When you buy plastic, think twice about whether you really need it. So, definitely do not buy it if you do not need it. Always take steps to use substitutes for plastic.

## 7.6 New innovations to replace plastic

We can produce eco-friendly material that can be used instead of plastic. It can also be redesigned from existing plastics to minimize emissions into the environment.

Below are a few such ideas

* Re-usage of existing plastics in new ways. For example, existing plastic bottles can be filled with compressed sand or soil, and can be used instead of bricks by low-income people.

* Introducing eco-friendly new substitutes for plastics. One such step is the use of paper bags instead of plastic bags. The common water hyacinth "ජපන් ජබර-" which are commonly grown and blocking the waterways/ reservoirs can be used for paper production. It serves the environment by cleaning the waterways as well as minimizing the use of plastics.
* Imposing new legislature or updating existing ones on the import and misuse of plastics.
* Design of filters that can be used at home to separate microplastics / nanoplastics in drinking water.
* Further study of innovations related to reduce emission of microplastics/ nanoplastics to environment by schools, vocational training institutes and universities.
* Encouraging the public to evaluate and give awards on plastic recycling at the institutional, school, provincial and national levels.

## 7.7 Collect the thrown plastics

If you see a plastic bottle or a plastic cup thrown away by someone on the street, think about the future of society as a whole and collect it and put it to a recycle bin.

## 7.8 Assemble and join hands

Join together to see this plastic menace and eradicate it. You can contribute towards this cause at school, university, or at a religious level, and even through social media. By joining forces to clean up the beaches and educate the public, we can save the environment.

# Chapter 08 - Some institutions that are important to you

**Dr. Sajith Edirisinghe and Mr. N.S. Gamage**

The web link shows the names, telephone numbers and addresses of several companies in our country that recycle solid waste, including plastics, and the types of solid waste they recycle. In addition to the companies listed here, there are many other companies that are involved in the recycling of solid waste, including plastics.

Source - Website - Central Environmental Authority

http://www.cea.lk/web/images/pdf/Downloadable/Waste_Collectors_in_Sri_Lanka.pdf

## References

AMARASINGHE, A., BANDARA, B., RANAWEERA RKMDSH, S. R. & ARACHCHIGE, U. S. 2020. Plastic Waste Management in Sri lanka.

CAI, L., WANG, J., PENG, J., TAN, Z., ZHAN, Z., TAN, X. & CHEN, Q. 2017. Characteristic of microplastics in the atmospheric fallout from Dongguan city, China: preliminary research and first evidence. *Environmental Science and Pollution Research,* 24**,** 24928-24935.

CLEANUP. 2013. *THE GREAT PACIFIC GARBAGE PATCH* [Online]. [Accessed].

COLE, M., LINDEQUE, P., FILEMAN, E., HALSBAND, C., GOODHEAD, R., MOGER, J. & GALLOWAY, T. S. 2013. Microplastic ingestion by zooplankton. *Environmental science & technology,* 47**,** 6646-6655.

GAO, H., YANG, B.-J., LI, N., FENG, L.-M., SHI, X.-Y., ZHAO, W.-H. & LIU, S.-J. 2015. Bisphenol A and hormone-associated cancers: current progress and perspectives. *Medicine,* 94.

GASPERI, J., WRIGHT, S. L., DRIS, R., COLLARD, F., MANDIN, C., GUERROUACHE, M., LANGLOIS, V., KELLY, F. J. & TASSIN, B. 2018. Microplastics in air: are we breathing it in? *Current Opinion in Environmental Science & Health,* 1**,** 1-5.

GEYER, R., JAMBECK, J. R. & LAW, K. L. 2017. Production, use, and fate of all plastics ever made. *Science advances,* 3**,** e1700782.

GUNARATNA, D. N. J. C. J. 2012. *Analysis on Future Trends of Plastic Recycling in Sri Lanka.* University of Sri Jayewardenepura, Nugegoda.

HUANG, J.-S., KOONGOLLA, J. B., LI, H.-X., LIN, L., PAN, Y.-F., LIU, S., HE, W.-H., MAHARANA, D. & XU, X.-R. 2020. Microplastic accumulation in fish from Zhanjiang mangrove wetland, South China. *Science of The Total Environment,* 708**,** 134839.

JAMBECK, J. R., GEYER, R., WILCOX, C., SIEGLER, T. R., PERRYMAN, M., ANDRADY, A., NARAYAN, R. & LAW, K. L. 2015. Plastic waste inputs from land into the ocean. *Science,* 347**,** 768-771.

KERSHAW, P. J. 2016. Marine plastic debris and microplastics–Global lessons and research to inspire action and guide policy change.

LEE, K.-W., SHIM, W. J., KWON, O. Y. & KANG, J.-H. 2013. Size-dependent effects of micro polystyrene particles in the marine copepod Tigriopus japonicus. *Environmental science & technology,* 47**,** 11278-11283.

LINKAGES, G. 2019. Global distribution of microplastics.

MASON, S. A., WELCH, V. G. & NERATKO, J. 2018. Synthetic polymer contamination in bottled water. *Frontiers in chemistry,* 6**,** 407.

NAPPER, I. E. & THOMPSON, R. C. 2016. Release of synthetic microplastic plastic fibres from domestic washing machines: Effects of fabric type and washing conditions. *Marine pollution bulletin,* 112**,** 39-45.

RAGUSA, A., SVELATO, A., SANTACROCE, C., CATALANO, P., NOTARSTEFANO, V., CARNEVALI, O., PAPA, F., RONGIOLETTI, M. C. A., BAIOCCO, F. & DRAGHI, S. 2021. Plasticenta: First evidence of microplastics in human placenta. *Environment International,* 146**,** 106274.

STATISTA 2020. Plastic industry worldwide. *Plastics industry - Statistics & Facts.*

TISEO, I, 2021, "Plastic material production worldwide by region 2019"

VAN SEBILLE, E., WILCOX, C., LEBRETON, L., MAXIMENKO, N., HARDESTY, B. D., VAN FRANEKER, J. A., ERIKSEN, M., SIEGEL, D., GALGANI, F. & LAW, K. L. 2015. A global inventory of small floating plastic debris. *Environmental Research Letters,* 10**,** 124006.

YANG, L., QIAO, F., LEI, K., LI, H., KANG, Y., CUI, S. & AN, L. 2019. Microfiber release from different fabrics during washing. *Environmental Pollution,* 249**,** 136-143.

Notes


Here is what the Kokilai beach in Sri Lanka looked like on the 22nd of February 2020. Pay your attention towards the labels of these bottles. These are not bottles that were used and disposed of in Sri Lanka. These are waste released by a foreign country that was washed ashore after being caught in the sea. There is no doubt that the plastic waste we throw away carelessly is washed away to foreign countries in the same manner.

Let's make a change today!

ISBN 978-955-9386-51-3

Photographs – Dr Sajith Edirisinghe
Location - Kokilai beach, Mullaitivu