# "State of Plastics Waste in Asia and the – Pacific – Issues, Challenges and Circular Economic Opportunities"

UNCRD

Coordinated by
The Secretariat of the Regional 3R and Circular Economy Forum in Asia and the Pacific, United Nations Centre for Regional Development (UNCRD) of Division for Sustainable Development Goals (DSDG)/UN DESA

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# Abbreviations

| | |
|---|---|
| ABS | Acrylonitrile Butadiene Styrene |
| ADB | Asian Development Bank |
| AIT | Asian Institute of Technology |
| APEC | Asia-Pacific Economic Cooperation |
| ASEAN | Association of Southeast Asian Nations |
| BPA | Bisphenol |
| CRED | Centre for Research on the Epidemiology of Disasters |
| CSR | Corporate Social Responsibility |
| DALYs | Disability Adjusted Life Years |
| DDTs | Dichlorodiphenyltrichloroethanes |
| D-P-S-I-R | Drivers, Pressures, State, Impact and Response |
| EDC | Endocrine Disorders |
| EPR | Extended Producer Responsibility |
| EPS | Expanded Polystyrene |
| FICCI | Federation of Indian Chambers of Commerce and Industry |
| GDP | Gross Domestic Product |
| GEO | Global Environment Outlook |
| GHG | Green House Gas |
| GIZ | Deutsche Gesellschaft für Internationale Zusammenarbeit |
| GNI | Gross National Income |
| GT | Gigaton |
| HDPE | High Density Polyethylene |
| ISWA | International Solid Waste Association |
| JICA | Japan International Cooperation Agency |
| LBSA | land based sources and activities |
| LCA | Life Cycle Assessment |
| LDPE | Low density Polyethylene |
| LLDPE | Linear Low Density Polyethylene |
| MBI | Market Based Instruments |
| MoEJ | Ministry of Environment Japan |
| MSW | Municipal Solid Waste |
| NGO | Non Government Organization |
| OECD | Organisation for Economic Co-operation and Development |
| PA | Polyamide (aliphatic) |
| PAN | Polyacrylonitrile |
| PBDE | Polybrominated Diphenyl Ether |
| PBT | Polybutylene Terephthalate |

| | |
|---|---|
| PC | Polycarbonate |
| PE | Polyethylene |
| PE-HD / PE-MD | Polyethylene – high and medium density |
| PE-LD - PE-LLD | Polyethylene – low and linear low density |
| PEMRG | Plastics Europe Market Research Group |
| PES | Polyster |
| PES | Polyester |
| PET | Polyethylene Terephthalate |
| PFOA | Pentadecafluorooctanoic Acid |
| PICT | Pacific Island Countries and Territories |
| PMMA | Poly(methyl) methacrylate |
| PP | Polypropylene |
| PRC | People's Republic of China |
| PS | Polystyrene |
| PTFE | Polytetrafluoroethylene |
| PUR | Polyurethane |
| PVC | Polyvinyl Chloride |
| PWD | Public Works Department |
| RandD | Research and Development |
| RSPs | Regional Seas Programmes |
| SCCP | Short Chain Chlorinated Paraffins |
| SDG | Sustainable Development Goal |
| SPREP | Secretariat of the Pacific Regional Environment Programme |
| SWM | Solid Waste Management |
| TPES | Total Primary Energy Supply |
| ULB | Urban Local Bodies |
| UNCRD | United Nations Centre for Regional Development |
| UNDESA | United Nations Department of Economic and Social Affairs |
| UNDP | United Nations Development Programme |
| UNEA | UN Environemnt Assembly |
| UNEP | United Nations Environment Programme |
| UNESCAP | United Nations Economic and Social Commission for Asia and the Pacific |
| USEPA | United States Environmental Protection Agency |
| UV | Ultra Voilet |
| VCM | Vinyl Chloride Monomer |
| WMF | Waste Minimization Fund |
| WtE | Waste to Energy |
| Zn | Zinc |

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# Preface

The Asia and the Pacific region is the most rapidly urbanizing and industrializing region in the world. Though the unprecedented scale and speed of the urban industrial transformation coupled with enhanced production and consumption have lifted millions of people out of poverty, this presents challenges for the countries in the sustainable environmental management of their natural and ecological resources. The growing volume and diversification of various waste streams have compounded these challenges. Waste management in many Asia-Pacific countries must deal with increasingly complex waste streams including industrial waste, electronic waste, plastics in coastal and marine environments, construction and demolition waste, and chemicals that add critical dimensions to the region's sustainability.

The policy and scientific community in the region have recognized the large challenges of resource supply security, increasing waste and pollution, and climate change as critical constraints to future growth and rising material standards of living in the region. One of such critical challenges is the rising level of plastic waste posing serious threat to natural ecosystem, human health and food security.

Today plastic materials are present in nearly all spheres of modern life, starting from simple packaging, clothes containing synthetic fibres, containers, drinking bottles and vehicle parts and tyres to various life-supporting medical equipment. The plastic waste pollution has become a critical concern in the urban and coastal marine environment of the Asia-Pacific region, including the small island developing states (SIDS). Their manufacture, use and discharge have significantly increased the amount of plastic waste, including also plastic marine litter in oceans which is detrimental to the ecosystems, biodiversity, fishing and tourism industry and potentially human health.

Unless well-coordinated preventive, collective and corrective measures are taken at the national, international, business and consumer levels to discourage the use of single-use plastics and the same time efforts are put to encourage the use of environmental friendly alternative materials, plastics pollution will continue to pose a serious challenge to the sustainability of the natural ecosystems of the region. The 2030 Agenda for Sustainable Development and the SDGs not only call for equitable economic growth, but also provide an important political and implementation framework to implement various 3R (Reduce, Reuse, Recycle), resource efficiency and circular economic development measures to address the issues of emerging waste streams such as the plastics.

This report is commissioned under the Second Phase of the State of the 3Rs in Asia and the Pacific with an objective to provide the policy and decision makers a comprehensive overview on the state of plastic waste in Asia and the Pacific addressing the underlying issues, challenges and circular economic opportunities. Under the aegis of the Regional 3R Forum in Asia and the Pacific, a number of regional declarations by countries such as the Hanoi 3R Declaration (2013-2023), the Adelaide 3R Declaration on circular economy (2016), the Indore 3R Declaration by Asian Mayors (2018) and the Bangkok 3R Declaration on prevention of plastic waste pollution provide important basis to develop and implement necessary 3R, resource efficiency and circular economy policy and measures in Asia and the Pacific to address the issue of plastic waste. This report is expected to serve as an important and supporting source book towards achieving the objectives underlined in such regional declarations and agreements.

## Executive Summary

### Introduction

Asia and the Pacific region which includes major parts of East Asia, South Asia, Southeast Asia, and Oceania (in or near the Western Pacific Ocean) has geographical area above 29 million $km^2$ with a population of about 4 billion.[1] The region's population is projected to rise from about 4 billion (2017) to 5.08 billion by 2050, which is about 60% of the world's total population. PR China with 1.36 billion and India with 1.31 billion people account for more than half of the total population of the region.[1] Urban population, which was about 48% of the region's population in 2017 is projected to increase to about 63% of the total by 2050.[2] The region has a significant difference in the growth of the urban population among the sub-regions, with Australia and New Zealand showing the least, (1.16% per year) while South Asia shows the largest (2.66% per year). The region has more than 242,000 km of coastline.[2] Geographically, Asia and the Pacific's coastline have multiple shore types. The region contains the world's two largest archipelagic nations (Indonesia and The Philippines) and all five of the world's nations that are entirely atolls (Kiribati, Maldives, Marshall Islands, Tokelau and Tuvalu). The Pacific islands region is located in the western, northern and central Pacific Ocean and consists of 14 independent countries and eight territories delineated into three major ethnic regions: Melanesia, Micronesia and Polynesia. The Pacific Islands region has a population of around 10.57 million that occupy just over 550,000 square kilometres of land. The unique demography, geography, climate and natural resources in the region drive its dynamic socio-economic and livelihood conditions where emerging environmental scenarios with new waste streams like plastic waste are posing major threat to its sustainable development.

### Economic Profile

As per 2017 estimates, combined GDP of the major countries in the region was above 25 trillion ranging from US$ 583 to US$ 73,187 per capita. The regions economy expanded to 4.0% in 2018 and 3.3% in 2019. [5] Over the past 50 years (1970–2015), Asia and the Pacific region has experienced rapid economic growth, leading to higher incomes, poverty reduction and the emergence of a rapidly-expanding middle class. About two thirds of the regional economies, accounting for 80% of the region's GDP, achieved faster economic growth in 2017.[3] Though developed Asia-Pacific economies continued to dominate economic growth in the region, it started to decelerate during 2018 to 2020, due to uncertain economic conditions as well as COVID-19 pandemic. Developing Asia-Pacific economies grew by an estimated 5.3% in 2018, 4.3% in 2019 and are projected to grow by 3.7% in 2020. A comparison across sub-regions reveals that South-East Asia continues to lead the region's economic growth, followed by South-West Asia.[3] Manufacturing (Japan, Republic of Korea, Australia, China and India), fisheries and tourism sector are the major contributors to the economy of the region. There have been significant changes in employment in Asia and the Pacific. Agriculture employment is decreasing, while industrial and services employment is increasing.[3] Since the 1990s, the population-weighted mean Gini index, a measure of income distribution, for Asia and the Pacific rose from 33.5 to 37.5.[3] However, developing Asia and the Pacific countries are characterized by a large degree of social and economic inequality. "Across Asia and the Pacific, more than 1 billion people live just above the extreme poverty line, on more than US$ 1.25 but less than US$ 2.50 a day".[4] More than 40% of workers in the region live in extreme, moderate, or near poverty levels. Among people who have been lifted out of extreme poverty, they remain vulnerable as many of them still live on less than $3.20 or $5.50 per day. The region's growing purchasing power and the

domestic private consumption has been the major economic growth driver in recent years leading to waste generation and environmental issues.

**Environmental Profile**

The population growth, industrialization and urbanization have led to a sharp increase in natural resource use in the region, which is both unsustainable and inefficient, and results in pollution, declining biodiversity and natural resource depletion.[5] Further, the environmental impact has increased, in part due to the shift in economic activity from very resource-efficient economies such as Japan and the Republic of Korea to the less resource efficient economies of China, India and Southeast Asia.

The region's material consumption has increased sharply over the past four decades, accounting for more than 50% of world consumption while material productivity has not improved and is double the world average and four times the rest of the world average. Material footpring of the region indicates that it increased by 124% as compared to 29% for the rest of the world. The use of materials in the region (biomass, fossil fuels, metal ores and non-metallic minerals) increased from 26.3 billion tonnes in 2005 to 46.4 billion tonnes in 2015, an annual rate of growth of 6.1%, which is higher than the economic and population growth rates of 4.9% and 0.9% respectively.[6] Domestic material consumption per person increased from 2.9 tonnes in 1970 to 11.9 tonnes in 2015, with a high growth rate at 5.2% per annum, and has now surpassed the global average of 11.2 tonnes.[6] Energy generation continues to rely on fossil fuels and the share of renewable energy remains small despite very significant investment in renewable-energy infrastructure.[2] The region accounts for more than 50% of the world's water use where water intensity is more than double of the world average.[2] The GHG emissions are forecasted to rise through 2050 with the current rate of domestic material consumption under business as usual scenario**.** The projected climate change in Asia and the Pacific could lead to a shortage of water resources, widespread land degradation and increased desertification.[2] Impacts of climate change in the Asia and the Pacific region include changes in natural vegetation types and associated changes in ecosystems at higher elevations and latitudes.[7] Climate change, with its impacts of increasing sea-surface temperature, ocean acidification and sea-level rise, is an increasing driver of pressures on coastal and marine eco systems particularly sea grass meadows, sea weed beds, fish migration and coral bleaching in the Asia and the Pacific region.[8] Of the ten economies in the world that are at greatest risk from climate-change impacts, six are in the Asia and the Pacific region, including low-lying Pacific island economies.[2] [8] In coastal regions of Asia, including Bangladesh and much of Southeast Asia, sea-level rise threatens the salinization of coastal aquifers, with effects on drinking water sources and coastal ecosystems.[2] [8]

Out of 28 mega-cities with more than 10 million people in the world, 15 are in Asia and the Pacific – Tokyo (37.8 million), Delhi (25 million) and Shanghai (23 million) are the three most populous cities in the world.[1] An estimated 120 000 people migrate to cities in the region every day. The proportion of people living in urban areas is likely to rise to around 3.3 billion people, by 2050. Therefore, the demographic transition to urban dwellers and environmental links with urbanisation will largely determine the sustainable development pathways of the region during the next 25 years and beyond.[1] Intensive human activities and energy consumption in urban areas will lead to the generation of increasing amounts of pollution and waste. Along with the land needs of urbanization, urban solid waste disposal through landfills and the management of industrial hazardous waste will become major concerns in the region.[9]

**Plastic Waste Management**

The total municipal solid waste (MSW) for Asia and the Pacific was estimated at around 870 million tonnes in 2014, with an average generation rate of 1.4 kilograms per person per day, accounting for 43% of the world total. It is projected to increase until 2030, when it could be 1.6 kilograms per person per day or around 1.4 billion tonnes a year.[10] The broad composition of municipal solid waste comprises of the organic share in (50–70%) low-income countries than (20–40%) in high-income ones. The percentage of paper is also proportional to income levels, at 23% of municipal solid waste in high income countries, 19–11% in middle-income ones and 7% in low-income countries.[10] The proportion of plastic, is around 8–12% across all the countries.[10] Considering this composition, the plastic waste generation in the region is expected to reach 140 million tonnes by 2030. Majority of plastic waste, which comes mixed with solid waste ranges from 0.02 to 0.04 tonnes per capita per year. The huge variation in waste generation can be explained by the strong correlation, which exists between per capita waste generation and the income level of a country. The higher the per capita GNI (gross national income), the higher is the per capita MSW generation.[10] Such trends also correlate to the plastic intensity of Asia and the pacific region. Similar trends have also been observed at city level.

Waste collection rates range from low to moderate in Asia and the Pacific's developing countries. In the developing countries, waste collection rates are moderate, at 40–80%, but reach almost 100% in more developed economies such as Japan, Australia, Republic of Korea and Singapore.[10] Waste separation at source is a common practice in more developed countries while in low- and middle-income countries, there has been informal waste separation with different types of waste collected separately for transfer to a facility and recycling. About 55 to 74% of the municipal solid waste is disposed off at disposal sites with zero to 26% being incinerated and 1 to 5% composted.[10] In general, recycling rates in high-income countries have increased progressively over the past 30 years, while in lower-income countries the informal sector often only achieves recycling rates of 20–30% for municipal solid waste.[11]

Top eleven countries which indicate highest mismanagement of plastic waste include China, Indonesia, The Philippines, Vietnam, Sri Lanka, Thailand, Malaysia, Bangladesh, India, Pakistan and Myanmar.[12] Broadly major hot spots of accumulated floating plastics occur in coastal waters adjacent to countries with high coastal populations and inadequate waste management.[12] Therefore, Asia and the Pacific which has a large ocean area are facing a rise in marine litter, mainly plastics waste. About 1.15 and 2.41 million tonnes of plastic currently flows from the global riverine system into the oceans every year. About 15 from the top 20 polluting rivers are located in Asia. These 20 rivers accounted for more than two thirds (67%) of the global annual input while covering 2.2% of the continental surface area and representing 21% of the global population. The Chinese Yangtze River is the largest contributing catchment, with an annual input of 0.33 (range 0.31–0.48) million tonnes of plastic discharged into the East China Sea, followed by the Ganges River catchment, between India and Bangladesh, with a computed input of 0.12 (range 0.10–0.17) million tonnes per year.[13] Estimates indicate that 1.7 to 4.6% of the total plastic waste generated on land enters the ocean and ultimately becomes marine litter.[13] Considering this hypothesis, the amount of plastic waste entering the ocean from Asia and The Pacific region ranges from 2.3 to 6.4 million tonnes in 2030.

**Circular Economy and Relevance of 3R Practices**

Asia and the Pacific region is the most resource-intensive region in the world, both in terms of domestic material consumption and material footprint. The Asia-Pacific region has approximately 2 Kg per US$ (domestic material consumption per dollar of economic output) in comparison to 1.2 Kg per US$ of world's average. During 1990 to 2017, the rapidly growing low- and middle-income countries in the region recorded significant

increases in resource use in both absolute and per capita terms. The domestic material consumption per capita in low-income, lower-middle-income and upper middle-income countries increased by 75%, 69% and 315% respectively, while that of high-income countries decreased by 2%. In the sub regions, the Pacific has the highest per capita domestic material consumption, followed by East and North-East Asia.[3][6][8]

As per 2015 data, the plastic consumption ranges from 0.13% to 0.75% of material consumption in Asia and the Pacific region, an indicator of variation resource usage. The region is importer of fossil fuel, the feedstock for manufacturing plastics. **Figure 1** indicates that a positive correlation exist between GDP growth rate and plastic consumption in the region. It indicates that as per capita income increases, the plastic consumption also increases.

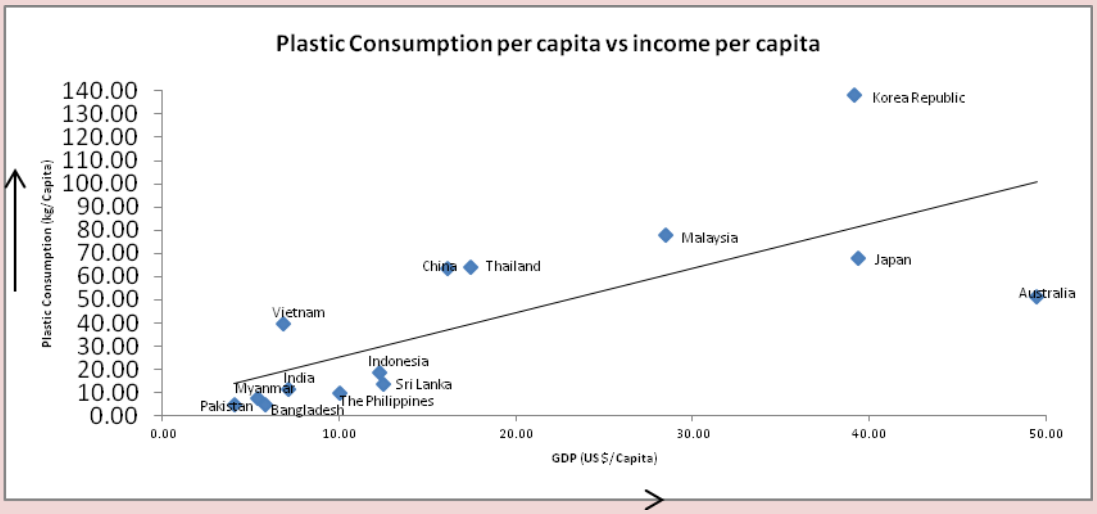


**Figure 1: Plastic consumption per capita versus income per capita**
Source: Amit Jain, February 2019

As per material cycle of plastics, the waste plastics, which enter the formal waste management system, they are either recycled, or disposed of in controlled landfill or incinerators (which may or may not recover electricity, heat or by-products). However, in communities where formal waste management systems do not exist, particularly in informal communities in low and middle income countries, a substantial proportion of waste plastics are disposed off in uncontrolled dumps, watercourses, or burned openly. Globally, around 14%-18% of waste plastics generation is collected for recycling.[14] Another 24% is thermally treated (e.g. by incineration, gasification or pyrolysis), while the remainder is disposed off in controlled, landfill, uncontrolled landfill, or the natural environment.[14] The partial geographical coverage of waste collection and its inefficiency in developing countries in Asia and the Pacific region results in huge amount of generation of uncollected plastic waste. A small fraction of plastic collection in both formal and informal sector goes for recycling in majority of countries in Asia and the Pacific.

Various materials from different waste streams are recycled across the Asia and the Pacific region. However, there is a wide variation in terms of the relative amounts, type of waste and technology employed in the process. Developed economies, such as Japan and Singapore have achieved high rates of plastic recycling (approximately 20% and 20% respectively) in the formal sector facilitated both through supportive institutional mechanisms and the utilization of different methodologies for the extraction/conversion of valuable resources.[15] Though the countries in Asia and the Pacific region claim more than 50% plastic recycling rate, majority of it is carried out in informal sector and focused on single use plastic recycling (majority PET, PE and PP).[16]

Environmental impacts of plastic pollution have started emerging relatively recently though uncertainty exists about the magnitude of the damages. Plastics disposed of in landfills break down over many hundreds of years, slowly emitting methane in the process while plastics disposed off in the natural environment, breakdown at slower rates and with carbon dioxide as the by-product. In both cases, the environmental impact is often underestimated because of the timescales involved. Microfibers add to the particulates in urban air environment further adding on to the existing severe air quality in major polluted cities in Asia and the pacific region. Microfibers have also been reported to pollute the soil quality thereby getting transported to its deeper layers by earthworms or other species thereby polluting ground water. Such type of impact is not documented in the context of Asia and the pacific region and requires further research. Thermal decomposition, either controlled or uncontrolled of plastics also results in GHG emissions. Plastics which has been disposed of into waterways has a range of detrimental effects on the aquatic life, including bioaccumulation, chemical leaching, prevention of transfer of oxygen and nutrients in the benthic zone. The magnitude of plastic waste generation and it's on land mismanagement in the region offers potential threat to both land and marine environment with linkages to livelihood issues particularly in least developed and pacific islands. Therefore, it requires an overarching framework for its management, which could address multiple issue and provide common framework for sustainable development in the region. Coastal tourism a subset of cultural services in the natural capital is also affected as tourists seek to avoid beaches known to have high concentrations of plastics litter. As per UN Environment, the economic cost of these impacts has been estimated at US$ 13 billion per year. McIlgorm, Campbell and Rule, 2011 has reported that Marine plastic debris has also been estimated to account for annual losses of US$ 622 million for the tourism sector in the Asia Pacific Economic Area. Asia-Pacific Economic Cooperation (APEC) forum further estimates that the cost of ocean plastics to the tourism, fishing and shipping industries is US$ 1.3 billion in the region alone.

Under business as usual scenario, an estimated 26 billion tonnes of plastics will be produced over the next ~30 years.[14] The environmental burden associated with the production, use, and eventual disposal of these plastics will tend to increase in parallel. Reducing these burdens will require greater efficiency of plastics use. This will require a change in thinking from traditional linear economic models (i.e. manufacture-use-dispose), to more circular economic models **(Figure 2)**, whereby the use of plastics is optimised (e.g. through product redesign and light-weighting), and plastics are kept within the use cycle for longer, through reuse and recycling.

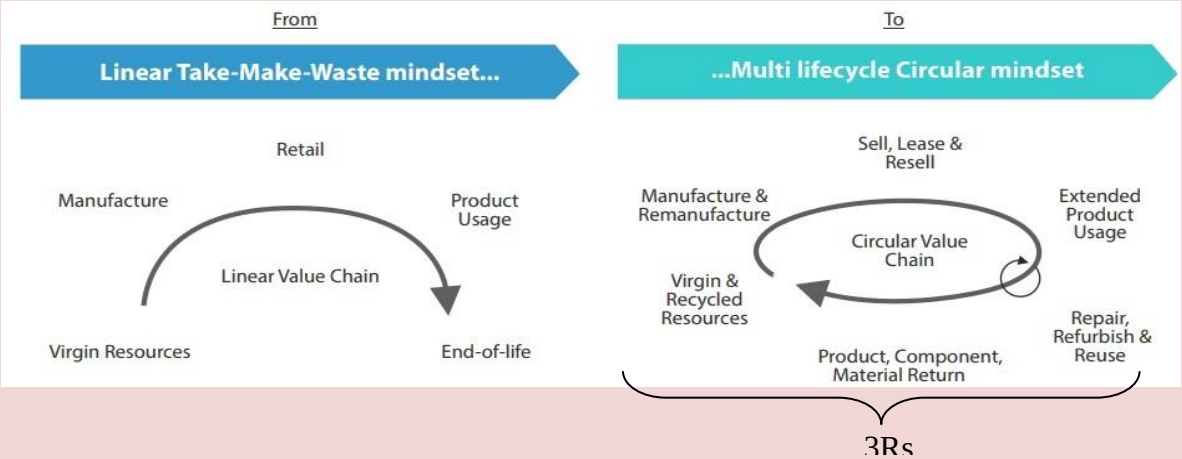


**Figure 2: Adopting circular business models - a shift in mindset**

Use of secondary raw material produced through recycling is an important pillar of circular mindset. An example of environmental implication of this mindset can be demonstrated through GHG reduction which can be achieved on account of energy conservation by recycling of plastics. Major GHG emissions associated with the plastics lifecycle results from the production of virgin polymer. Large amounts of energy are required to refine the fossil fuel like crude oil, crack the distilled constituents into monomers, and then synthesise the base starting materials. This process is highly energy-intensive, and was estimated to account for 400 million tonnes of greenhouse gas emissions (around 1% of the global total) in 2012. The fossil fuel feedstock used in plastics production accounts for an additional 4% of global oil and gas production.[17] Recycling of plastics avoids 80% of use energy.[18] However, recycled plastics compete in price with virgin plastics, which are much cheaper due to market volatility and policy misalignments e.g. government support for hydrocarbon inputs in different countries.

Conceptually, 3Rs being an integral part of circular mindset **(Figure 1.2)** offers a viable policy option to reduce material intensity in Asia and the Pacific region. In this regard, the implementation of Hanoi 3R Goals in the region offers significant potential to achieve resource efficiency. The status of their implementation between 2011-15 in Asia and the Pacific region indicates that total MSW generation and MSW per capita increased in most countries (Goal 1). At the same time, recycling rates in the region improved between the years 2000 and 2015, suggesting that 3R-related efforts focused on waste management are being successfully implemented by a number of countries, both in terms of legislation and policy development, as well as actions taken specifically within large cities (Goals 1 and 3). However, recycling activities in many countries are still widely conducted by the informal sector with environmentally unsound technologies. Total direct material consumption and waste generation volumes show an increasing trend across the Asia and the Pacific region (Goal 1 and 17) whilst resource productivity1 has been steadily improving in a number of countries (Goal 17). Certain countries, such as Bangladesh and India, have enacted bans on plastic carry bags to prevent flooding resulting from clogged drainage systems and maintain clean cityscapes by reducing waste at source. However, concrete actions taken at the national level remain limited in most countries (Goal 12). Several countries are advancing GHG mitigation efforts through landfill diversion and the use of intermediate waste treatment approaches (Japan, China, and Singapore). This requires a careful evaluation of different waste treatment approaches and methodologies from not only the perspective of GHG emission reduction potentials but also of other environmental, economic and social aspects (Goal 19). Although the region saw an average reduction in resource intensity in 2010 and in 2017, this progress was not uniform across Asia and the Pacific.[15][16]

The evaluation of the intermediate waste treatment approaches will establish main linkages between economic activity, materials use and environmental pressures. A case study of India indicates that annual plastic waste generation in India is about 5.6 million tonnes. About 60% of this waste is collected by both formal and informal sector. About 46% of this waste is treated while 11% is used for energy recovery. Therefore, 40% of the uncollected waste, which is dumped into landfills offers huge opportunity for achieving environmental and socio-economic benefits. One ton of plastic recycling is expected to save about 1.7 $km^2$ of landfill area. Further, it can also create 1.39 million incremental jobs in plastic recycling industry.[19] Therefore, a granular approach is needed to understand which 3R policy intervention may improve resource efficiency at the sectoral level, and how major environmental consequences may be avoided in each country and the entire Asia and the Pacific region.

**Implications and connectivity to SDGs and Targets**

Plastic pollution can be broadly addressed under an overarching framework of Agenda 2030 and the UN Sustainable Development Goals (SDGs). SDG 12, "Sustainable Consumption and Production" identifies decoupling economic growth from resource use as one of the most critical and complex challenges facing humanity today. The effective decoupling require policies that create a conducive environment for such change, social and physical infrastructure and markets, and a profound transformation of business practices along global value chains. SDG 14, Life below water, identifies that advancing the sustainable use and conservation of the oceans continues to require effective strategies and management to combat the adverse effects of overfishing, growing ocean acidification and worsening coastal eutrophication. Global trends point to continued deterioration of coastal waters due to pollution and eutrophication. Without concerted efforts, coastal eutrophication is expected to increase in 20 per cent of large marine ecosystems by 2050.[20]

In Asia and the Pacific region, thirteen targets from five SDGs (SDG 6, 11, 12, 14 and 15) are relevant to reducing the inputs and impacts of waste plastic on terrestrial and marine ecosystem. These five SDGs cover sustainable management of water and sanitation; sustainable consumption and production; inclusive, safe, resilient and sustainable use of terrestrial and marine ecosystem while ensuring their protection, restoration and conservation. SDG target 12.4 clearly states that "By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment" Further, SDG target 12.5 complements SDG target 12.4 aiming, "By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse. SDG 14 "Life below water" in particular 14.1, 14.2, 14.7, 14.a and 14.c are important under which the framework to address marine plastic can be evolved. Target14.1 is one of the most important and aims "By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution. Other, SDG targets, which encompass the promotion of alternative to the use of conventional plastic as well as social and economic resilience include SDG 1 (1.4), SDG 8 (8.3), SDG 9 (9.3 and 9.4). These additional three SDGs cover poverty, sustained, inclusive and sustainable economic growth and employment and resilient infrastructure and inclusive and sustainable industrialization.[20] In order to demonstrate their renewed commitment to realizing a promising decade (2013-2023) of sustainable actions and measures for achieving resource efficient society and a green economy in the Asia-Pacific region through the implementation of the 3Rs, the countries in Asia and the Pacific resolved to voluntarily develop, introduce and implement policy options, programmes and projects towards realizing the thirty three sustainable 3R goals in the region. These goals were declared as the part of "Ha Noi 3R Declaration Sustainable 3R Goals for Asia and the Pacific for 2013-23" at the Fourth Regional 3R Forum in Asia held in Ha Noi, Vietnam in 2013.[21] The countries in Asia and the Pacific region reaffirmed their commitment under "Adelaide 3R Declaration" at regional 3R forum held in Adelaide, Australia in November 2016 towards the Promotion of Circular Economy in Achieving the Resource Efficient Societies by integrating the 3R and resource efficiency plans, programs and policies in the overall policy, planning and development practices at local, provincial and national level while keeping the 2030 Agenda for Sustainable Development with 17 Sustainable Goals at its core in the context of waste including plastic waste in Asia and the Pacific region.[22] In the context of plastic waste, 3R Declaration of Asian Mayors in April 2018 at Indore, India specifically stated, "Strive towards complete ban of illegal disposal of plastics in eco-sensitive or eco-fragile areas, including tourist areas close to oceans, rivers, lakes,

wetlands, other water bodies and mountains, to preserve coastal, marine and mountains ecosystems and resources, keeping in mind the widespread plastic littering which affects eco-systems".[23] The declaration also focussed on sound and effective management of new emerging waste streams such as micro-plastics.[23].The Nineth Regional 3R Forum in Asia and the Pacific held in Bangkok, Thailand in 2019 with the theme of "3R as a way for moving towards sufficiency economy – Implications for SDGs" discussed and adopted the goodwill, voluntary and legally non-binding Bangkok 3R Declaration Towards Prevention of Plastic Waste Pollution through 3R and Circular Economy.[24]

The countries in Asia and the Pacific region have very high material footprint including plastic footprint. Except for Australia and Japan, this decoupling requires policies and its enforcement in majority of the countries in the region. Further, a number of companies have recognized the importance of sustainability reporting, however, the data related to their number in the region is not available. Further, majority of countries have policies and regulations to address onland plastic waste either as part of waste management rules or specific rules. Plastic waste is generally covered under the regulation of solid waste in majority of countries in the Asia and the Pacific Region. However, many countries have specific regulations related to packaging, single use plastic, plastic bags and microbeads. It majorly falls under policy and regulatory jurisdiction of nodal ministry of environment and forest in Asia and the Pacific region. However, the regulations are also implemented at the sub-national and city level respectively. A number of other institutions like private sector both formal and informal and civil society organizations are also involved in the implementation of regulations. All the stakeholders are involved at each level of policy, plan / strategy program and projects development and implementation. Therefore, a number of policy, regulatory, technological, economic and institutional issues have been identified in the region. Countries like Australia, New Zealand, Japan, Republic of Korea and Singapore have minimized these issues by institutionalizing policy, regulations, programs and plan to achieve higher recycling rate and circularity of materials. The countries in the region have also started regulation consumption and production either through mandating bans, fines, import and export controls, and market based instruments such as extended producer responsibility (EPR) based rules, fixing up recycling rates or imposition of taxes and levees. However, these are restricted to plastic bags and single use plastics.[21] The implementation of the policies and regulations as well as creation of waste plastic management infrastructure coupled with capacity building through regional knowledgebase (database, experts, indicator monitoring, information sharing and awareness) are the major challenges which need to mitigated to achieve the specific targets committed under SDGs in the region.

A number of barriers related to regulatory, economic, technology, data and information have been identified. These include Costs of collecting, sorting and processing waste plastics; Limited resilience of the sector to market shocks; Costs of collecting; sorting and processing waste plastics; Limited resilience of the sector to market shocks; Plastics contaminated and mixed with other materials; Lack of differentiated demand for recycled plastics; Poor data on the plastics recycling industry; Problematic additives; Bio-degradable plastics mixing with other plastics; Limited collection schemes and treatment technologies for thermosets.; Hazardous additives; Competition between recycling and energy from waste; Regulatory burdens of materials classified as waste; Uncontrolled dumping and burning of municipal wastes; Illegal trafficking in waste plastics; Concerns over environmental standards for recycling in emerging markets; Concerns over environmental standards for recycling in emerging markets; Limited resilience of the sector to market shock; Global markets concentrated in a small number of countries; Biodegradable plastics mixing with other plastics; Collection systems for wastes not available for a substantial proportion of the global population; Plastics contaminated and

mixed with other materials; Limited collection schemes and treatment technologies for thermosets; Uncontrolled dumping and burning of municipal wastes; Poor data on the plastics recycling industry. A number of interventions have been proposed as a way forward. These include interventions broadly under (1) Regulatory; (2) Economic instruments; (3) Technology; (4) Data and information and (5) Voluntary measures by industries.

While the international community are committed to the 2030 Agenda for Sustainable Development and the SDGs, the New Urban Agenda, the Paris Climate Agreement, the Addis Ababa Action Agenda, the Nairobi Mandate, and the Sendai Framework for Disaster Reduction, among others, there is an increasing need for Asian-Pacific countries to integrate 3R and resource efficiency into their national development plans and macroeconomic policy agendas. By pursuing resource efficient and circular economic development approach, countries and cities can embark on the path of low-carbon and green growth, including realizing eco-efficient infrastructures in key development sectors such as urban design and planning, building, transport, energy, water and waste systems.

As Asia-Pacific countries industrially and economically grow, financing implementation of 3R policies, programs, including infrastructure development, will be critical to reducing the volume of all waste streams – MSW, plastics, chemicals and hazardous wastes, etc. in living environment and natural ecosystem, and in mitigating negative environmental impacts, while supporting a wide range of domestic and global priorities to improve health and environment. In moving towards zero waste societies, the countries need to explore new sources of funding to finance development of appropriate 3R infrastructures (e.g., state of art waste collection and processing facilities, resource recovery facilities, recycling industries, eco-industrial zones, science parks, etc.), to promote collaboration among key stakeholders and active participation of citizens. Moving from plastics economy to circular economy could provide an important basis for new source of funding while contributing towards achieving the SDGs, in particular SDG 9, SDG 11, SDG 12 and SDG 14.

*A careful assessment of plastic economy indicates the development of applications for plastics. Plastics has focussed on the part of the plastics economy that starts with the raw material and ends either at the factory gate or upon delivery to the retail outlet or customer. This excludes the downstream costs of plastics use and an almost complete absence of the social and environmental costs of plastics. The implementation of the interventions mentioned in Table 6.1 will not only extend the plastic economy to the complete material flow of plastic but also internalize cost of plastic waste management. This is expected to boost the circularity of plastic waste as a resource and extend plastic economy to circular economy.[11]*

The redefined plastic economy paradigm offers opportunities to not only deliver better system wide economic and environmental outcomes by creating an effective after-use plastics economy, thereby drastically reducing the leakage of plastics into natural systems (terrestrial & marine) in particular the air, soil, water, seas and oceans but also decoupling from fossil feedstock. Further, the new plastics economy offers an attractive opportunity for the global plastic value chain and governments to collaboratively work towards achieving the sustainable development goals. The economic recovery post COVID-19 pandemic necessitates regional cooperation and commitment to green recovery and natural resource management. On the national level, these responses can be translated to supporting measures related to SDGs and building resilient and sustainable infrastructure. In this context, Indore 3R Declaration

of Asian Mayors agreed at the Eighth Regional 3R Forum in Asia and the Pacific (April'2018, India) stating complete ban of illegal disposal of plastics in eco-sensitive or eco-fragile areas, including tourist areas close to oceans, rivers, lakes, wetlands, other water bodies and mountains, to preserve coastal, marine and mountains ecosystems and resources, the Malé 3R Declaration by private resorts for the promotion of 3Rs and resource efficiency towards protection of local environment and marine ecosystem agreed at the Sixth Regional 3R Forum in Asia-Pacific (August'2015, Maldives) and the voluntary and legally non-binding Bangkok 3R Declaration for prevention of plastic waste pollution through 3R and Circular Economy agreed at the Ninth Regional 3R Forum in Asia and the Pacific (March'2019, Thailand) provide the adequate institutional mechanism and policy framework to collaboratively work towards circular economic utilization of the plastics.

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# Chapter 1: Introduction

## 1.0 Introduction

Asia and the Pacific region which typically includes major parts of East Asia, South Asia, Southeast Asia, and Oceania (in or near the Western Pacific Ocean) has geographical area above 29 million $km^2$ with a population of about 4 billion. The region's population is projected to rise to 5.08 billion by 2050, which is about 60% of the world's total population.[1] China with 1.36 billion and India with 1.25 billion people account for more than half of the total population of the region.[1] The urban population, which was 42% of the region's population in 2014 is projected to increase to about 63% of the total by 2050.[2] The region has a significant difference in the growth of the urban population among the sub-regions, with Australia and New Zealand showing the least, (1.16% per year) while South Asia shows the largest (2.66% per year). The region has more than 242,000 km of coastline.[1] Asia and the Pacific's coastline has multiple shore types. The region contains the world's two largest archipelagic nations (Indonesia and The Philippines) and all five of the world's nations that are entirely atolls (Kiribati, Maldives, Marshall Islands, Tokelau and Tuvalu). The Pacific Islands region is located in the western, northern and central Pacific Ocean and consists of 14 independent countries and eight territories delineated into three major ethnic regions: Melanesia, Federal States of Micronesia and Polynesia. The Pacific Islands region has a population of around 10.57 million that occupy just over 550,000 square kilometres of land ranging from large volcanic landforms to low-lying atolls and raised coral islands[3]. The unique demography, geography, climate and natural resources in the region drive its dynamic socio-economic and livelihood conditions where emerging environmental scenarios with new waste streams like plastic waste are posing major threat to its sustainable development.[1]

## 1.1 Economic Profile

As per 2017 estimates, combined GDP of the major countries in the region was above 25 trillion ranging from US$ 583 to US$ 73,187 per capita.[4] The regions economy expanded to 4.0% in 2018 and 3.3% in 2019. [5] Over the past 50 years (1970–2015), Asia and the Pacific region has experienced rapid economic growth, leading to higher incomes, poverty reduction and the emergence of a rapidly-expanding middle class. About two thirds of the regional economies, accounting for 80% of the region's GDP, achieved faster economic growth in 2017.[4] Though developed Asia-Pacific economies continued to dominate economic growth in the region, it started to decelerate during 2018 to 2020, due to uncertain economic conditions as well as COVID-19 pandemic. Developing Asia-Pacific economies grew by an estimated 5.3% in 2018, 4.3% in 2019 and are projected to grow by 3.7% in 2020 **(Figure 1.1)**. [5] A comparison across sub-regions reveals that South-East Asia continues to lead the region's economic growth, followed by South-West Asia.[5] Manufacturing (Japan, Republic of Korea, Australia, China and India), fisheries and tourism sector are the major contributors to the economy of the region. There have been significant changes in employment in Asia and the Pacific. Agriculture employment is decreasing, while industrial and services employment is increasing. Since the 1990s, the population-weighted mean Gini index, a measure of income distribution, for Asia and the Pacific rose from 33.5 to 37.5.[4] However, developing Asia and the Pacific countries are characterized by a large degree of social and economic inequality. "Across Asia and the Pacific, more than 1 billion people live just above the extreme

poverty line, on more than US$ 1.25 but less than US$ 2.50 a day".[6] More than 40% of workers in the region live in extreme, moderate, or near poverty levels. Among people who have been lifted out of extreme poverty, they remain vulnerable as many of them still live on less than $3.20 or $5.50 per day. [5]

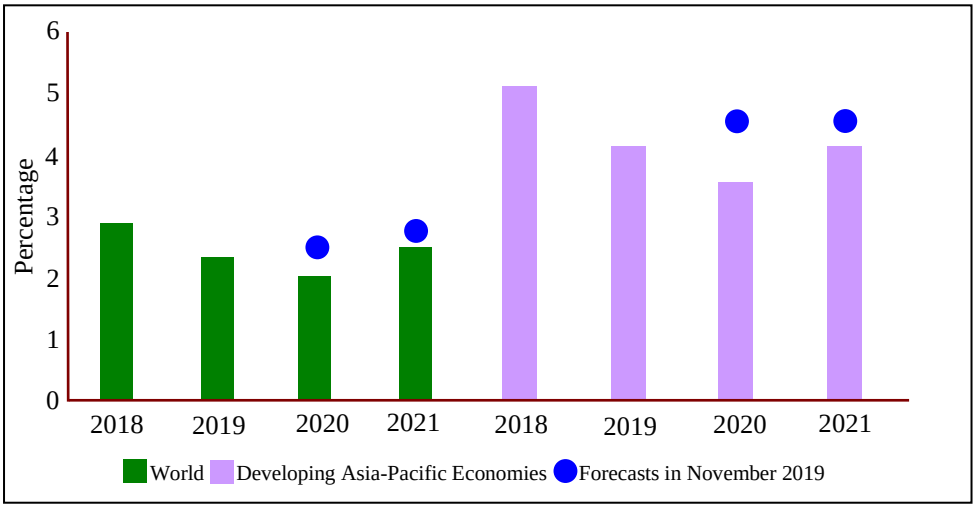


**Figure 1.1: Growth of Developing Asia – Pacific Region Continues to Outpace the Rest of the World**

Source: Estimates by the United Nations Department of Economic and Social Affairs, and ESCAP (2020);

Disclaimer: These are very preliminary forecasts based on data and information available up to 10 March 2020. As the COVID-19 pandemic is still evolving rapidly and showing no signs of abating as of 31 March 2020, its negative impacts on economic performance of countries and territories in the world will likely be very significant. On 1 April 2020, the United Nations Department of Economic and Social Affairs updated its GDP growth forecast. In the face of COVID-19, global GDP growth could slow to between -0.9 and 1.2 per cent in 2020.

In line with the region's growing purchasing power, domestic private consumption has been the major economic growth driver in recent years leading to waste generation and environmental issues.

## 1.2 Environmental Profile

The population growth, industrialization and urbanization have led to a sharp increase in natural resource use in the region, which is both unsustainable and inefficient, and results in pollution, declining biodiversity and natural resource depletion.[7] Further, the environmental impact has increased, in part due to the shift in economic activity from very resource-efficient economies such as Japan and the Republic of Korea to the less resource efficient economies of China, India and Southeast Asia. The region's material consumption has increased sharply over the past four decades, accounting for more than 50% of world consumption while material productivity has not improved and is double the world average and four times the rest of the world average. Material footpring of the region **(Figure 1.2)** indicates that it increased by 124% as compared to 29% for the rest of the world. The use of materials in the region (biomass, fossil fuels, metal ores and non-metallic minerals) increased from 26.3 billion tonnes in 2005 to 46.4 billion tonnes in 2015, an annual rate of growth of 6.1%, which is higher than the economic and population growth rates of 4.9% and 0.9% respectively.[8] The domestic material consumption per person increased from 2.9 tonnes in 1970 to 11.9 tonnes in 2015, with a high growth rate at 5.2% per annum, and has now surpassed the global average of 11.2 tonnes.[8] The energy generation continues to rely on fossil fuels and the share of renewable energy remains small despite very significant investment in renewable-energy infrastructure. The region accounts for more than 50% of the world's water use where water intensity is more than double of the world average.[1]

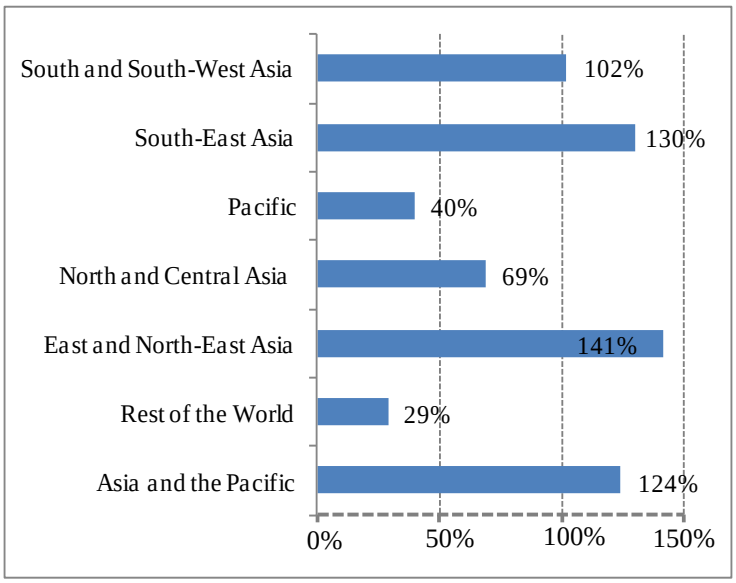


**Figure 1.2: Net Change in Material Footprint, 2000-2017**

Source: UN ESCAP (2020); Based on Methodology in UNEP International Resource Panel's Global Resource Outlook 2019

Available at www.resourcepanel.org/file/1172/download?token=muaePxOQ

The GHG emissions are forecasted to rise through 2050 with the current rate of domestic material consumption under business as usual scenario **(Figure 1.3).** The projected climate change in Asia and the Pacific could lead to a shortage of water resources, widespread land degradation and increased desertification.[1] Impacts of climate change in the Asia and the Pacific region include changes in natural vegetation types and associated changes in ecosystems at higher elevations and latitudes.[9] Climate change, with its impacts of increasing sea-surface temperature, ocean acidification and sea-level rise, is an increasing driver of pressures on coastal and marine eco systems particularly sea grass meadows, sea weed beds, fish migration and coral bleaching in the Asia and the Pacific region.[10] Of the ten economies in the world that are at greatest risk from climate-change impacts, six are in the Asia and the Pacific region, including low-lying Pacific island economies.[1, 10] The risk of landfills being inundated due to sea level rise and/or landfills being washed into the ocean as a result of more severe tropical storms on account of climate change compounds the problem. In coastal regions of Asia, including Bangladesh and much of Southeast Asia, sea-level rise threatens the salinization of coastal aquifers, with effects on drinking water sources and coastal ecosystems.[1, 10]

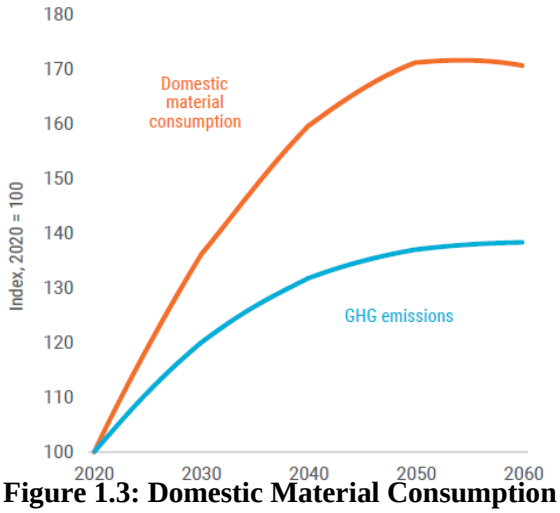


**Figure 1.3: Domestic Material Consumption and GHG Emissions in 2020-2060 with 2020 Levels**

Source: UN ESCAP (2020); Based on Methodology in UNEP International Resource Panel's Global Resource Outlook 2019

Note: East Asia and Oceania = Brunei Darussalam; Cambodia; Dem. People's Rep. of Korea; Hong Kong SAR, China; Lao People's Democratic Republic; Macao, China; Malaysia; Mongolia; Myanmar; the Philippines; Singapore; Taiwan Province of China; Thailand; Timor-Leste; Viet Nam; Federated States of Micronesia; Fiji; Kiribati; Marshall Islands; Nauru; Palau; Papua New Guinea; Samoa; Solomon Islands; Tonga; Tuvalu; and Vanuatu.

Out of 28 mega-cities with more than 10 million people in the world, 15 are in Asia and the Pacific. Tokyo (37.8 million), Delhi (25 million) and Shanghai (23 million) are the three most populous cities in the world.[2] An estimated 120 000 people migrate to cities in the region every day. The proportion of people living in urban areas is likely to rise to around 3.3 billion people, by 2050. Evidence suggests that climate change, climate variability and sea-level rise will exacerbate multi-dimensional poverty in most developing countries. By 2050 storm surge zones, with a combined total of more than 58 million people at risk, are expected in Bangladesh, China, India, Indonesia, and the Philippines.[11] The small island developing states, with their high proportion of productive capital located on the coast, are particularly at risk.[12] This will further accelerate population migration and urbanization in the region. Therefore, the demographic transition to urban dwellers and environmental links with urbanisation will largely determine the sustainable development pathways of the region during the next 25 years and beyond.[2] The intensive human activities and energy consumption in urban areas will lead to the generation of increasing amounts of pollution and waste. Along with the land needs of urbanization, urban solid waste disposal through landfills and the management of industrial hazardous waste will become major concerns in the region.[13]

## 1.3 Plastic Waste Management

The total global waste generation is around 7–10 billion tonnes per year, of which total municipal solid waste (MSW) is around 2 billion tones.[14] With an average generation rate of 1.4 kilograms per person per day, the annual total MSW for Asia and the Pacific was estimated at around 870 million tonnes in 2014, accounting for 43% of the world's total. Municipal solid waste generation in Asia and the Pacific is projected to increase until 2030, when it could be 1.6 kilograms per person per day or around 1.4 billion tonnes a year[15]. The broad composition of municipal solid waste comprises of the organic share in (50–70%) low-income countries than (20–40%) in high-income ones.[14] The percentage of paper is also proportional to income levels, at 23% of municipal solid waste in high income countries, 19–11% in middle-income ones and 7% in low-income countries. The proportion of plastic, is around 8–12% across all the countries[15]. Considering this composition, the plastic waste generation in the region is expected to reach 140 million tonnes by 2030[15]. In the developing countries in the region, waste collection rates are moderate, at 40–80%, but reach almost 100% in more developed economies such as Japan, Australia, Republic of Korea and Singapore[15].

The waste separation at source is a common practice in more developed countries while in low- and middle-income countries, there has been informal waste separation with different types of waste collected separately for transfer to a facility and recycling. In general, recycling rates in high-income countries have increased progressively over the past 30 years, while in lower-income countries the informal sector often only achieves recycling rates of 20–30% for municipal solid waste.[14] Top eleven countries which indicate highest mismanagement of plastic waste include China, Indonesia, The Philippines, Vietnam, Sri Lanka, Thailand, Malaysia, Bangladesh, India, Pakistan and Myanmar.[16] Broadly major hot spots of accumulated floating plastics occur in coastal waters adjacent to countries with high coastal populations and inadequate waste management.[16] Therefore, Asia and the Pacific which has a large ocean area is facing a rise in marine litter, mainly plastics waste.[17] For example, it has been reported that in the waters around Australia, up to 70% of the marine litter that enters the sea ends up on the seabed, while 90% of floating marine litter is plastic or polystyrene. In Indonesia alone, 690 000 items were

found to be present per square kilometre on the seafloor and 29.1 items per square metre on the shorelines.[18] Plastics in the marine litter are drawn into circulating ocean currents and finally into gyres across the globe e.g. the Great Pacific Garbage patch located in the North Pacific Gyre. The gyres in the Indian ocean and the Pacific. Ocean are recipients of plastic waste from Asia and the Pacific region.[15]

## 1.4 Relevance of (Reduce, Reuse and Recycle) 3R, Practices and connectivity to SDGs and its Targets

The magnitude of plastic waste generation and its on land mismanagement in the region offers potential threat to both land and marine environment with linkages to livelihood issues particularly in least developed and pacific islands. Therefore, it requires an overarching framework for its management, which could address multiple issue and provide common framework for sustainable development in the region.[19] Plastic pollution can be broadly addressed under an overarching framework of the 2030 Agenda 2030 for Sustainable Development Goals (SDGs). Thirteen targets from five SDGs (SDG 7, 12, 13, 15 and 16) are relevant to reducing the inputs and impacts of waste plastic on terrestrial and marine ecosystem. These five SDGs cover sustainable management of water and sanitation; sustainable consumption and production; inclusive, safe, resilient and sustainable use of terrestrial and marine ecosystem while ensuring their protection, restoration and conservation. SDG 14 "Life below water" in particular 14.1, 14.2, 14.7, 14.a and 14.c are important under which the framework to address marine plastic can be evolved. SDG targets, which encompass the promotion of alternative to the use of conventional plastic as well as social and economic resilience include SDG 1.4, SDG 8.3, SDG 9.3 and 9.4.[20] These additional three SDGs cover poverty, sustained, inclusive and sustainable economic growth and employment and resilient infrastructure and inclusive and sustainable industrialization. The relevant eight SDGs and their targets have been summarized in **Annexure 1.1.**

In order to demonstrate their renewed commitment to realizing a promising decade (2013-2023) of sustainable actions and measures for achieving resource efficient society and a green economy in the Asia-Pacific region through the implementation of the 3Rs, the countries in Asia and the Pacific resolved to voluntarily develop, introduce and implement policy options, programmes and projects towards realizing the thirty three sustainable 3R goals in the region. These goals were declared as the part of "Ha Noi 3R Declaration Sustainable 3R Goals for Asia and the Pacific for 2013-23" at the Fourth Regional 3R Forum in Asia held in Ha Noi, Vietnam in 2013.[21] The countries in Asia and the Pacific region reaffirmed their commitment under "Adelaide 3R Declaration" towards the Promotion of Circular Economy in Achieving the Resource Efficient Societies in Asia and the Pacific under the 2030 Agenda for Sustainable Development in November 2016.[22] This can be achieved by integrating the 3R and resource efficiency plans, programs and policies in the overall policy, planning and development practices at local, provincial and national level with an aim for a higher level of circularity at the business and whole economy level, while keeping the 2030 Agenda for Sustainable Development with 17 Sustainable Goals at its core in the context of waste including plastic waste.[22]

In the context of plastic waste, 3R Declaration of Asian Mayors in April 2018 at Indore, India under the head, "Achieving Clean Land, Clean Water and Clean Air in Cities" specifically stated, "Strive towards complete ban of illegal disposal of plastics in eco-sensitive or eco-fragile areas, including tourist areas close to oceans, rivers, lakes, wetlands, other water bodies and mountains, to preserve coastal, marine and

mountains ecosystems and resources, keeping in mind the widespread plastic littering which affects eco-systems".[23] The declaration also focussed on sound and effective management of new emerging waste streams such as micro-plastics.[23]

The Nineth Regional 3R Forum in Asia and the Pacific held in Bangkok, Thailand in 2019 with the theme of "3R as a way for moving towards sufficiency economy – Implications for SDGs" aimed to address how 3R and resource efficiency could play a critical role in achieving sufficiency economy, which advocates rationale use of natural resources that gives people better environment, quality of life and livelihood security as well as prudence and built-in self-immunity to cope with external shocks and global volatility through balanced development.[24]

Recognizing the growing problem of plastics waste in the region and underscoring the multiple benefits of pursuing a circular economic development approach through effective 3R policies, programmes and institutions, the 9th Regional 3R forum discussed and adopted the goodwill, voluntary and legally non-binding Bangkok 3R Declaration Towards Prevention of Plastic Waste Pollution through 3R and Circular Economy.[24]

Box No 1: Voluntary and legally non-binding commitments under Bangkok 3R Declaration Towards Prevention of Plastic Waste Pollution through 3R and Circular Economy (2019) [24]

1. Identify gaps in the existing laws and institutions and regulations, and further reinforce the ongoing 3R and sustainable waste management actions and measures towards the issue of plastic waste, including single-use plastics;
2. Develop effective 3R policies, programmes, including infrastructure development in order to upscale the reusing and the recycling towards circular economic utilization of plastics, and to prevent leakage into the coastal and marine environment;
3. Support various innovative solutions for new and sustainable business models which would promote greening the supply chain and multi-use alternatives, including alternatives to single-use plastics products such as reusable, environmentally friendly biodegradable products, and eco-design of plastic products;
4. Support necessary research and development programmes on bio-based alternatives which would promote environment friendly bio-economy bringing in new sustainable business and employment opportunities while influencing consumer behavior towards green procurement;
5. Strengthen international agreements, policies, and cooperation towards efficient reduction and impacts of plastic waste pollution by reducing single-use plastics, promoting plastic waste recycle as resources, recyclable materials and waste-to-energy, among others;
6. In conformity with pertinent regulations and standards governing environmental quality, eco-systems, health and safety, protection of sensitive areas, costal and marine environment and endangered species, sitting, and land-use control, promote and implement environmentally friendly waste collection, segregation, transportation, recycling and final disposal;
7. Promote various public awareness programmes and campaigns in order to discourage the use of single-use plastics as a first priority; build an effective after-use plastic economy and explore ways to utilize end-of-life plastics as a

valuable resource, which would help to make a transition towards circular economy;

8. Promote sharing of knowledge and best practices on the effective management of marine litter in the region and support the establishment of a regional knowledge hub for the purpose;
9. Consider mobilizing dedicated funds and investments for cost-effective plastic waste management technologies and plastics waste recycling facilities with an objective to protect the local environment and ecosystem, including coastal and marine environment which will in return attractinternational tourism resulting in increased government revenue generation and local employment opportunities;
10. Promote multilayer collaborations and partnerships such as the public-private-partnerships (PPP), as called upon by the Surabaya 3R Declaration (2014) and ASEAN+3 Marine Plastics Debris Cooperative Action Initiative, in order to implement various 3R programmes towards the prevention and proper management of plastic waste, including the marine debris; to this regard, strengthen regional cooperation in addressing the issues of single-use plastic products, including their detrimental impact on coastal and marine ecosystem; and
11. Recognize the importance of monitoring marine litter, and thereby, explore, develop and harmonize methods on counting beach litter items (such counts are internationally accepted as a reasonable indicator of the composition of marine litter towards informed decision making).
12. Attach significance of 3R and circular economy, and to that regard, the important role the private, business and industry sectors can play in mainstreaming 3R in their business operations and solutions, as Corporate Social Responsibility (CSR) and Extended Producer Responsibility (EPR), to many sustainability challenges faced by the Asia-Pacific countries.

Source: http://www.uncrd.or.jp/content/documents/7761Chiar%20summary-for%20website.pdf

## 1.5 Scope of the Report

This report is relevant to all countries in Asia and the Pacific, regardless of their current state of development in terms of plastic waste and resource management. In this report the Driver-Pressure-State-Impact-Response (DPSIR) framework has been conceptually used for describing the interactions between society and the environment: human impact on the environment and vice versa because of the interdependence of the components.[25] In the context of plastic waste, DPSIR framework assumes a chain of causal links starting with driving forces (economic sectors human activities) through ‘pressure’ (emissions, waste) to ‘states’ (physical, chemical and biological) and ‘impacts’ on ecosystems, human health and functions, eventually leading to responses’ (prioritization, target setting, indicators). The scope of this report includes description and evaluation of the state of whole of value chain related to plastic in Asia and the Pacific region. It covers material cycle of plastic including production, consumption, waste generation, segregation, treatment and disposal. Further, the key pressures due to plastic wastes are discussed. For example, emissions of substances which may accumulate on lands, rivers, lakes and oceans, may directly affect human and animals, and / or may produce by products which contaminate environment. Major policy initiatives and the responses related to plastic waste in Asia and the Pacific have been described in this report. It includes brief description of environmental laws and regulations institutional roles and actions,

multilateral environmental agreements; capacity building in local, national and regional levels, technological interventions and successful cases of pilot and demonstration projects in preventing / managing plastics wastes. Finally, way forward on how Asia and the Pacific countries should address plastics economy as a way in advancing circular economy as well as in achieving clean land, clean water and clean air in support of the 2030 Agenda for Sustainable Development / SDGs[26] and the Habitat III New Urban Agenda[27] have been described based on D-P-S-I-R framework. It places particular focus on countries, which are major hotspots of plastic pollution and marine litter and are struggling to address challenges related to its management. This report is targeted at a relatively high, but non-technical, level to a wide range of professionals and decision makers at regional, national as well as local government level and other groups of stakeholders, including NGOs, community-based organisations, businesses, the manufacturing sector, the waste industry, financial institutions and research institutions and academia.

**Key Messages: Chapter-1**

Asia and the Pacific region which has 242,000 km of coastline, typically includes major parts of East Asia, South Asia, Southeast Asia, and Oceania (in or near the Western Pacific Ocean). It has geographical area above 29 million $km^2$ with a population of about 4 billion. The region's population is projected to rise to 5.08 billion by 2050, which is about 60% of the world's total population. Out of 28 mega-cities with more than 10 million people in the world, 15 are in Asia and the Pacific. An estimated 120 000 people migrate to cities in the region every day. The proportion of people living in urban areas in the region is likely to rise to around 3.3 billion people, by 2050.

As per 2017 estimates, combined GDP of the major countries in the region was above 25 trillion ranging from US$ 583 to US$ 73,187 per capita. Over the past 45 years (1970–2015), the region has experienced rapid economic growth, leading to higher incomes, poverty reduction and the emergence of a rapidly-expanding middle class. A comparison across sub-regions reveals that South and South-East Asia continues to lead the region's economic growth, followed by South-West Asia. However, during 2019 South East Asia lead the economic growth. Though the current COVID-19 pandemic has decelerated economic growth, in the region it is expected to relead post 2020.

The population growth, industrialization, urbanization and economic growth have led to a sharp increase in natural resource use in the region, which is both unsustainable and inefficient, and results in pollution, declining biodiversity and natural resource depletion. However, the environmental impact has increased, in part due to the shift in economic activity from very resource-efficient economies such as Japan and the Republic of Korea to the less resource efficient economies of China, India and Southeast Asia. Further, the region is vulnerable to climate change and related extremely climate events thereby increasing pressure on coastal & marine ecosystem.

The domestic material consumption per person in region has now surpassed the global average of 11.2 tonnes. The greater consumption of resources in the regions leading to greater waste generation. The plastic waste generation in Asia and the Pacific region is expected to reach 140 million tonnes by 2030. Top eleven countries which indicate highest mismanagement of plastic waste include China, Indonesia, The Philippines, Vietnam, Sri Lanka, Thailand, Malaysia, Bangladesh, India, Pakistan and Myanmar.

Therefore, Asia and the Pacific region which has a large ocean area is facing a rise in marine litter, mainly plastics waste.

Plastic pollution in Asia and the Pacific region can be broadly addressed under an overarching framework of the Agenda 2030 for Sustainable Development Goals (SDGs) mainly through achieving thirteen targets from five SDGs (SDG 6, 11, 12, 14 and 15). Further, achievement of thirty three sustainable 3R goals in the region as part of "Ha Noi 3R Declaration" in 2012-13, reaffirmed commitment under "Adelaide 3R Declaration" in 2016, complete ban of illegal disposal of plastics in eco-sensitive or eco-fragile areas under Indore 3R Declaration in 2018 and voluntary and legally non-binding Bangkok 3R Declaration Towards Prevention of Plastic Waste Pollution through 3R and Circular Economy will support achievement of SDGs relevant to plastic pollution.

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# Chapter 2: Material Cycle of Plastic

## 2.0 Introduction

The mismanagement of onland plastic waste generation and its subsequent leakage in environment causes the major environmental impacts such as higher material footprint and GHG emissions in Asia and the Pacific region. Therefore, it is important to map the material cycle of plastic and identify sources and causes of plastic waste in the region. The following sections describe material cycle of plastic based on life cycle approach. This is followed by description of plastic production and consumption trends in eleven material resource intensive as well as polluting countries in Asia and the Pacific region. The major focus of this chapter is on resource intensity and related aspects of plastic consumption and production. Finally, results of 3R efforts and their potential for circular economy have been described.

## 2.1 Material Cycle of Plastic

Material cycle of plastic has been described considering life cycle approach. Conceptually, life cycle approach considers the range of impacts throughout the life of a product by taking the entire life cycle into account i.e. from the extraction of natural resources to material processing, manufacturing, distribution and use, and finally to the reuse, recycling, recovery and disposal of any remaining waste. Life cycle assessments (LCA) quantify these steps by assessing the emissions, resources consumed and pressures on environment, health and safety that can be attributed to a product or service. A conceptual plastic value chain in the context of Asia and the Pacific region has been described in **Figure 2.1**. It starts from material engineering for plastic and leads to its production followed by its consumption, collection, recycling and repurposing and finally its conversion and disposal. **Figure 2.2** describes activities at each stage of plastic value chain. The material / product input versus output at each stage determine the sources of plastic waste along the plastic value chain. Stage wise description of plastic value chain is given below[1].

**Material Engineering (Stage 1):** Different raw materials e.g. petroleum, non petroleum and other resources are identified to develop plastic product for a particular use. This may consist of virgin raw materials or their combination. At this stage, the formulation of plastic product determines extraction of raw materials from finite natural resource e.g. petroleum or secondary materials such as plastic waste.

**Production and Business Model (Stage 2):** At this stage, raw materials are converted into products using physical or chemical processes based on technology, economics and business model (export or domestic consumption). The efficiency of conversion determine plastic waste generation at this stage. Further, the formulation at stage 1 determines reuse or recycling of plastic waste generated at this stage or stage 5.

**Consumer Use, Reuse and Behavior (Stage 3):** Consumer behavior determines consumption of plastic products. It determines whether consumer wants to use brand new or used product. End of life product is discarded as plastic waste. Therefore, it is the major stage for plastic waste generation.

**Collection (Stage 4):** Waste plastic is collected using formal and informal collection system. At this stage efficiency of collection system determines plastic leakage into the environment. Uncollected plastic waste leaks into drainage and sewer system or directly into waterways or seas.

**Recycling and Repurposing (Stage 5):** Collected plastic waste is segregated for reuse, recycling, energy recovery (non recyclable) and disposal. The efficiency of segregation in both formal and informal plastic waste management system determines leakage into the environment.

**Conversion and Disposal (Stage 6):** Plastic waste after recycling and repurposing is meant for disposal. The disposal mechanism includes disposal on land or water such as organized dumping into sanitary landfill site, unorganized burying / dumping, wild dumping close to waterways and directly into waterways.

**Last Chance Capture (Stage 7):** Plastic waste dumped on land can be captured at landfill or dump sites through manual or mechanical mechanism used for waste segregation. Plastic waste dumped into waterways can be captured through retention mechanism.

**Figure 2.3** describes cause, problem and effect of plastic waste generation. Further, it depicts stage wise sources of plastic waste generation and its leakage into the environment.

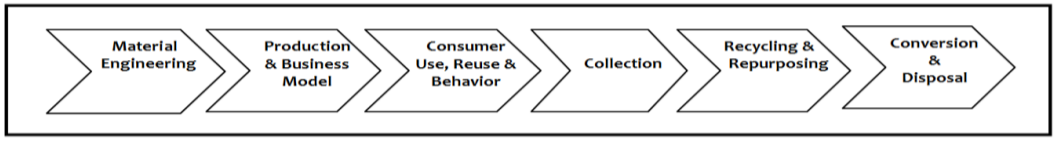



**Figure 2.1: Conceptual Plastic Value Chain in Asia and the Pacific[2]**

Source: UN Environment (2017) - Reducing Marine Litter by Addressing the Management of the Plastic Value Chain in Southeast Asia

It has been cited that uncontrolled landfilling and open burning have been the most prevalent waste disposal method in Asia and the Pacific region. Controlled waste disposal rates can reach 95–100% in upper-middle and high-income countries of the region. It is often below 50% in low-income countries, and no controls on disposal is still relatively common in rural areas.[5] The current plastic waste disposal practices result in mismanagement of waste leading to their leakage into natural drainage system and finally oceans.[6]

**Figure 2.4** shows geographically how the plastic waste from Asia Pacific enters the waterways, oceans and seas. About 1.15 and 2.41 million tonnes of plastic currently flows from the global riverine system into the oceans every year.[6] About 15 from the top 20 polluting rivers are located in Asia.[2] These 20 rivers accounted for more than two thirds (67%) of the global annual input while covering 2.2% of the continental surface area and representing 21% of the global population.[2] The Chinese Yangtze River is the largest contributing catchment, with an annual input of 0.33 (range 0.31–0.48) million tonnes of plastic discharged into the East China Sea, followed by the Ganges River catchment, between India and Bangladesh, with a computed input of 0.12 (range 0.10–0.17) million tonnes per year.[6] Estimates indicate that 1.7 to 4.6% of the total plastic waste generated on land enters the ocean and ultimately becomes marine litter. Considering this hypothesis, the amount of plastic waste entering the ocean from Asia and The Pacific region ranges from 2.3 to 6.4 million tonnes in 2030. **Figure 2.4** also indicates that proportion of mismanaged plastic waste is very less in Australia, New Zealand, Japan, the Republic of Korea and Hong Kong Special Administrative Region of the People's Republic of China, Special Administrative Region of China.

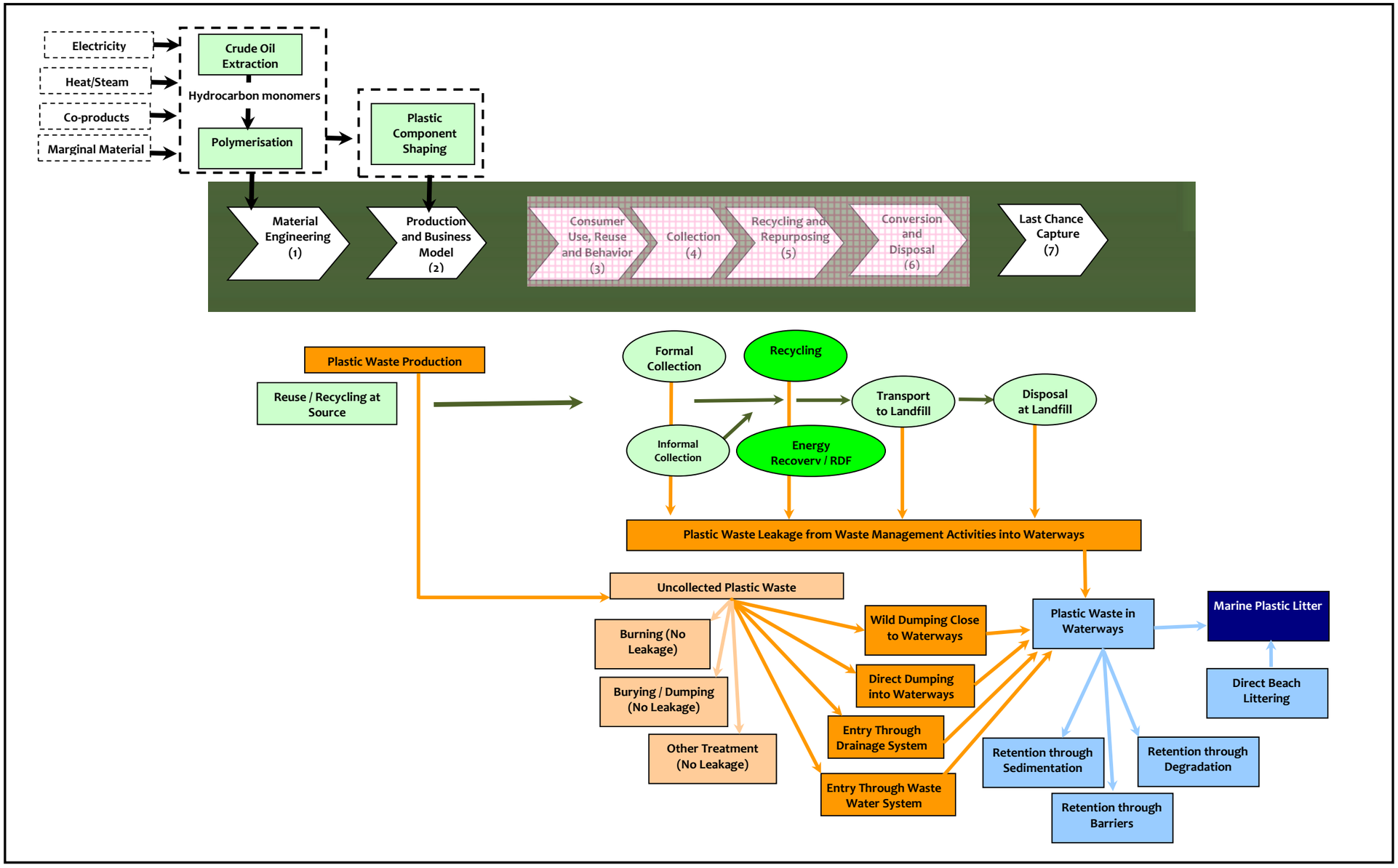



**Figure 2.2: Stage-wise Activities in Plastic Value Chain[2][3][4]**

Source: Prepared by Amit Jain (2019); From UN Environment (2017) - Reducing Marine Litter by Addressing the Management of the Plastic Value Chain in Southeast Asia ; OECD (2018) – Improving Markets for Recycled Plastics – Trends, Prospects and Policy Responses; GIZ (2018) – Marine Litter Prevention (Reducing Plastic Leakage into Waterways and Oceans through Circular Economy and Sustainable Waste Management

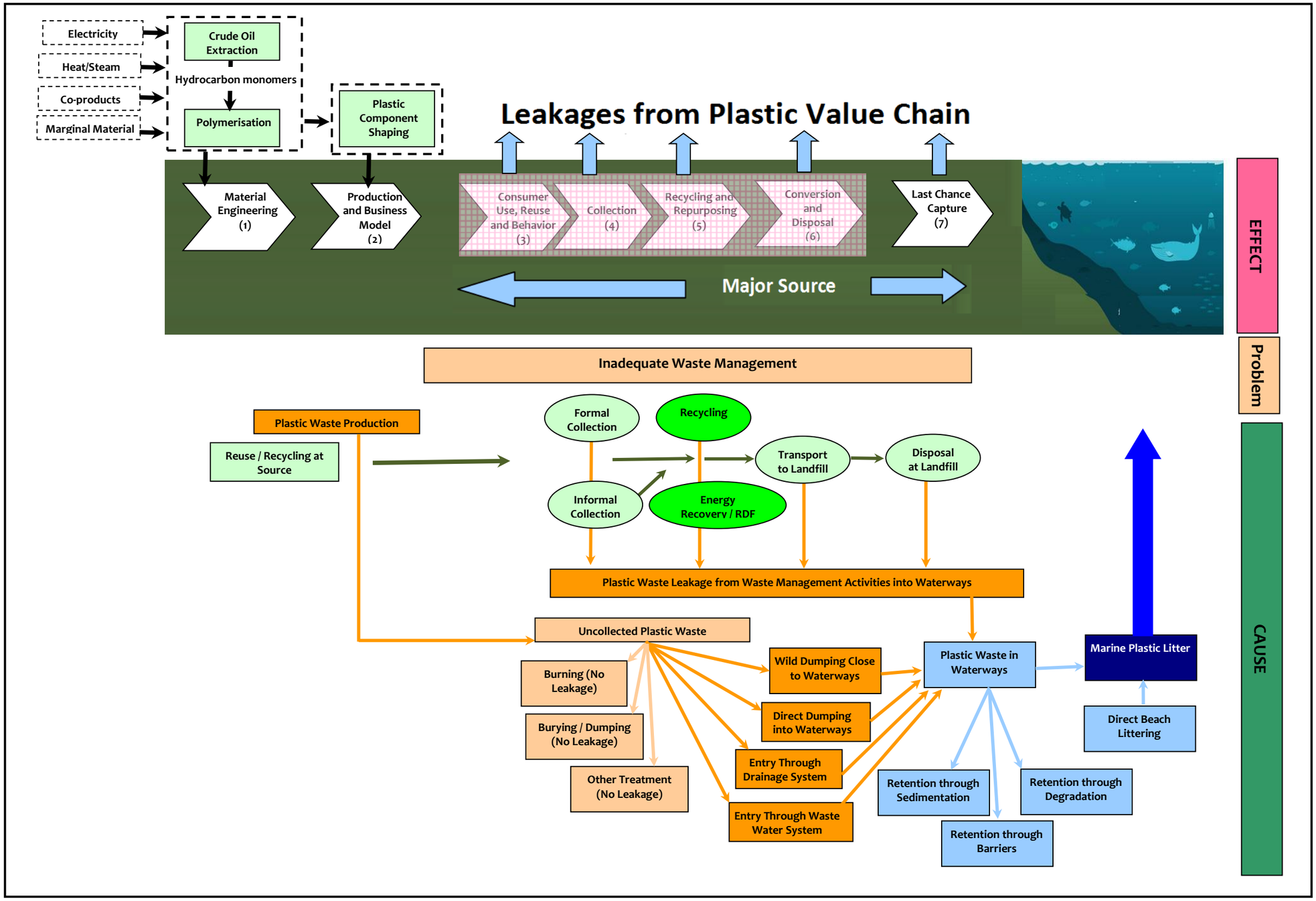



**Figure 2.3: Sources of Plastic Waste Leakage into Environment[2][3][4]**

Source: Prepared by Amit Jain (2019); From UN Environment (2017) - Reducing Marine Litter by Addressing the Management of the Plastic Value Chain in Southeast Asia ; OECD (2018) – Improving Markets for Recycled Plastics – Trends, Prospects and Policy Responses; GIZ (2018) – Marine Litter Prevention (Reducing Plastic Leakage into Waterways and Oceans through Circular Economy and Sustainable Waste Management

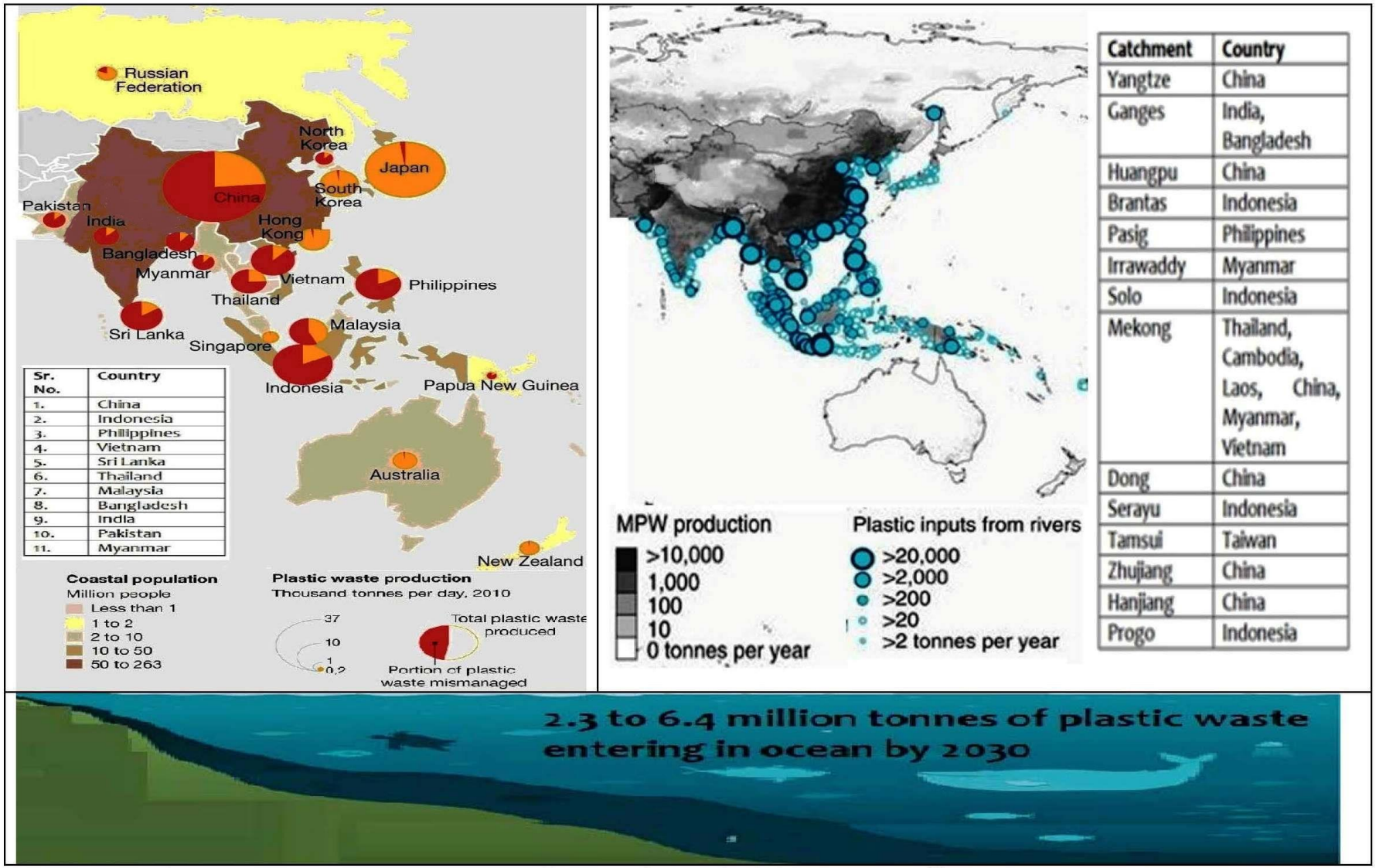



**Figure 2.4: Plastic Waste Leakage into Waterways, Seas and Oceans in Asia and the Pacific Region**

**Source:** http://www.grida.no/resources/6931 and https://www.nature.com/articles/ncomms15611/figures/1[3]

Note: The designations employed and the presentation of material on this map do not imply the expression any opinion whatsoever on the part of the Secretariat of United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

## 2.3 Material Inputs, Plastic Production, Consumption

The wide range of mismanaged plastic in Asia and the Pacific region necessitates assessment of material inputs, plastic production and consumption in the material cycle of plastic for the region. This has been done based on trends in fossil fuel consumption, plastic production, domestic material consumption and plastic consumption in Asia and the Pacific region.

**Figure 2.5** indicates that oil consumption in the Asia and the Pacific region was 36.5 million barrel per day in 2019.[7] About 4% by mass of oil extracted is used as a feedstock for plastic production.[8] Therefore, it can be assumed that 1.4 million barrel per day of oil was consumed for plastic production in Asia and the Pacific region in 2019. **Figure 2.6** shows the distribution of global plastic production. World's plastics production in 2018 stood at 359 million tonnes. About 183 million tonnes (51%) of plastic was produced in Asia. China, Japan and rest of Asia accounted for 30%, 4% and 17% of plastic production respectively.[9]

The total domestic material consumption of 44 countries in Asia and the Pacific increased (134%) from 22.9 billion metric tons in 2000 to 54.4 billion metric tons in 2017. China registered the highest total domestic material consumption at 35.2 billion metric tons. In per capita terms **(Figure 2.7)**, Australia reported highest domestic material consumption at 37.9 metric tons per person in 2015, followed by Mongolia (34.5 metric tons per person), Singapore (32.6), New Zealand (24.2), PRC (25), and Brunei Darussalam (22.9). The Pacific economies of Palau (1.2 metric tons per person), Tuvalu (1.1), and the Marshall Islands (2.0) reported the lowest consumption of domestic materials per capita in 2017. From 2000 to 2017, 12 countries in Asia and the Pacific more than doubled their levels of consumption per capita. These included Cambodia, the Lao PDR, the Marshall Islands, Palau, the PRC, Timor-Leste, Tonga, and Viet Nam. Conversely, consumption per capita was reduced over the same period in 6 of the 44 reporting countries, including the two developed economies of Australia and Japan.[10]

Plastics are an integral part of the material consumption in Asia and the Pacific. **Figure 2.8** indicates trends in major plastic consuming countries in the region from 2015 to 2019. It indicates that Republic of Korea ranks first in per capita plastic consumption followed by Malaysia, Japan, Thailand, China, Australia, Vietnam, Indonesia, India and Pakistan. Per capita plastic consumption of China, Japan and Thailand is expected to converge by 2019, while Australia is expected to experience decline during the same period.[11]

Considering least proportion of mismanaged plastic waste in Japan, Republic of Korea and Australia, a brief profile of plastic industry (consumption and production) of major polluting countries in Asia and the Pacific region is summarized in **Table 2.1** and described in **Annexure 2.1**.

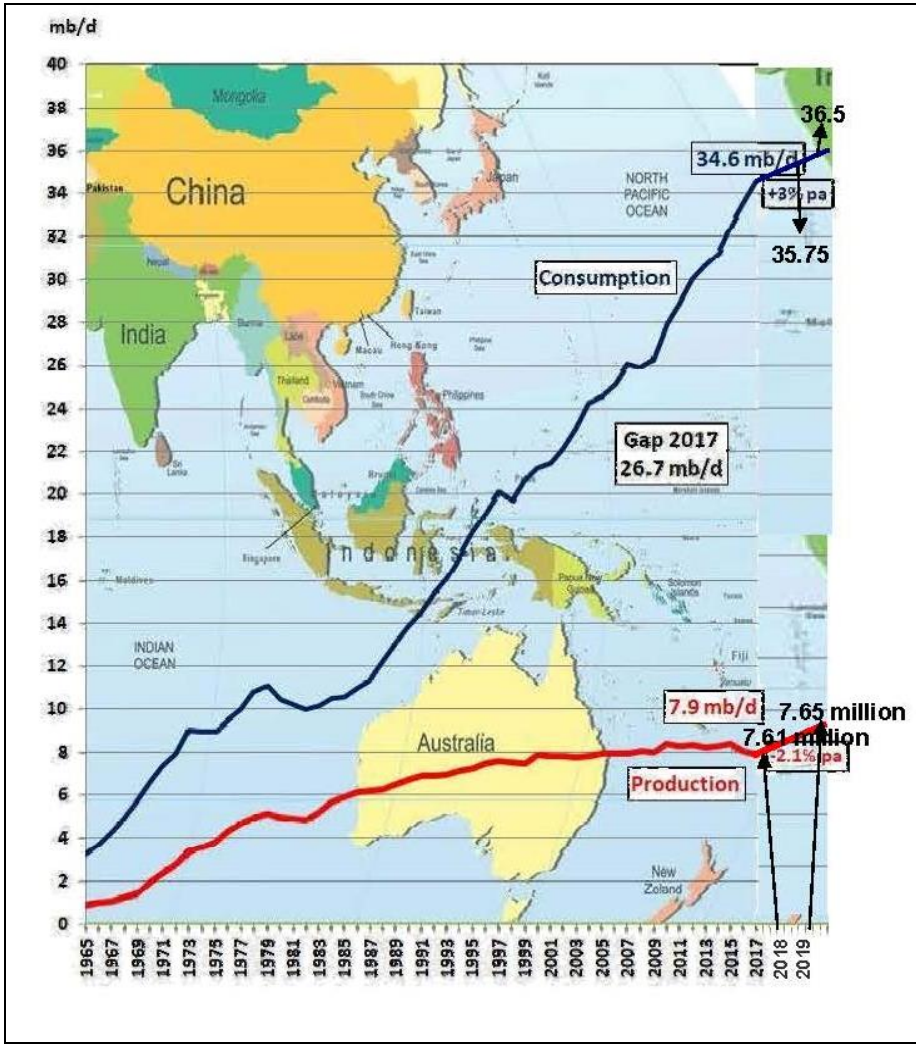



**Figure 2.5: Asia-Pacific Oil Production and Consumption 1965-2017[7]**
Source: BP Statistical Review (June 2020); Peak Oil in Asia Pacific (Part 1); https://crudeoilpeak.info/peak-oil-in-asia-pacific-part-1 (accessed on 29/01/2019)


**Figure 2.6: Distribution of Global Plastic Production[9]**
*Includes thermoplastics, polyurethanes, thermosets, elastomers, adhesives, coatings and sealants and PP-fibers.
Not included PET-, PA- and polyacryl-fibers
Source: PlasticsEurope Market Research Group (PEMRG) / Conversio Market and Strategy GmbH

Note: The designations employed and the presentation of material on this map do not imply the expression any opinion whatsoever on the part of the Secretariat of United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

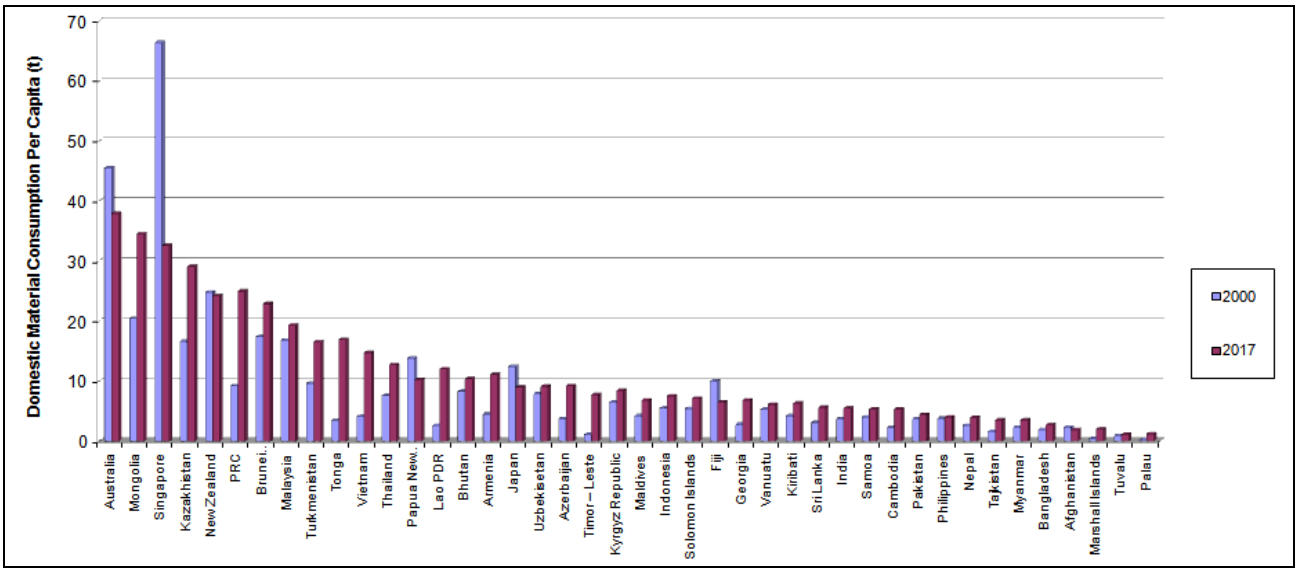



**Figure 2.7: Domestic Material Consumption per Capita (t)[10]**

Source: Asian Development Bank (ADB) 51st Edition (September 2020); Key Indicators for Asia and the Pacific

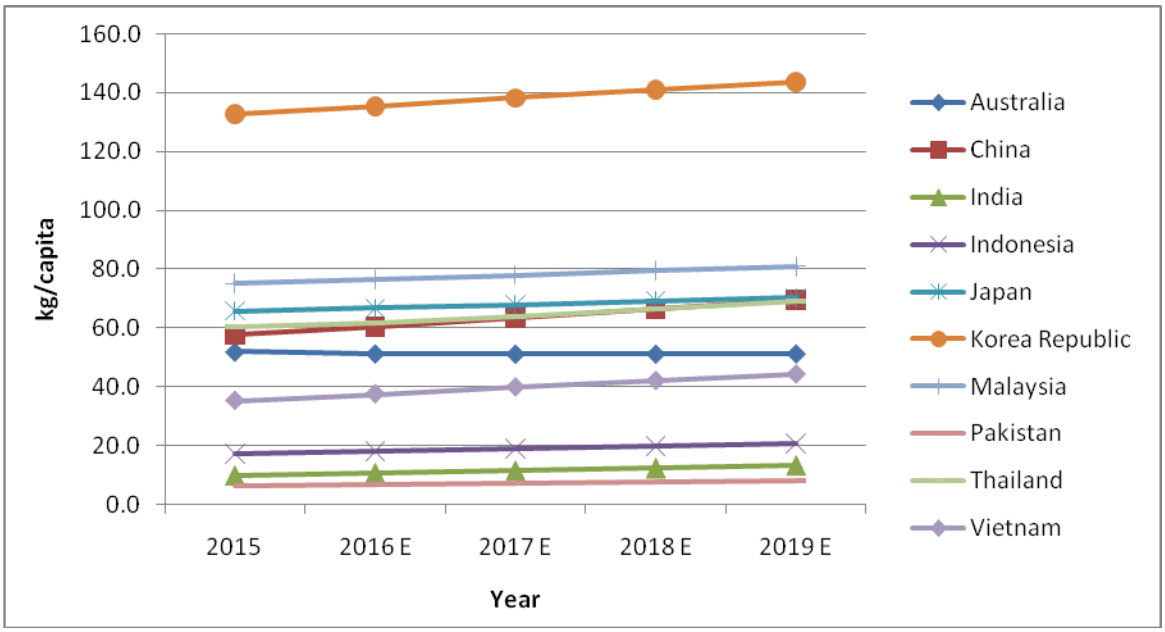



**Figure 2.8: Country wise Plastic Consumption per capita 2015-2019[10]**

Source: Euromap (October 2016); Plastic Resin Production and Consumption in 63 Countries Worldwide

E - Estimated

**Table 2.1: Socio-economic of Eleven Major Polluting Countries in Asia – Pacific[12][13][14][15][16][17][18][19][20][21][22]**

| Sr. No. | Country | Area ($km^2$) | Population (million) | GDP (Nominal Billion US$) | GDP Per Capita US$ | Plastic Consumption (kg) Per Capita (2017) |
|---|---|---|---|---|---|---|
| 1. | Bangladesh | 143,998 | 163 | 285 | 1,748 | 5 |
| 2. | China | 9,600,000 | 1400 | 14,172 | 10,099 | 63.5 |
| 3. | India | 3,287,263 | 1300 | 2611 | 2,016 | 11.6 |
| 4. | Indonesia | 1,910,931 | 263.9 | 1016 | 3,850 | 8.8 |
| 5. | Malaysia | 330,290 | 32.05 | 364.9 | 11,385 | 78 |
| 6. | Myanmar | 678,500 | 54 | 69.3 | 1,283 | 4.6 |
| 7. | Pakistan | 881,913 | 204.9 | 304.04 | 1,484 | 7.3 |
| 8. | Sri Lanka | 65,610 | 21.6 | 98.04 | 4,539 | 13.5 |
| 9. | Thailand | 513,120 | 69.03 | 455.2 | 6,594 | 63.9 |
| 10. | The Philippines | 300,000 | 104.9 | 313.6 | 2,989 | 10 |
| 11. | Vietnam | 330,972 | 95.5 | 223.8 | 2,343 | 39.9 |

## 2.4 Demographic Change, Material Distribution, Recycling Rates and Technology

The economic development has positive correlation with resource intensity. It indicates that if countries are developed then they will have higher per capita resource consumption. However, if developing countries are in a high growth trajectory then their per capita resource consumption will accelerate in future. As a result, net cumulative effect can strain the finite pool of natural resources and may exceed the threshold rate at which these resources could be replenished.[23] In this context, geographical distribution of material intensity at global and in Asia and the Pacific region has been described. Further, its correlation to GDP and plastic consumption in Asia and the Pacific has been analyzed.

It has been estimated that the annual global GDP growth rate is projected to stabilise below 2.5% per year at the turn of the century. Global primary materials use, and thus global primary materials extraction, is projected to double in the coming decades from 79 GT in 2011 to 167 Gt in 2060. In parallel to the growth in materials use, materials intensity is projected to gradually decrease over time. While global GDP is projected to grow on average by 2.8% annually between 2011 and 2060, global primary materials use is projected to grow by 1.5% per year. The materials intensity of the global economy is projected to increase till 2025 but is expected to decrease thereafter by 1.3% per year on average. This has been predicted due to improvements occurring mostly after 2025 as the global economy orients towards more services and the construction boom in emerging economies (China and India) is projected to slow down.[23]

Asia and the Pacific region has been experiencing high growth and high material consumption since 1990. In terms of material resource use (comprising fossil fuels, biomass, metals and non-metallic minerals), the Asia and the Pacific region is the most resource-intensive region in the world, both in terms of domestic material consumption and material footprint. The Asia-Pacific region has approximately 2 Kg per US$ (domestic material consumption per dollar of economic output) in comparison to 1.2 Kg per US$ of world's average. During 1990 to 2017, the rapidly growing low- and middle-income countries in the region recorded significant increases in resource use in both absolute and per capita terms. The domestic material consumption per capita in low-income, lower-middle-income and upper middle-income countries increased by 75%, 69% and 315% respectively, while that of high-income countries decreased by 2%.[24] In the sub regions, the Pacific has the highest per capita domestic material consumption, followed by East and North-East Asia. **Figure 2.9** and **Figure 2.10** indicates variation in the level of resource-use intensity within sub regions. Apart from the Pacific, all sub regions have a higher resource intensity than the world average.[24]

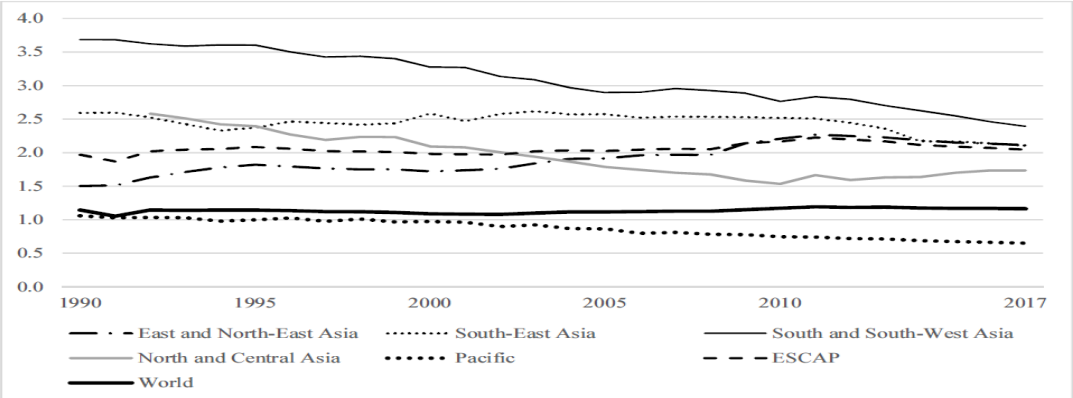



**Figure 2.9: Trends in resource intensity: domestic material consumption, 1990–2017 (Kilograms per United States dollar)[24]**

UNESCAP (2018); Economic and Social Commission for Asia and the Pacific - Key environment issues, trends and challenges in the Asia-Pacific region

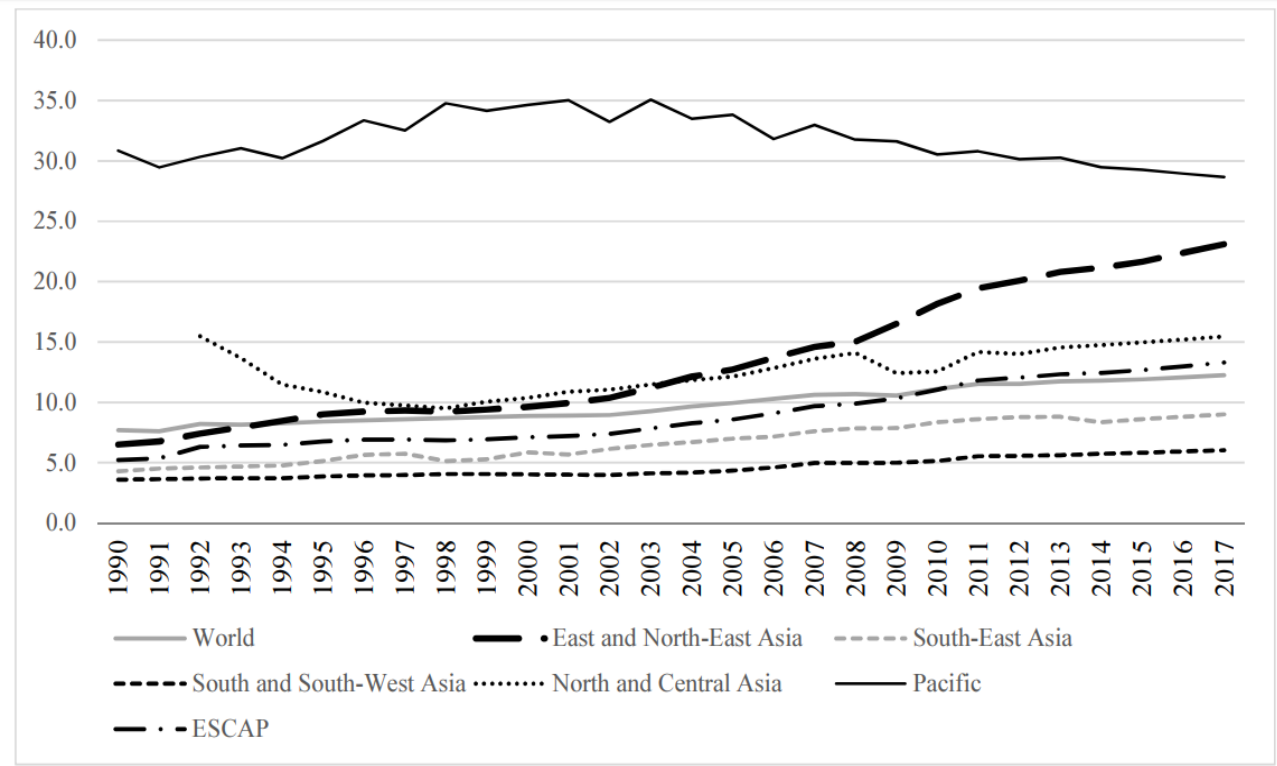



**Figure 2.10: Trends in domestic material consumption, 1990–2017 (Tons per capita)[24]**

UNESCAP (2018); Economic and Social Commission for Asia and the Pacific - Key environment issues, trends and challenges in the Asia-Pacific region

There is also a significant difference in levels of resource usage between high-income countries and other countries in the region. As per 2015 data, the plastic consumption ranges from 0.13% to 0.75% of material consumption in Asia and the Pacific region **(Figure 2.11)**,[11] an indicator of variation in resource usage. **Figure 2.5** also indicates that the region is importer of fossil fuel, the feedstock for manufacturing plastics. A positive correlation exist between GDP growth rate and plastic consumption in Asia and the Pacific region **(Figure 2.12)**. It indicates that as per capita income increases, the plastic consumption also increases.

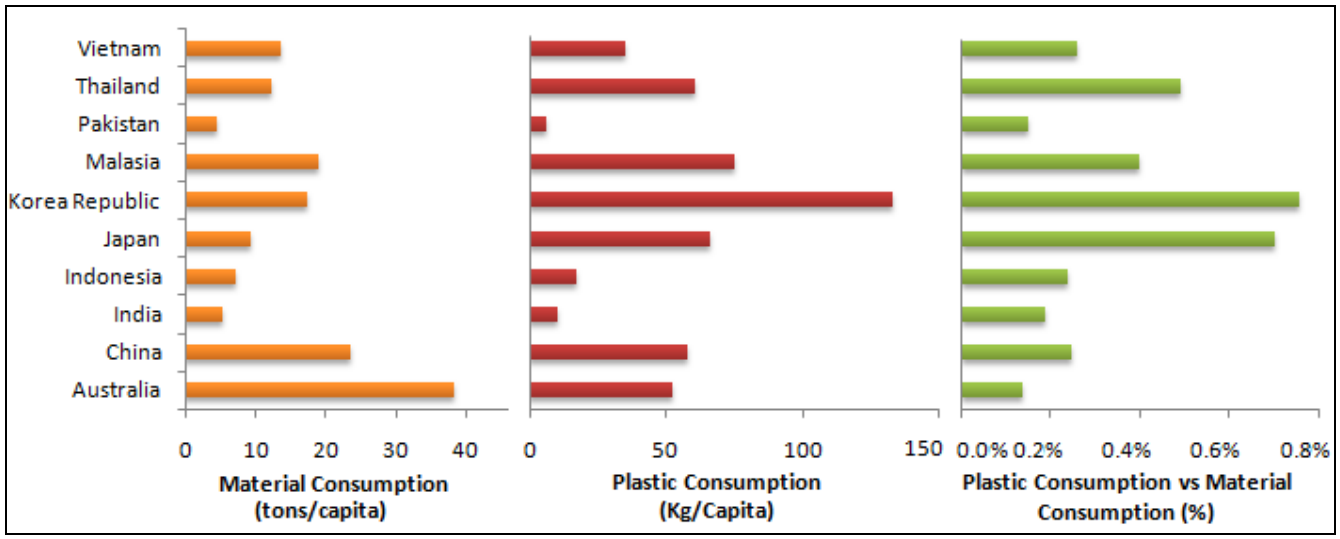



**Figure 2.11: Country wise Plastic Consumption vs Material Consumption (%) (2015)[11]**

Source: Prepared From Euromap (October 2016); Plastic Resin Production and Consumption in 63 Countries Worldwide

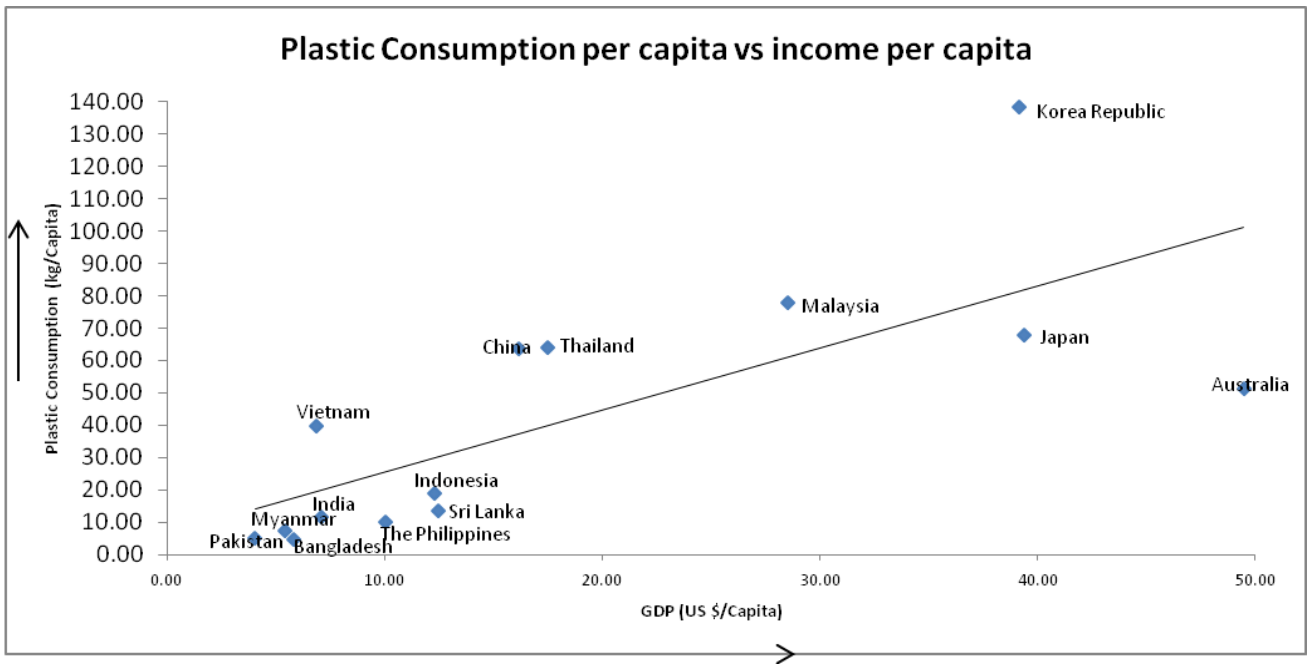



**Figure 2.12: Country wise Plastic Consumption Per Capita vs Income Per Capita[11]**

Source: Prepared From Euromap (October 2016); Plastic Resin Production and Consumption in 63 Countries Worldwide

Rapid growth rate fuelled by urbanization, expansion of manufacturing and the consumption patterns of the emerging middle class have led to an increase in demand for materials in Asia and the Pacific. Infrastructure, accounts for a significant share of resource use reflecting urbanization of the region. Increasing population **(Figure 2.13)** and converging living standards in China and to a lesser extent in India and the rest of Southeast Asia, will drive growth in the Asia and the Pacific region post 2020. GDP per capita versus projected plastic consumption from the period 2015 to 2019 in developed countries and developing countries in the region is shown in **Figure 2.14** and **Figure 2.15**.

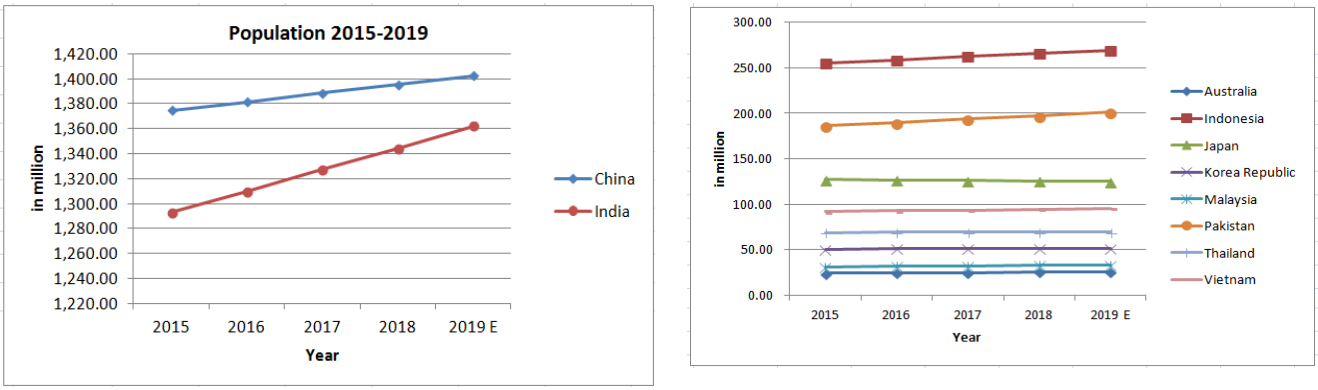
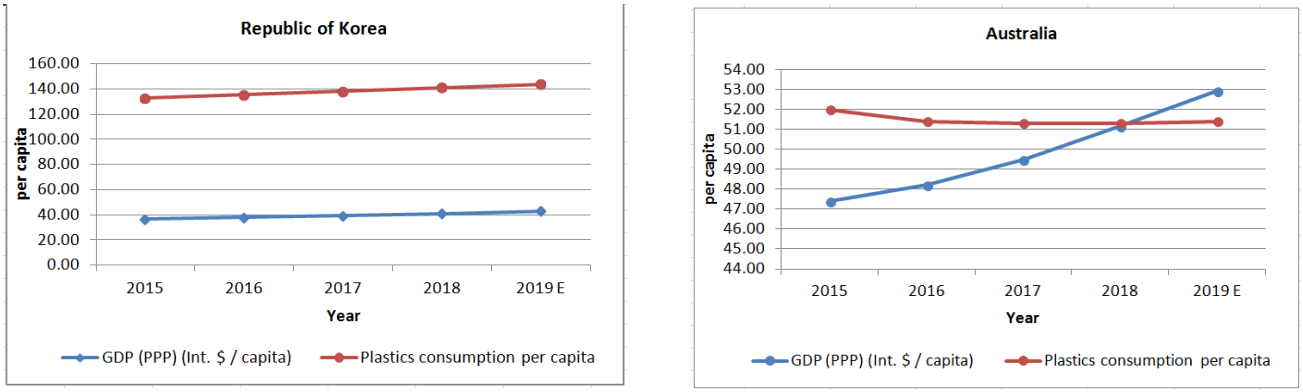



**Figure 2.13: Country wise Population 2015-2019[11]**

Source: Prepared From Euromap (October 2016); Plastic Resin Production and Consumption in 63 Countries Worldwide



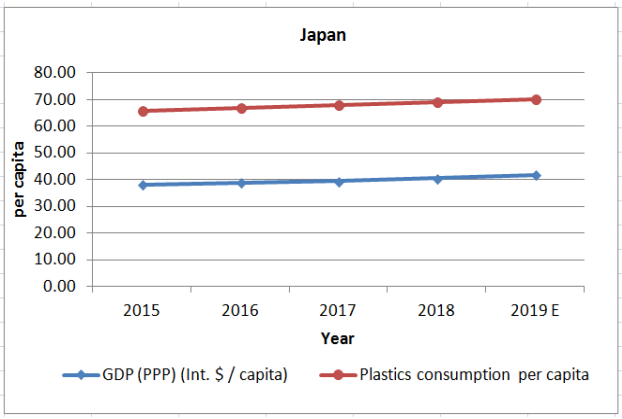
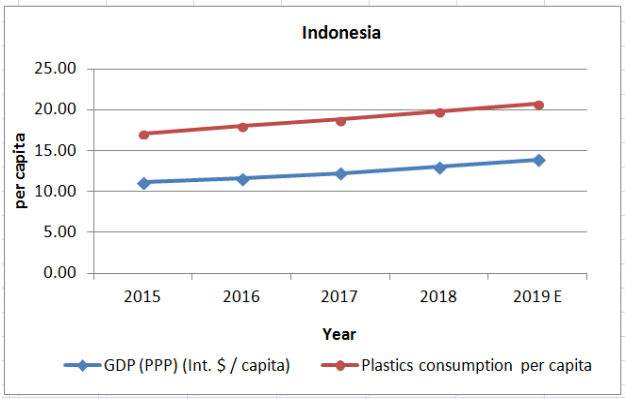
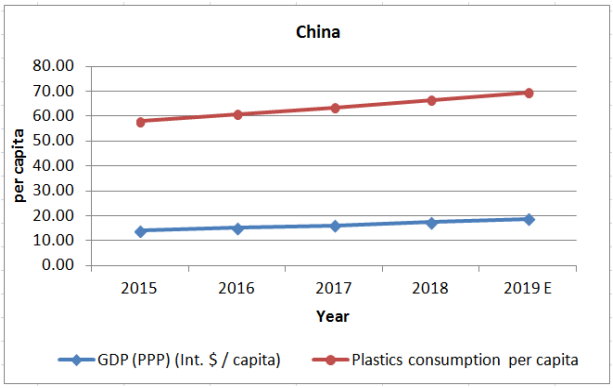
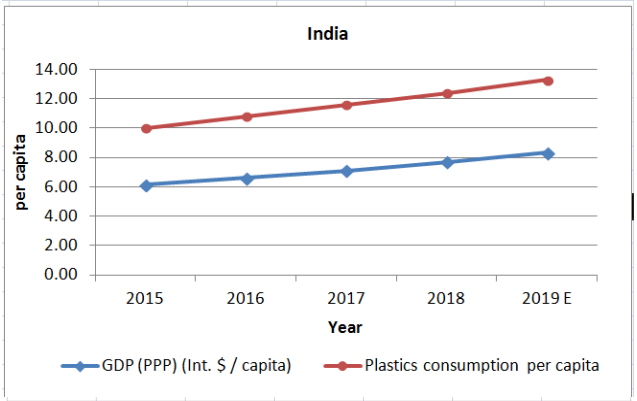


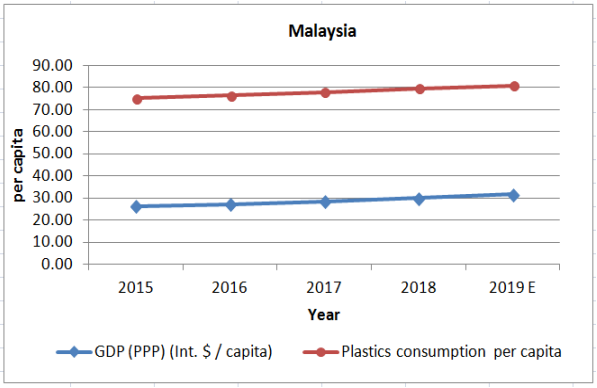

**Figure 2.14: Per Capita Income versus Per Capita Plastic Consumption in Developed Countries in the Asia and the Pacific[11]**

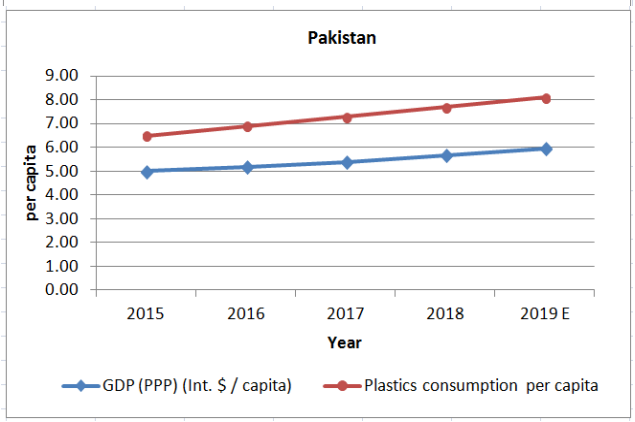
Source: Prepared From Euromap (October 2016); Plastic Resin Production and Consumption in 63 Countries Worldwide

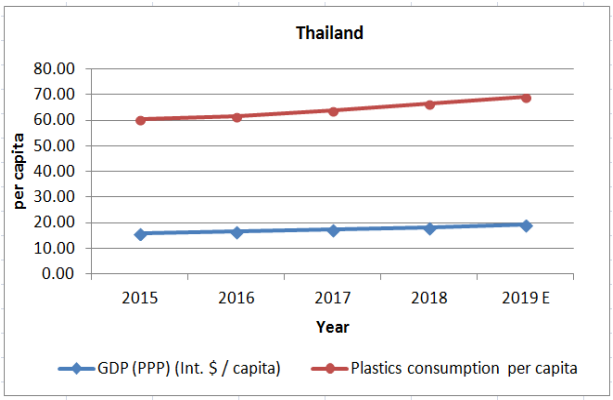


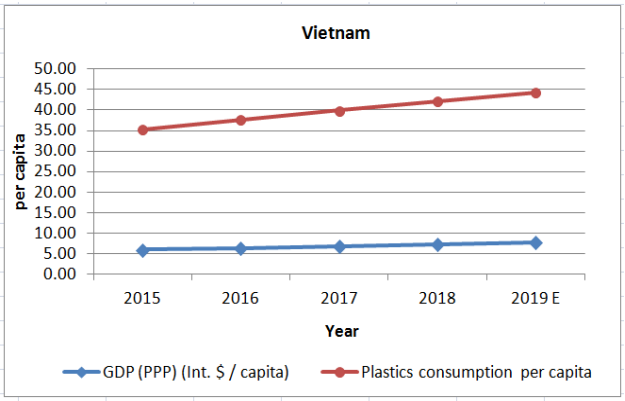



**Figure 2.15: Per Capita Income versus Per Capita Plastic Consumption in Developing Countries in Asia and the Pacific[11]**

Source: Prepared From Euromap (October 2016); Plastic Resin Production and Consumption in 63 Countries Worldwide

Per capita plastic consumption is showing an increasing trend with the increase in GDP per capita except for Australia. It is expected to be high in Republic of Korea, Malaysia, China, Japan and Thailand post 2020. In Vietnam it is expected to catch up with Australia during the same period. **Figure 2.14** also indicates per capita plastic consumption is decreasing in Australia. The partial geographical coverage of waste collection and its inefficiency in developing countries in Asia and the Pacific region results in huge amount of uncollected plastic waste. **Figure 2.2** indicates that where waste plastics enter the formal waste management system, they are either recycled, or disposed off in controlled landfill or incinerators (which may or may not recover electricity, heat or by-products). However, in communities where formal waste management systems do not exist, particularly in informal communities in low and middle income countries, a substantial proportion of waste plastics are disposed off in uncontrolled dumps, watercourses, or burned openly. Globally, around 14%-18% of waste plastics generation is collected for recycling.[14][15] Another 24% is thermally treated (e.g. by incineration, gasification or pyrolysis), while the remainder is disposed off in controlled, landfill, uncontrolled landfill, or the natural environment.[3]

A small fraction of plastic collection in both formal and informal sector goes for recycling. Various materials from different waste streams are recycled across the Asia and the Pacific region. However, there is a wide variation in terms of the relative amounts, type of waste and technology employed in the process. Developed economies, such as Japan and Singapore have achieved high rates of recycling (approximately 20% and 20% respectively) facilitated both through supportive institutional mechanisms and the utilization of different methodologies for the extraction/conversion of valuable resources. A snapshot of recycling in Asia and the Pacific is given in **Annexure 2.2**.[16] However, rate of plastics recycling is not monitored by countries in Asia and the Pacific region. Australia and Japan give an indication of the plastic recycling rate in the region.[3] The global rate of plastic recycling has increased by approximately 0.7% per annum from 1990s to the current rate of 20%.[15] Recycling rates for waste plastics differ significantly between different polymers, applications and regions. Packaging plastics, and the polymers commonly used in packaging (e.g. PET, HDPE and LDPE), represent the majority of plastics that are collected for recycling. Recycling rates for plastics from other sectors, such as automotive, construction, and electrical equipment, and for other polymers, are substantially lower. Recycling of post-industrial plastics is well-established and has been relatively stable over recent decades.[3] In contrast, recycling of post-consumer plastics is less common, but has increased steadily since the 1980s as municipal recycling schemes have developed in high income countries.[3] Plastics recycling rates **(Figure 2.16)** in Europe have steadily increased, driven by statutory targets by the European Union. Recycling rates in the United States have increased steadily but have not yet exceeded 10%.[3] Plastic recycling rate in Japan is closer to those in the European Union while Australia's recycling rate fell in between the US and European rates.[3]

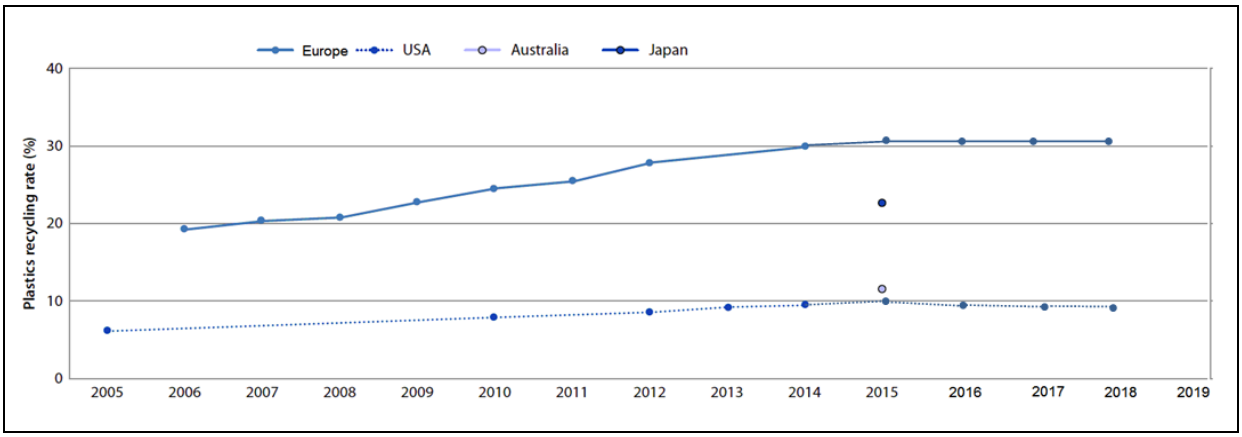



**Figure 2.16: Plastics recycling in the EU, USA, Australia and Japan (2005-15)[3]**

Source: OECD (2018) – Improving Markets for Recycled Plastics – Trends, Prospects and Policy Responses

Data for Australia provides an indicator of the relative levels of recycling for different sectors.

**Table 2.2: Australian plastics consumption by waste stream (2015/16)[3]**

| Application area | Recovery (tonnes) | Recycling rate | Polymer | Japan (Recycling rate % in 2015) |
|---|---|---|---|---|
| Packaging | 263 000 | 31.1% | PET | 85% |
| Electrical and electronic | 8 200 | 5.5% | HDPE | 16% |
| Agriculture | 4 500 | 5.3% | LDPE | |
| Automotive | 4 400 | 2.5% | PS | 21% |
| Built environment | 8 700 | 1.6% | PP | 15% |
| Other application areas | 14 100 | 2.4% | EPS | No data |
| Unidentified applications | 26 000 | 5.2% | PVC | 24% |
| **Total** | **328 900** | **11.3%** | | |

Source: OECD (2018) – Improving Markets for Recycled Plastics – Trends, Prospects and Policy Responses

In Pacific Island Countries and Territories (PICT), in situ recycling is not widely observed due to absence of recycling policy as well as their considerable distance from mainland markets, posing challenges for business-based recycling both in terms of cost and scale.

**Box – 1: Plastic Pollution in Pacific Island Nation**

Pacific Island nations bear a huge burden imposed on them by the plastic economy. They are one of the regions that contribute least to plastic pollution while being highly vulnerable to its impacts. The 30,000 Pacific islands in the region are subject to sea-bound plastic pollution originating from Pacific-rim neighbors due to the nature of ocean currents. Pacific nations lack the capacity to clean-up and dispose of this waste due to factors such as geographic isolation and dispersed and low populations. The Pacific region generate low volumes of plastic waste generated from a one-way flow of commodities into the countries and lack a large manufacturing sector. This means that the volume of any plastic material collected for recycling is low and not suited as a regular supply of secondary material for large scale overseas manufacturers. It calls for special dispensation and support in negotiation with the global community (government, industry, science and technology, donor organisations, amongst others). Further, the effects of climate change through sea-level rise, severe tropical storms and tidal surges places, in particular, low-lying Pacific Atolls at risk of having their landfills being inundated and/or washed into the ocean. This adds to marine plastic pollution with these nations having little capacity to rehabilitate these landfills, nor resources to put in place alternative solutions for managing waste. Rising sea-levels also reduces the amount of land available for all needs, including waste management. The net result of these unique circumstances is that it threatens the livelihoods of Pacific communities that are based on agriculture, fisheries and tourism and rely on a clean environment to be viable as well as their traditions and cultures that are entwined with healthy island ecosystems and biodiversity.

Source: Hall Vicki (2019); Secretariat of the Pacific Regional Environment Programme

Accordingly, countries report varying degree of collection rate: Tonga (9%) Tuvalu (15%) report relatively low rate; Fiji (57%), Samoa (36%), Vanuatu (37%) and French Polynesia (39%).[17] The plastics are collected, compacted and shipped off to other countries. Plastic recycling is a major industry in China, India, Malaysia, Indonesia and Thailand. Till 2017, China has traditionally accounted for two thirds of global trade in waste plastics. It announced in July 2017 its catalogue of solid wastes forbidden to import into China. All post consumer plastic waste was included in this ban to be effective from January 2018.[18]

Industrial-scale incinerators are often considered the technology of choice in many industrialized or developed countries.[19] It not only offers advantages with regard to the hygienic management of waste, but also due to its capacity to resolve geographical constraints associated with final disposal and its potential to provide a viable source of energy and/or heating (WtE) (Box 2). In 2018, about 42.6% of waste plastic used for energy recovery in Europe, while 15.7% in USA and 3-4% in Australia. Incineration has been recommended as one of the secondary preferred technologies after autoclaving / sterilization by UNEP.[20]

**Box – 2: Technology Options for Waste Plastics**[21]
In countries like Singapore, Japan and China, land constraints necessitate the recycling and incineration of materials in order to optimize available space for final disposal. In 2011, Singapore recycled 59% of generated waste, incinerated 38% and the remaining 3% of non incinerable waste was sent to landfill. In Japan, 80% of generated municipal solid waste is treated by incineration. In China, MSW incineration rate increased from 20% in 2010 to 35% in 2015. At the same time, the use of waste incineration is increasing in many developing countries, especially in larger cities. Thailand presently hosts 12 integrated system facilities where a combination of incineration, biological treatment and recycling are being used.

Source: Ministry of the Environment (2012); Solid Waste Management and Recycling Technology of Japan – Toward a Sustainable Society; https://www.env.go.jp/en/recycle/smcs/attach/swmrt.pdf

## 2.5 3R Efforts for Circular Economy and Environmental Implications in Asia and the Pacific

Environmental impacts of plastic pollution have started emerging relatively recently though uncertainty exists about the magnitude of the damages. Plastics disposed off in landfills break down over many hundreds of years, slowly emitting methane in the process while plastics disposed off in the natural environment, breaks down at slower rates and with carbon dioxide as the by-product. In both cases, the environmental impact is often underestimated because of the timescales involved. Thermal decomposition of plastics, either controlled or uncontrolled also results in GHG emissions. Plastics which has been disposed of into waterways has a range of detrimental effects on the aquatic life, including bioaccumulation, chemical leaching, prevention of transfer of oxygen and nutrients in the benthic zone.[22] Under business as usual scenario, an estimated 26 billion tonnes of plastics will be produced over the next ~30 years.[15] The environmental burden associated with the production, use, and eventual disposal of these plastics will tend to increase in parallel. Reducing these burdens will require greater efficiency of plastics use. Therefore, marine plastic litter is recognized as a resource efficiency problem that can be sufficiently addressed by circular economy through reduction of source.[23] This will require a change in thinking from traditional linear economic models (i.e. manufacture-use-dispose), to more circular economic models **(Figure 2.17)**, whereby, the use of plastics is optimised (e.g. through product redesign and light-weighting), and plastics are kept within the use cycle for longer, through reuse and recycling.

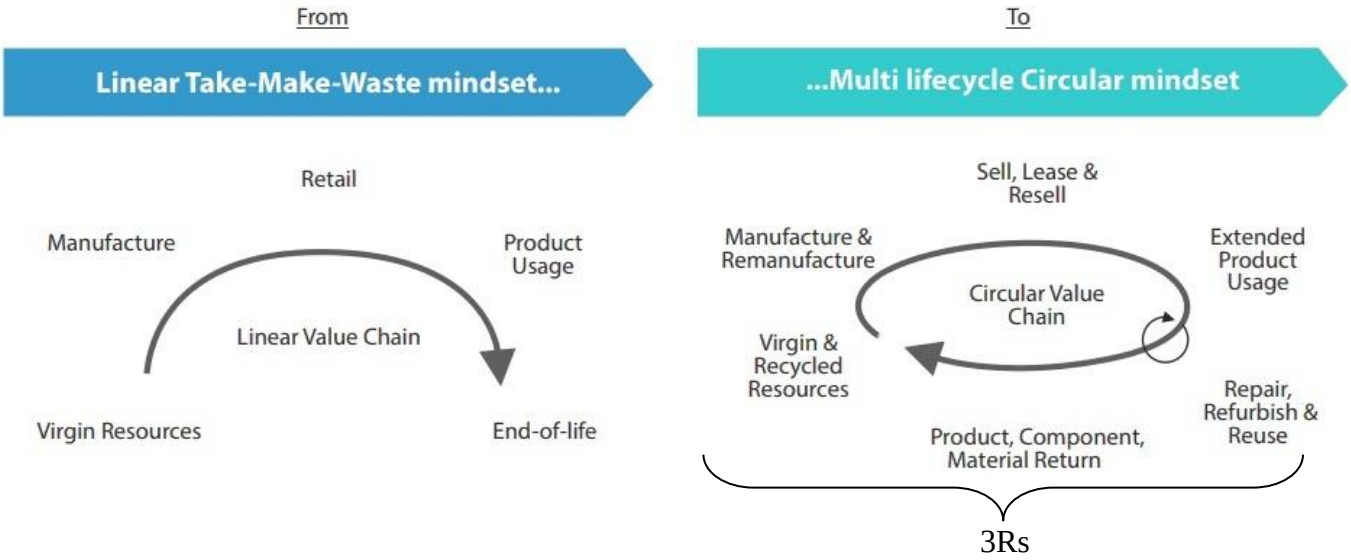



**Figure 2.17: Adopting circular business models - a shift in mindset[33]**
Source: FICCI Circular Economy Symposium (2018); Accelerating India's Circular Economy Shift

Use of secondary raw material produced through recycling is an important pillar of circular mindset. An example of environmental implication of this mindset can be demonstrated through GHG reduction which can be achieved on account of energy conservation by recycling of plastics (Box 3). Therefore, there is a need for increasing the demand for recycled plastics designing for recyclability, keeping plastic out of one environment & closing the loop through chemical recycling.[25] However, recycled plastics compete in price with virgin plastics, which are much cheaper due to market volatility and policy misalignments e.g. government support for hydrocarbon inputs in different countries.

**Box – 3: Energy Conservation and GHG Reduction Due to Plastic Recycling**
Major GHG emissions associated with the plastics lifecycle results from the production of virgin polymer. Large amounts of energy are required to refine the fossil fuel like crude oil, crack the distilled constituents into monomers, and then synthesise the base starting materials. This process is highly energy-intensive, and was estimated to account for 400 million tonnes of greenhouse gas emissions (around 1% of the global total) in 2012. The fossil fuel feedstock used in plastics production accounts for an additional 4% of global oil and gas production.[8] Recycling of plastics avoids 80% of use energy,[19] as shown in **Table 2.3**.

**Table 2.3: Impact of Production and Transport Activities on Plastics Recycling**

| Activities | Virgin plastics | Recycled plastics |
|---|---|---|
| Energy consumption due to production | 84 MJ/kg | 7.97 MJ/kg |
| Energy consumption due to local transportation (recycling) | None | 0.85 MJ/kg |
| Energy consumption due to export transportation (recycling) | None | 1.53 MJ/kg |
| Atmospheric emission (CO2) due to production | 6 kg/kg | 3.5 kg/kg |
| Atmospheric emission (CO2) due to local transportation (recycling) | None | 0.10 kg/kg |
| Atmospheric emission (CO2) due to export transportation (recycling) | None | 0.13 kg/kg |

Conceptually, 3Rs being an integral part of circular minset **(Figure 2.17)** offers a viable policy option to reduce material intensity in Asia and the Pacific region. In this regard, the implementation of Hanoi 3R Goals in the region offers significant potential to achieve resource efficiency.[25] The status of their implementation between 2011-15 in Asia and the Pacific region indicates that total MSW generation and MSW per capita increased in most countries (Goal 1). At the same time, recycling rates in the region improved between the years 2000 and 2015 **(Annexure 2.2)**, suggesting that 3R-related efforts

focused on waste management are being successfully implemented by a number of countries, both in terms of legislation and policy development, as well as actions taken specifically within large cities (Goals 1 and 3). However, recycling activities in many countries are still widely conducted by the informal sector with environmentally unsound technologies. Total direct material consumption and waste generation volumes show an increasing trend across the region (Goal 1 and 17) whilst resource productivity has been steadily improving in a number of countries (Goal 17). Certain countries, such as Bangladesh and India, have enacted bans on plastic carry bags to prevent flooding resulting from clogged drainage systems and maintain clean cityscapes by reducing waste at source. However, concrete actions taken at the national level remain limited in most countries (Goal 12).[23] Several countries are advancing GHG mitigation efforts through landfill diversion and the use of intermediate waste treatment approaches (Japan, China, and Singapore). This requires a careful evaluation of different waste treatment approaches and methodologies from not only the perspective of GHG emission reduction potentials but also of other environmental, economic and social aspects (Goal 19). Although the region saw an average reduction in resource intensity in 2010 and in 2017, this progress was not uniform across Asia and the Pacific. Between 2010 and 2017, economic growth recoupled with domestic material consumption in about 30% of countries implying higher material resource use in these countries per unit of economic output produced over that period.[26]

The evaluation of the intermediate waste treatment approaches will establish main linkages between economic activity, materials use and environmental pressures (Box 4). Therefore, a granular approach is needed to understand which 3R policy intervention may improve resource efficiency at the sectoral level, and how major environmental consequences may be avoided in each country and the entire Asia and the Pacific region.

**Box – 4: Case Study 1: Plastic Recycling, a circular economy opportunity of India**[25]

Annual plastic waste generation in India is about 5.6 million tonnes. About 60% of this waste is collected by both formal and informal sector. About 46% of this waste is treated while 11% is used for energy recovery. Therefore, 40% of the uncollected waste, which is dumped into landfills offers huge opportunity for achieving environmental and socio-economic benefits. One ton of plastic recycling is expected to save about 1.7 $km^2$ of landfill area. Further, it can also create 1.39 million incremental jobs in plastic recycling industry[19].

Source: FICCI Circular Economy Symposium (2018); Accelerating India's Circular Economy Shift

A conceptual plastic value chain evaluation in the context of Asia and the Pacific region gives an understanding of plastic waste management. It starts from material engineering for plastic and leads to its production followed by its consumption, collection, recycling and repurposing and finally its conversion and disposal.

Asia and the Pacific region is the most resource-intensive region in the world, both in terms of domestic material consumption and material footprint. In the sub regions, the Pacific has the highest per capita domestic material consumption, followed by East and North-East Asia.

World's plastics production in 2017 stood at 348 million tonnes. About 174 million tonnes (50%) of plastic was produced in Asia. China, Japan and rest of Asia accounted for 29.4%, 3.9% and 16.8% of plastic production respectively. Under business as usual scenario, an estimated 26 billion tonnes of plastics will be produced over the next ~30 years. The environmental burden associated with the production, use, and eventual disposal of these plastics will tend to increase in parallel.

The plastic consumption ranges from 0.13% to 0.75% of material consumption in the region which is an indicator of variation in resource usage. The region is importer of fossil fuel, the feedstock for manufacturing plastics. Republic of Korea ranks first in per capita plastic consumption followed by Malaysia, Japan, Thailand, China, Australia, Vietnam, Indonesia, India and Pakistan. Per capita plastic consumption of China, Japan and Thailand is expected to converge by 2020, while Australia is expected to experience decline during the same period.

A positive correlation exist between GDP growth rate and plastic consumption in Asia and the Pacific region. Per capita plastic consumption is showing an increasing trend with the increase in GDP per capita except for Australia. It is expected to be high in Republic of Korea, Malaysia, China, Japan and Thailand after 2020. In Vietnam it is expected to catch up with Australia during the same period. Per capita plastic consumption is decreasing in Australia.

Inefficiencies in waste management in developing countries in Asia and the Pacific region results in huge amount of uncollected plastic waste. The current plastic waste disposal practices result in mismanagement of waste leading to their leakage into natural drainage system and finally oceans. About 1.15 and 2.41 million tonnes of plastic currently flows from the global riverine system into the oceans every year. About 15 from the top 20 polluting rivers are located in Asia. These 20 rivers accounted for more than two thirds (67%) of the global annual input while covering 2.2% of the continental surface area and representing 21% of the global population. The amount of plastic waste entering the ocean from Asia and The Pacific region ranges from 2.3 to 6.4 million tonnes in 2030.

The proportion of mismanaged plastic waste is very less in Australia, New Zealand, Japan, the Republic of Korea and Hong Kong Special Administrative Region of the People's Republic of China, Special Administrative Region of China. Developed economies, such as Japan and Singapore have achieved high rates of recycling (approximately 20% respectively) facilitated both through supportive institutional mechanisms and the utilization of different treatment methodologies / technologies, extraction/conversion of valuable resources. Plastic recycling rate in Japan is closer to those in the European Union while Australia's recycling rate fell in between the US and European rates. Plastic recycling is a major industry in China, India, Malaysia, Indonesia and Thailand. Energy recovery / incineration is being widely used globally. Till 2017, China has traditionally accounted for two thirds of global trade in waste plastics till it announced ban on import in July 2017.

In Pacific Island Countries and Territories (PICT), in situ recycling is not widely observed due to absence of recycling policy as well as their considerable distance from mainland markets, posing challenges for business-based recycling both in terms of cost and scale.

Reducing environmental burdens will require greater efficiency of plastics use. This will require a change in thinking from traditional linear economic models (i.e. manufacture-use-dispose), to more circular economic models, whereby, the use of plastics is optimised (e.g. through product redesign and light-weighting), and plastics are kept within the use cycle for longer, through reuse and recycling.

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# Chapter 3: Status of Plastic Waste

## 3.0 Introduction

Asia and the Pacific region are experiencing increased waste generation. The rapid population growth coupled with fast urbanization is catalyzing higher consumption of resources, which in turn is driving the increased waste generation in the region. However, the mismanagement of waste is resulting in increased pressure on finite natural resources, terrestrial, aquatic and marine ecosystem of the region. The emergence and rapid growth of plastic waste stream is a major concern, which needs to be addressed in the region.[1] This chapter describes the current status of plastic waste, the future implications, its management particularly using 3R approach and existing gaps and barriers.

## 3.1 Plastic Waste in Asia and the Pacific

Asia, with a population of more than 4.45 billion (2016), recorded a huge amount of waste generation, making it the largest waste-producing continent on earth.[1] Per capita waste generation rate, treatment and disposal options in the region have been described in **Table 3.1**. **Table 3.1** shows that per capita MSW generation in the region varies from 0.21 to 0.37 tonnes per year. Majority of plastic waste, which comes mixed with solid waste ranges from 0.02 to 0.04 tonnes per capita per year. About 55 to 74% of the municipal solid waste is disposed off at disposal sites with zero to 26% being incinerated and 1 to 5% composted.[1]

**Table 3.1: MSW Generation and Treatment Data in Asia and the Pacific Region[1]**

| Region | MSW Generation Rate (tonnes/ capita/year) | MSW disposed at disposal sites (%) | MSW Incinerated (%) | MSW Composted (%) | Other MSW management, un-specified (%) |
|---|---|---|---|---|---|
| Eastern Asia | 0.37 | 55% | 26% | 1% | 18% |
| South-Central Asia | 0.21 | 74% | - | 5% | 21% |
| South-East Asia | 0.27 | 59% | 9% | 5% | 27% |

Source: Asia Waste Management Outlook - United Nations Environment Programme, 2017

**Table 3.2** describes the waste generation and composition in selected Pacific islands. The per capita waste generation per year in the Pacific islands shows huge variation and ranges from 0.036 to 0.693 tonnes. Plastic constitutes about 5 to 25% of the total waste composition.[2]

**Table 3.2: Waste Generation and Composition in Selected Pacific Island Countries and Territories[2]**

| Country/ Territory | State or municipality | Year | Data source | Waste Generation Rate | | | | Comment on 'other residues' |
|---|---|---|---|---|---|---|---|---|
| | | | | Household waste (kg/p/day) | Commercial waste | Total urban MSW (kg/p/day)A | Plastic (%) | |
| American Samo | Tutuila Island | 2011 | (Busche et al. 2011) | | | 1.0 | 12.8 | Disposable nappies = 5.1% |
| FSM | Pohnpei | 2011 | B | 0.1 | | | 25.0 | |
| | Yap | 2011 | B | 0.5 | | | 37.2 | |
| | Chuuk | 2011 | B | 0.2 | | | 22.5 | |
| | Kosrae | 2011 | B | 0.1 | | | 20.0 | |

| Country/ Territory | State or municipality | Year | Data source | Waste Generation Rate | | | | Comment on 'other residues' |
|---|---|---|---|---|---|---|---|---|
| | | | | Household waste (kg/p/day) | Commercial waste | Total urban MSW (kg/p/day)A | Plastic (%) | |
| Fiji | Nadi | 2008 | (JICA 2009) | 0.4 | | 1.9 | 7.1 | |
| | Lautoka | 2008 | (JICA 2009) | 0.4 | | 1.1 | 7.9 | |
| French Polynesia | All | 2012 | (Murzilli et al. 2012) | 1.2C | | | | |
| Marshall Islands | Majuro | 2014 | B | 0.4 | | 1.1 | 12.5 | Disposable nappies = 10.5% |
| PNG | Port MoresbyD | 2014 | (NCDC 2014) | 0.36 | 0.09 kg/m2/day | | 18.5 | |
| Samoa | Vaitele | 2011 | B | 0.4 | 0.01 kg/m2/day | | 13.0 | Disposable nappies = 15.1% |
| Solomon Islands | HoniaraD | 2011 | B | 0.9 | 0.09 kg/p/day | | 19.5 | Disposable nappies = 5.7% |
| | Gizo | 2011 | B | | | | 25.2 | |
| Tonga- Vava'u | Vava'u | 2012 | B | 0.5 | | | 13.4 | |
| Vanuatu | Port VilaD | 2011 | B | 0.4 | | | 7.9 | |
| | Luganville | 2014 | (O'Reilly, 2014) | 1.2 | 0.18 kg/p/day | 1.3 | 5.0 | |
| Unweighted Mean | | | | 0.5 | | 1.3 | 16.5 | |

Legend: A: Municipal solid waste includes household, commercial and institutional waste
B: Waste characterisation studies completed as part of the J-PRISM Project
C: Includes green waste and special collections
D: Data represents the unweighted average of low-, middle- and high-income areas
Source: SPREP (2016); Cleaner Pacific 2025; Pacific Regional Waste and Pollution Management Strategy (2016-2025)

**Table 3.1** and **Table 3.2** indicates huge variation in plastic waste generation and composition. Further, it also indicates variation in definition of waste across the region. The huge variation in waste generation can be explained by the strong correlation, which exists between per capita waste generation and the income level of a country.[1] **Figure 3.1** indicates this correlation between gross national income (GNI) and waste generation in some countries in Asia and the Pacific region. The higher the per capita GNI (gross national income), the higher is the per capita MSW generation. Such trends also correlate to the plastic intensity of Asia and the pacific region described in chapter 2. Similar trends have also been observed at city level in the region.[1]

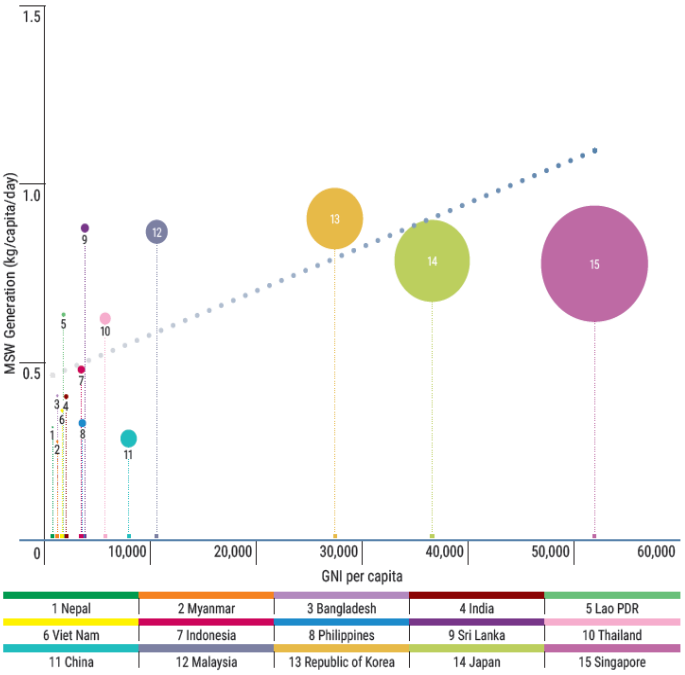


**Figure 3.1: MSW Generation Related to GNI Per Capita in Selected Asian Countries[1]**
Source: UNEP/AIT/ISWA (2017); Asia Waste Management Outlook

Trends of waste generation in Asia and the Pacific region are similar to global waste generation. **Figure 3.2** indicates such trends in South Asia, East Asia and the Pacific. The waste generation trend is expected to grow rapidly till 2030 and will stabilize beyond 2050.[1] This trend also strongly correlates with material intensity trends for the region as described in Chapter 2.

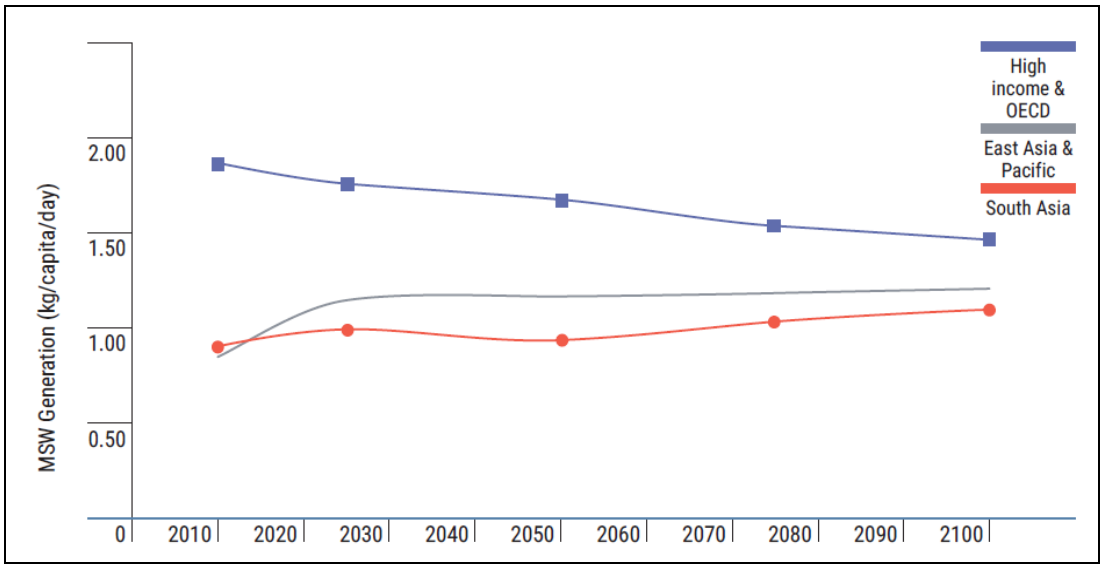


**Figure 3.2: Forecasted MSW Generation Per Capita Across Different Regions, 2010–2100[1]**
Source: UNEP/AIT/ISWA (2017); Asia Waste Management Outlook

**Table 3.3** describes the percentage of plastic waste in eleven countries, which are majorly contributing to marine litter and plastic pollution in Asia and the Pacific region. Plastic constitutes about 7.35 to 18% of the municipal solid waste in the region.[3] Source segregation of waste is less than 50% in six countries, while it ranges from 50-70% in other countries. Percentage of plastic recycled also show the similar trend, though it does not indicate the type of plastics recycled i.e. single use or all types of plastics. Uncertain events such as lockdowns during COVID-19 pandemic increased the demand for online shopping, and home deliveries of food and other necessities, leading to significant growth in organic and inorganic wastes generated from households (Zambrano Monserrate, Ruano, & Sanchez-Alcalde, 2020).[9] Online food purchased increased by 92.5% and for other products like masks by 44.5% in Republic of Korea (Cho, 2020). Demand for online shopping has also increased in Vietnam (57%), India (55%) & China (50%), which is resulted in the proliferation of single use plastic as packaging (Sharma, et. Al., 2020).[10] The volume of waste and recyclables generated from residential areas have increased owing to the rise in home deliveries and demand for PPEs such as face masks and gloves (Kulkarni & Anantharama, 2020).[11] Single-use plastics have become once again the default material of choice in many establishments (food delivery services and e-commerce) as a COVID-19 precaution. Further, the national reporting varies from country to country considering differences in the definition of recycling rate.[3] The difference in definition is visible in **Table 3.4**, where recycling rate has been used in the context of exports in Pacific island countries.

**Table 3.3: Plastic Waste in Countries in Asia and the Pacific Region[3]**

| Country | Total MSW Generation (Million tonnes) | Source Segregation (%) | Plastic (%) | Plastic Recycling (%) |
|---|---|---|---|---|
| Bangladesh | 8.6 (2014) | <50% (2018) | 7.35 | >70% (2018) |
| China | 480 (2013) | <50% | >10% | <50% |

| Country | Total MSW Generation (Million tonnes) | Source Segregation (%) | Plastic (%) | Plastic Recycling (%) |
|---|---|---|---|---|
| India | 55 | 70% | 8-12% | >70% (2018) |
| Indonesia | 65.03 (2015) | <50% (2018) | 14% | <50% (2018) |
| Malaysia | 12.8 (2014) | 50-70% (2018) | 25.2% | >70% (2018) |
| Myanmar | 0.84 (2014) | 50-70% (2018) | 17.7% | >70% |
| Pakistan | 48 (2016) | <50% (2019) | 9% | 50 - 60% (2019) |
| Sri Lanka | 2.5 | 50-70% (2019) | 10% | 50 - 60% (2019) |
| Thailand | 27.37 (2017) | <50% (2019) | 18% | >70% (2019) |
| The Philippines | 14.63 (2016) | 50 - 70% (2019) | 10.55% | >90% (2019) |
| Vietnam | 19 (2015) | <50% (2018) | 10% | >70% (2018) |

Source: Country reports, 3R Forum, 2013, 2014, 2015, 2016, 2017, 2018 and 2019; http://www.uncrd.or.jp/index.php?menu=389

**Table 3.4: Recycling Rate in Selected Pacific Island Countries and Territories[2]**

| Country/ Territory | Potentially recyclable waste (tonnes) | Amount exported or recycled/reused locally | | Quantity landfilled or dumped (tonnes) | Data source | Comments |
|---|---|---|---|---|---|---|
| | | (tonnes) | (%) | | | |
| Fiji | 66,788 | 38,081 | 57% | 28,707 | 1 | End-of-life vehicles, white goods, cans, PET bottles, paper and cardboard |
| Samoa | 13,308 | 4,741 | 36% | 8,567 | 1 | As above |
| Tonga | 6,567 | 598 | 9% | 5,969 | 1 | As above |
| Tuvalu | 685 | 103 | 15% | 582 | 1 | As above |
| Vanuatu | 12,591 | 4,642 | 37% | 7,949 | 1 | As above |
| French Polynesia | 16,300 | 6,300 | 39% | 10,000 | 2 | Cans, PET bottles, paper and cardboard, glass |
| Total | 116,239 | 54,465 | 47% | 61,774 | - | - |

Note: [1] JICA. 2013. Data collection survey on reverse logistics in the Pacific Islands: Final report. JICA. [2] Completed country profile questionnaire submitted by Department of Environment (DIREN)
Source: SPREP (2016); Cleaner Pacific 2025; Pacific Regional Waste and Pollution Management Strategy (2016-2025)

Post-consumer plastics waste includes all plastic items including single use having short life cycle and others having long end of life. They arise from domestic activities, such as food packaging, or other consumable goods, as well as commercial sources and through agriculture and construction. Increasingly, plastics are used in the construction activities and manufacture of electrical equipment, further complicating their separation, collection, treatment and disposal.[4] **Figure 3.3** shows the distribution of plastics waste generation across eight important product categories at global level.[4]

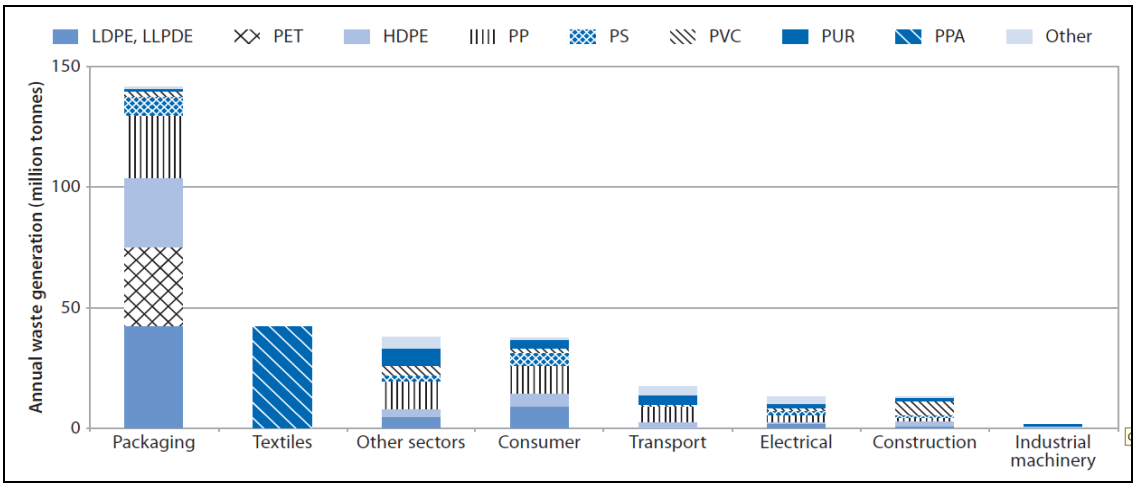


**Figure 3.3: Global plastics waste generation (million tonnes) by product category in 2015[4]**
Source: OECD (2018); Improving Markets for Recycled Plastics: Trends, Prospects and Policy Responses

Polyethylene (HDPE and LDPE) and Polypropylene are most common polymers found in the waste stream, which account for 40-50% of the waste plastics produced in Asia and the Pacific region. A number of beach cleanup efforts in Asia and the Pacific region not only indicate the magnitude but also diversity of the problem and confirm the dominance of packaging and single use plastic waste in the region. This is due to the widespread use of packaging plastics and single use items, which are often discarded soon after they are purchased. Low segregation rate of mixed plastic waste further adds to the complexity of their treatment and disposal in the region.[4]

## 3.2 Institutional Stakeholders

At institutional level, urban local bodies (ULBs) as well as private sector (formal and informal) are involved in collection, transportation, treatment and disposal of MSW and plastic waste in Asia and the Pacific region.[5] **Table 3.5** and **Table 3.6** indicate the institutional structure for MSW management with plastic waste as its subset in the region. Policies and regulations related to MSW and Plastic waste are formulated by the nodal ministry in each country while plan, program and projects are formulated by both nodal ministry and as well as local governments (ULBs) in respective country.

**Table 3.5: Municipal Solid Waste (MSW) [5]**

| Country | Roles of Stakeholders | | | |
|---|---|---|---|---|
| | Regulator | ULBs | Private Sector (Formal) | Private Sector (Informal) |
| Indonesia | √ ($P_1$, R) | √ ($P_2$, $P_3$, $P_4$) | ($P_4$) (Collection, Transportation and Disposal) | √ (Collection, Transportation and Disposal) |
| Malaysia | √ ($P_1$, R) | √ ($P_2$, $P_3$, $P_4$) | √ ($P_4$) (Collection, Transportation and Disposal) | √ (Collection, Transportation and Disposal) |
| Myanmar | √ ($P_1$, R) | √ ($P_2$, $P_3$, $P_4$) | ($P_4$) | √ (Collection, Transportation and Disposal) |
| The Philippines | √ ($P_1$, R) | √ ($P_2$, $P_3$, $P_4$) | Limited ($P_4$) | √ (Collection, Transportation and Disposal) |
| Thailand | √ ($P_1$, $P_2$, $P_3$, R) (Ministry of | √ ($P_4$) | √ ($P_4$) (Recycling and Disposal) | √ (Collection, Transportation and |

| Country | Roles of Stakeholders | | | |
|---|---|---|---|---|
| | Regulator | ULBs | Private Sector (Formal) | Private Sector (Informal) |
| | Natural Resource and Environment) | | | Disposal) |
| Vietnam | √ ($P_1$, R) | √ ($P_2$, $P_3$, $P_4$) | (Collection, Transportation and Disposal) ($P_4$) | √ (Collection, Transportation and Disposal) |

Note: $P_1$ – Policy, $P_2$ – Programme, $P_3$ - Plan/Strategy, $P_4$ – Project, R – Regulations and Standard, √ Yes
*Source*: UNEP / IETC (2016); Waste Management in ASEAN Countries

**Table 3.6: Plastic Waste Streams[5]**

| Country | Roles of Stakeholders | | | |
|---|---|---|---|---|
| | Regulator | ULBs | Private Sector (Formal) | Private Sector (Informal) |
| Indonesia | √ ($P_1$, $P_2$, $P_3$, $P_4$, R) | √ ($P_4$) | | √ (Collection, Transportation and Disposal) |
| Malaysia | √ ($P_1$, $P_2$, $P_3$, $P_4$, R) | √ ($P_4$) | √ ($P_4$) (Collection, Transportation and Disposal) | √ (Collection, Transportation and Disposal) |
| Myanmar | √ ($P_1$, $P_2$, $P_3$, $P_4$, R) | √ ($P_4$) | | √ (Collection, Transportation and Disposal) |
| The Philippines | √ ($P_1$, $P_2$, $P_3$, $P_4$, R) | √ ($P_4$) | | √ (Collection, Transportation and Disposal) |
| Thailand | √ ($P_1$, $P_2$, $P_3$, $P_4$, R) (Ministry of Natural Resource and Environment, Ministry of Health and Ministry of Industry) | √ ($P_4$) | √ ($P_4$) (Collection, Transportation and Disposal) | √□(Collection, Transportation and Disposal) |
| Viet Nam | √ ($P_1$, $P_2$, $P_3$, $P_4$, R) | √ ($P_4$) | √ ($P_4$) (Collection, Transportation and Disposal) | √□(Collection, Transportation and Disposal) |

Note: $P_1$ – Policy, $P_2$ – Programme, $P_3$ - Plan/Strategy, $P_4$ – Project, R – Regulations and Standard, √ Yes
*Source*: UNEP / IETC (2016); Waste Management in ASEAN Countries

An analysis of the solid waste as well as plastic waste institutional structure indicates that multiple agencies both at national and city level with strong presence of informal sector further exacerbate the existing regulatory compliance and management (segregation, treatment and disposal) issues in the region.

## 3.3 3R Approach and Achievement in Asia and the Pacific

The need to conserve resources for a low carbon economy and to properly manage various waste streams for environmental protection as well as convert them as resource material, the waste hierarchy presents a preferential or ordered list of management practices that guides the formulation of policies and programs on waste management.[6] The concept of 3R (Reduce, Reuse and Recycle) is generated around in 1990, and these ideas have taken root in the society as an effective measure against waste problems. The waste hierarchy prioritizes practices that prevent the generation of waste, followed by the 3Rs (reduce, reuse and recycle) and waste treatment before final disposal. Conceptually, the principle of reducing waste, reusing and recycling

resources and products is often referred to as the "3Rs." The highest priority goes to “Reduce”, and then “Reuse” and lastly, “Recycle”. The term “3R” is an acronym standing for these three words. Reducing means choosing to use things with care to reduce the amount of waste generated. Reusing involves the repeated use of items or parts of items which still have usable aspects. Recycling implies recovering and using waste itself as a resource. Literature cites that waste minimization can be achieved in an efficient way by focusing primarily on the first of the 3Rs, "reduce," followed by "reuse" and then "recycle".[6] **Figure 3.4** describes the conceptual 3R approach as part of the waste hierarchy. It illustrates the circulation flow of resources, production and disposal to explain the principle of “3R plus”. The right part shows the conventional idea of “3R” and the left part shows the new concept of “3R plus” with the explanation of Renewable and Recovery. Globally, Japan is one of the countries in Asia and the Pacific region, which has demonstrated establishing a sound material society based on 3Rs. This example of successful demonstration had catalyzed the launch of the Regional 3R Forum in Asia and the Pacific in 2009. It was at the 4th Meeting of the Regional 3R Forum in Ha Noi, Viet Nam in March 2013 that the countries agreed on the Ha Noi 3R Declaration which proposed 33 goals and their indicators – Sustainable 3R Goals for Asia and the Pacific for 2013-2023 (Ha Noi 3R Goals). As a result, corresponding indicators were developed to monitor the progress of implementation of each goal in Asia and the Pacific region.[7] **Annexure 3.1** describes monitoring indicators in the current context of solid waste and plastic waste management. The 3R Forum also provides a knowledge sharing platform for disseminating and sharing 3R best practices, including new and emerging waste management concerns. **Table 3.7** summarizes progress in policy readiness for related Ha Noi 3R goals, while **Annexure 3.2** describes specific items supporting **Table 3.7** viz, “Reference on waste management in its basic environmental policy”; “Waste management law”; “Framework strategy and law on resource circulation and the 3 Rs”; and “The law for recycling and take-back scheme for specific end of life products” in major countries in Asia and Pacific region.[8]

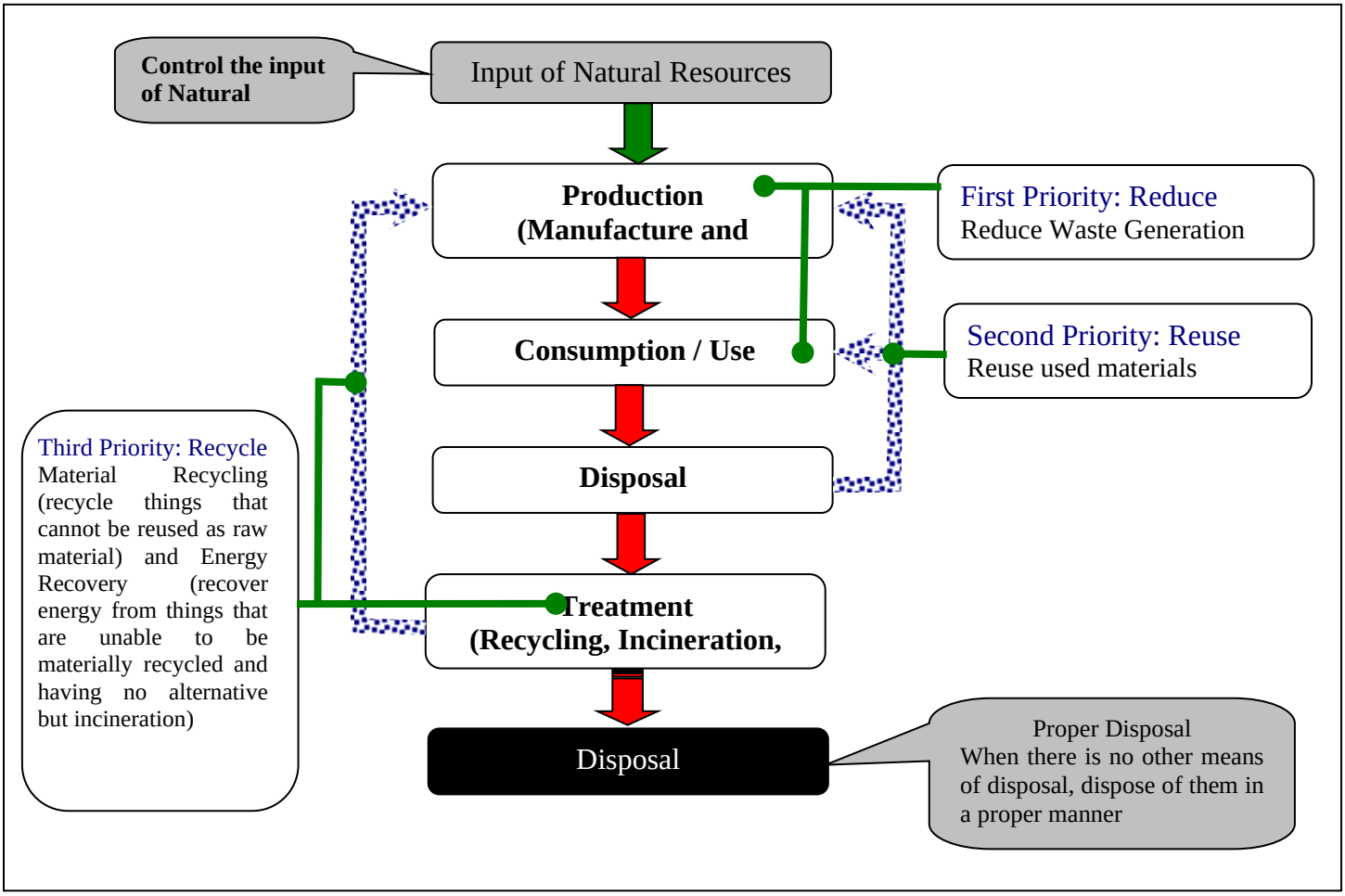


**Figure 3.4: Concept of 3Rs[6]**

Source: UNCRD/IGES/MoEJ (2018); Regional 3R Forum in Asia and the Pacific; State of 3Rs in Asia and the Pacific

The application of this approach and beyond can address the plastic pollution & marine litter. Reduce, also called as waste prevention, is an idea of reducing waste generation. This should be the top priority action for plastic waste reduction. The approach must be taken in the first place also for the prevention of environmental pollution by plastic waste. It is important to develop prevention measures based on this idea. For example, we can reduce the amount of waste through following measures: (1) a long-term use of plastic products, (2) use my bags and my bottles in place of plastic bags and PET bottles, (3) make thin PET bottles for less usage of raw materials, and (4) use heat-proof containers instead of (unnecessary) plastic wrap for microwave cooking.

The conventional concept of "3R" is not enough for more effective prevention of marine pollution by plastics and micro plastics, effective prevention of greenhouse gas emission as well as effective use and preservation of fossil resources. In addition to Reduce, Reuse, and Recycle, it is required to adopt the perspectives of Renewable and Recovery. Currently, we depend on various kinds of fossil resources for products including plastic materials. So, it is desirable to use these exhaustible resources as little as possible. It is required to shift the way to the use of renewable resources such as plant resources. The term "Recovery" includes the meanings of both energy recovery and plastic recovery from the marine environment. The application of this approach is given in **Figure 3.5**.

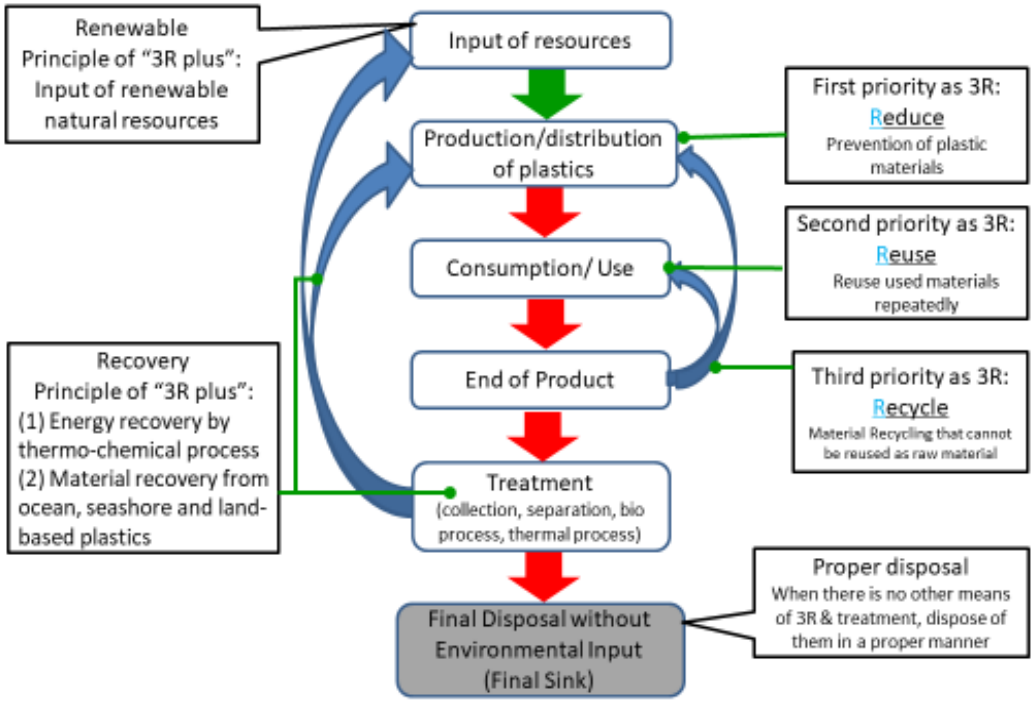


**Figure 3.5: "3R Plus" Concept with Renewable and Recovery Principles for Plastic Materials**

Source: UNCRD/IGES/MoEJ (2018); Regional 3R Forum in Asia and the Pacific; State of 3Rs in Asia and the Pacific

**Table 3.7: Progress in Policy Readiness for Related Ha Noi 3R Goals[6]**

| Ha Noi Goals | Country | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Bangladesh | China | India | Indonesia | Malaysia | The Philippines | Thai land | Viet Nam | Palau |
| Goal 1(MSW) | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓ | ✓✓✓ |
| Goal 3 (RR) | ✓✓✓ | ✓✓✓ | ✓✓✓ | – | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓ | ✓✓✓ |
| Goal 9 (HW) | ✓ | ✓✓✓ | ✓✓✓ | ✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓ | ✓ |
| Goal 11(Agri.) | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | ✓✓✓ | – | ✓✓✓ | ✓✓✓ | – |
| Goal 12 (Marine) | – | ✓✓ | ✓✓ | – | ✓ | – | ✓✓✓ | ✓ | ✓ |
| Goal 15 (EPR) | ✓✓ | ✓✓✓ | ✓✓✓ | ✓✓ | ✓✓✓ | ✓ | ✓ | ✓✓ | ✓✓✓ |
| Goal 17 (MFA) | – | ✓✓ | ✓✓✓ | – | ✓ | ✓✓✓ | ✓✓✓ | ✓ | – |
| Goal 18 (GHGs) | ✓ | ✓✓✓ | ✓✓✓ | – | ✓✓✓ | – | ✓✓✓ | ✓✓ | – |

Notes: ✓✓✓ National law/regulation incorporating 3R principles has been enforced;
✓✓ National law/regulation has been enacted but not yet (fully) implemented;
✓ Department-level regulation and/or project-based implementation and/or informal sector activity exists/National level policy yet to be prepared;
– Actions yet to be initiated or insufficient data and information

Source: UNCRD/IGES/MoEJ (2018); Regional 3R Forum in Asia and the Pacific; State of 3Rs in Asia and the Pacific

Pacific island countries have also taken initiatives to measure their performance linked to four strategic goals as per their strategy "Cleaner Pacific 2025". **Table 3.8** summarizes the key performance indicators (linked to each of the four strategic goals) and the targets to be achieved by them by the year 2020 and 2025.[2] The targets will contribute to achieving the post-2015 global sustainable development goals. Despite constraints, some countries have implemented marine litter related policies as part of their overall approach to waste management, specifically with regard to addressing land based activities using 3 R approach as described in **Annexure 3.3**.[2]

**Table 3.8: Performance Indicators and Targets for Cleaner Pacific 2025[2]**

| Strategic goals | Performance indicators | 2014 (Baseline) | Targets | |
|---|---|---|---|---|
| | | | By 2020 | By 2025 |
| Prevent generation of wastes and pollution | Per capita generation of municipal solid waste (kg/person/ day) | 1.3 | 1.3 | 1.3 |
| | No. of marine pollution incidents | 6 (2 Pacific island countries/ territories) | 0 | 0 |
| | No. of port waste reception facilities | 5 | 10 | 20 |
| Recover resources from waste and pollutants | Waste recycling rate (= amount recycled, reused, returned/ amount recyclable) (%) | 47% | 60% | 75% |
| | No. of national or municipal composting programmes | 18 | 30 | 40 |
| | No. of national or state container deposit programmes | 4 (KI, PA, Kosrae, Yap) | 7 | 10 |
| | No. of national EPR programmes for used oil | 2 (NC, FP) | 3 | 10 |
| | No. of national EPR programmes for e-waste | 1 (NC) | 5 | 8 |
| Improve management of residuals | No. of national or state user-pays systems for waste collection | 9 | 14 | 21 |
| | Waste collection coverage (% of population) | 88% (urban) (= 35% nationally) | 100% (urban) (= 40% nationally) | 60% (nationally) |
| | Waste capture rate (= amount collected/amount generated) (%) | Insufficient data | Establish baseline and targets | |
| | No. of temporary, unregulated and open dumps | Over 333 | 5% reduction (316) | 10% reduction (300) |
| | Quantity of asbestos stockpiles ( m3) | > 187,891 m2 | 159,700 m2 | 131,500 m2 |
| | Quantity of healthcare waste stockpiles (tonnes) | > 76 tonnes | < 20 tonnes | 0 tonnes |
| | Quantity of e-waste stockpiles (tonnes) | Insufficient data | Establish baseline and targets | |
| | Quantity of used oil stockpiles (m3) | 2,960 m3 | 1,480 m3 | 0 m3 |
| | Quantity of pharmaceutical and chemical stockpiles (tonnes) | Insufficient data | Establish baseline and targets | |
| | Urban sewage treated to secondary standards (%)Q | 65% | Establish after regional assessment | |
| Improve monitoring of the receiving environment | No. of water and environmental quality monitoring programmes | ~ 3 (AS, CI, GU) | 5 | 7 |
| | No. of national chemicals and pollution inventories | 2 (SA, PA) | 3 | 6 |

Source: SPREP (2016); Cleaner Pacific 2025; Pacific Regional Waste and Pollution Management Strategy (2016-2025)

A cross-country comparison of major treatment options and 3R technologies/practices for SWM with relevance to plastic waste management in Asia and the Pacific has been carried out and summarized in **Table 3.9**. This includes separation at source, collection mechanism, intermediate treatment options and final treatment/ disposal methodologies. Japan and Singapore clearly indicate the marked difference in the level of technology interventions as well as 3R technologies/ practices in comparison to other countries in Asia and the Pacific region.[6]

## Table 3.9: Cross Country Comparison of Major Treatment Options and 3R Technologies/Practices of Asia and the Pacific Countries[6]

| Country | Separation at source | Collection (Note 1) | | | | Intermediate Treatment Processes | | | | | | | | | | | | | Final Treatment / Disposal Methodologies | | | | | | Notes (Sampling Year etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Separation | Recycling | | | | Biological Treatment | | | Incineration | | | | | | | | | | | | |
| | | Regular Truck | Compactor Truck | Waste Banks | Remarks (Note 3) | Mechanical Sorting (MBT / MRF) | Informal Recycling (Note 2) (paper, metal, bottles, glasses and etc.) | RDF | Gasification | Remarks (Note 3) | Composting | Anaerobic Digestion (bio-gas) | Remarks (Note 3) | Open burning | Small scale incineration (without pollution control system) | (Incineration (with pollution control system) | WtE (thermal energy recovery) | Remarks (Note 3) | Open dumping | Controlled Dumping | Sanitary / Engineered Landfill without Gas Recovery | Sanitary Engineered Landfill with Gas Recovery | Landfill Mining (LFMR) | Remarks (Note 3) | |
| Bangladesh | | √ | | | √<br>55% (G) | | √<br>15% (G)<br>Dhaka City | | | √ | √ | √ | √ | √ | √ | | | | √ | | | | | | |
| Cambodia | √<br>For valuable wastes for selling only | √<br>Widely accepted | √<br>Only in capital and tourist cities | | Only in major cities | | √<br>39.7 t/day = 4.3% (Phnom Penh, 2004)<br>Private recyclers and NGOs | | | √ | √ | √ | √ | √ | √<br>6 units for IW 3,525 t/year (5 units WtE in garment industry) | | | | √<br>72 units | | √<br>1 unit (Phnom Penh) | | | | 2012 |
| China | √<br>Pilot city | √<br>Rural area | √<br>Urban area | | | √<br>Pilot city | √ | | | √ | √<br>2% (C) | √ | √ | | √ | √<br>16% (C)<br>Incl. all types of incinerators | √ | | √<br>Rural area | √<br>Small city | √ | √<br>Mega city | √<br>Pilot | 83% (C) incl all types of landfill | |
| India | √<br>Pilot city | √<br>Rural area | √<br>Urban area | | √<br>Major Cities 90% | √<br>200 manual MRF in 100 cities | √<br>15% (C) in 3000 small urban local bodies | √<br>12 RDF plants | 4831 MW biomass power / cogen for agricultural waste mainly (11% of RES) | √ | √<br>8,542 units of all types of composting | √<br>2 mil cubic meters in 2014-15 gas; 645 units | √<br>More than 0.5 mil small and micro bio-gas plants operating | | √ | √<br>6% (C) incl. all types of incinerators (127 MW) | √ | √<br>8 WtE plants in pipeline | √<br>Rural area | √<br>1380 in big and small city | √<br>4,515 TPD | √<br>One | √ | 73% incl. all types of landfill | 2015-16 |
| Indonesia | | √ | √ | √ | √<br>70% in major cities | √<br>200 MRF in 150 cities manual sorting | √ | Planned in Bogor area in 2018 | For agricultural wastes only | √ | √<br>7.19% (C) | √ | √ | √<br>4.79% (C) | √<br>6.59% (C) | | Planned in 7 cities (but: cancelled for a moment) | | √ | √ | √ | 6 units | | 71.85% (C) | 2006 |
| Japan | √ | | √ | | | | | √ | √ | √ | √ | √ | | | | √ | √<br>356 Plants | | | | √ | | | | 2016 |
| Malaysia | | √ | | √<br>1 unit | | | √<br>15%≦x (G) | √<br>1 unit (integrated power plant) | | √<br>Green chemical, bio polymers, bio composites | √<br>1.0% (G) | | √ | | √ | √<br>5 units | | | | | √<br>8/165 units | | | √<br>93.5% (G)<br>165/296 units (operational / total) | |
| Pacific Island Countries | | √ | √ | | | | √<br>Public redemption in Palau, Kiribati, New Caledonia, FSM and Samoa | √<br>Paper briquettes in RMI | √<br>Plastic to oil in Palau | √<br>Not very extensive; mainly return | √<br>Pilot scale | √<br>Pilot scale (Tuvalu and Samoa) | | √<br>In some schools paper | | √<br>Healthcare wastes only | | | √ | √ | √<br>Fukuoka method | | | | |
| The Philippines | √ | √ | √ | √<br>Few | Collection by IWS | √<br>Few | √ | √<br>Few | √ | √ | √ | √<br>Few | √ | √ | | | √<br>Few | | √<br>341 units | √<br>215 units | √<br>114 units | √<br>Few | | √<br>9,794 units | 2016 |
| Singapore | √ | | √ | | | | √ | √<br>Wood chip and rubber chips | | √<br>60% | √<br>Composting of horticultural | | | | | | √<br>38% (C)<br>MSW, Agricultural | | | | √<br>No landfilling of organic | | | √<br>2% (C) | |

| Country | Separation at source | Collection (Note 1) | | | | Intermediate Treatment Processes | | | | | | | | | | | | | Final Treatment / Disposal Methodologies | | | | | | Notes (Sampling Year etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Separation | Recycling | | | | Biological Treatment | | | Incineration | | | | | | | | | | | | |
| | | Regular Truck | Compactor Truck | Waste Banks | Remarks (Note 3) | Mechanical Sorting (MBT / MRF) | Informal Recycling (Note 2) (paper, metal, bottles, glasses and etc.) | RDF | Gasification | Remarks (Note 3) | Composting | Anaerobic Digestion (bio-gas) | Remarks (Note 3) | Open burning | Small scale incineration (without pollution control system) | (Incineration (with pollution control system) | WtE (thermal energy recovery) | Remarks (Note 3) | Open dumping | Controlled Dumping | Sanitary / Engineered Landfill without Gas Recovery | Sanitary Engineered Landfill with Gas Recovery | Landfill Mining (LFMR) | Remarks (Note 3) | |
| | | | | | | | | | | | waste | | | | | | biomass | | | | and incinerable waste | | | | |
| Thailand | √ | √ | √ | √ | | √ 3 units | √ | √ Experimental | √ Experimental | √ | √ | √ Experimental 1 unit | √ | √ | √ 8 units | √ 2 units | √ 1 unit | | √ | √ 367 units | √ 73 units | √ 1 unit | | | 2013 |
| Vietnam | √ Few pilot scale implementation only | √ | √ | | | √ Normally part of composting plants | √ 8-15% (C) | √ | | √ | √ 28/31 units operational Not prevalent (a) | √ 500,000 units mostly house hold scale units in rural area (b) | √ | √ | √ | √ 44 units plus 25 units in intermediate treatment centres | √ | | √ 337 units 50% Of Landfilled Waste | √ | √ 121/458 units (C) | √ | | √ 458 units 76-82% (C) | 2014 (SPONRE and IGES 2013, VNEEP 2016, N.H. Tien, MOC) |

The table describes the existing waste management and the 3R related technologies/practices in the waste management system of Asia Pacific countries, based on the Country Chapters and expert assessment. Upper cells are marked as "✔" for "active" treatment options (BLANK means "inactive"), while lower cells provide the percentage of the generated (or collected) waste being treated by the treatment option and/or any relevant information where such data is available.
(G) = of generated ; (C) = of collected; IW= industrial waste
Note 1: Collection service provided under municipal responsibility. Note 2: Includes range of market-based processes from collection to processing/treatment by informal sector.
Note 3: Marked "✔"if practice/technology is observed but the specific technology type(s) is unknown.
Source: UNCRD/IGES/MoEJ (2018); Regional 3R Forum in Asia and the Pacific; State of 3Rs in Asia and the Pacific

## 3.4 Implications in Asia and the Pacific Region and Regional Challenges to Achieve 3R Goals

Majority of countries in Asia and the Pacific region have poor waste collection coverage (geographical area) as well as collection efficiency. Major factors responsible for plastic waste generation in the Asia and the Pacific region include:[4]

- Municipal solid waste quantities are increasing as a result of population growth and urbanization as described in Chapter 1. Urban populations are reported to generate roughly 40% more waste than rural population in low and middle-income countries in Asia and the Pacific.[5]
- The proportion of plastics in the waste streams of emerging economies is increasing due to increased consumption as described in Chapter 2.[4]
- Trends in the consumer packaging industry. Increasingly small products require more weight of packaging per kilogram of product. Similarly, improvements in food safety and enhanced preservation of freshness require additional packaging.[5]
- An increasing variety of different packaging formats used to market products.[4]
- It is expected that plastic waste generation will experience proportional growth vis a vis plastic intensity of the countries in the Asia and the Pacific region.[4]
- Lack of recycling, treatment and disposal infrastructure leads to mismanagement of plastic waste resulting in marine litter.[5]

Some of the major challenges related to plastic pollution and marine litter are described below.[8]

**Database on marine litter and plastic pollution:** Marine and coastal plastic waste has been receiving increasing regional attention considering scientific studies indicating eleven countries in the region as leading sources of marine and coastal plastic waste. However, these studies are indicative and need to be supported by strong database. Generally, there is limited data availability on the generation of marine and coastal plastic from individual countries. Despite having a large shoreline, only a few countries in Asia and the Pacific region monitor marine litter generation. However, there is also lack of uniform methodology to assess the quantity of marine litter. Therefore, there is a need to develop, create and share the database across the region.

**Collection, segregation, treatment and disposal of Plastic waste:** Marine litter and coastal plastic waste issues can largely be addressed by improving waste collection, segregation and enhancing recycling of plastic and residual waste, and even by last mile capturing activities which are important in preventing such waste from entering oceans and waterways.

- Collection systems for wastes (including plastics) are not available for a substantial proportion of the regional population. It means that large quantities of waste plastics are not collected at all in lower income countries, particularly in rapidly developing, unplanned urban areas. Plastics are informally collected and disposed off. Further, a significant proportion of plastics waste escapes from the formal waste management system into the wider environment and is burnt or dumped, often ending up in rivers or marine environments where it becomes very difficult to recover.

- Identifying and successfully segregating plastic waste that are mixed with MSW is technically challenging e.g. colored black Polypropylene (PP) is difficult to separate from other types of plastics because it is not readily identified by automatic sorting equipment. Further, different polymers that are combined within products, in the form of mixed material components or assemblies of components (multilayered plastic packaging and waste electrical and electronic items) presents challenges in disassembly and separation to extract target polymers.

- Some additives used in primary plastics can have a detrimental effect on the physical characteristics of recycled plastics (for example, affecting brittleness, flame retardancy, oxidation). The uncertainty around the presence and nature of additives that may be present in primary plastics can dis-incentivise plastics recycling because recyclers cannot be certain that their feedstocks are free from additives.

- Limited collection schemes and treatment technologies for thermosets. Limited technologies for recycling thermosets.

Majority of the countries are lagging in the region due to lack of policy formulation and regulatory enforcement and human, financial and institutional resources. For example, plastic waste is one area of concern wherein certain countries, such as Bangladesh and India, have enacted bans on plastic carry bags with a view to prevent flooding resulting from clogged drainage systems and maintain clean cityscapes. However, involvement of multiple line ministries and institutions also leads to lack of coordination and jurisdictional overlaps in enforcement of policy and regulations. The dominance informal sector, lack of recycling and treatment infrastructure leads to unscientific dumping of majority of plastic waste. Further, limited market transforming RandD capacity for plastic waste management i.e. assessment, reuse, recovery, development of alternate materials, treatment and disposal at national and regional level lead to limited capacity to address plastic waste in the region.

Asia and the Pacific region are experiencing increased waste generation. However, the mismanagement of waste is resulting in increased pressure on finite natural resources, terrestrial, aquatic and marine ecosystem of the region. The emergence and rapid growth of plastic waste stream is a major concern, which needs to be addressed in the region.

Per capita MSW generation in the region varies from 0.21 to 0.37 tonnes per year. Majority of plastic waste, which comes mixed with solid waste ranges from 0.02 to 0.04 tonnes per capita per year. About 55 to 74% of the municipal solid waste is disposed off at disposal sites with zero to 26% being incinerated and 1 to 5% composted. The per capita waste generation per year in the Pacific islands shows huge variation and ranges from 0.036 to 0.693 tonnes. Plastic constitutes about 5 to 25% of the total waste composition.

The huge variation in waste generation can be explained by the strong correlation, which exists between per capita waste generation and the income level of a country. The higher the per capita GNI (gross national income), the higher is the per capita MSW generation. Such trends also correlate to the plastic intensity of Asia and the pacific region. Similar trends have also been observed at city level in the region. The waste generation trend is expected to grow rapidly till 2030 and will stabilize beyond 2050.

Plastic constitutes about 7.35 to 18% of the municipal solid waste in the region. Source segregation of waste is less than 50% in seven countries, while it ranges from 50-70% in other countries. Percentage of plastic recycled also show the similar trend, though it does not indicate the type of plastics recycled i.e. single use or all types of plastics.

Polyethylene (HDPE and LDPE) and Polypropylene are most common polymers found in the waste stream, which account for 40-50% of the waste plastics produced in Asia and the Pacific region. Trends in the consumer packaging industry. Increasingly small products require more weight of packaging per kilogram of product. Similarly, improvements in food safety and enhanced preservation of freshness require additional packaging. A number of beach cleanup efforts in Asia and the Pacific region not only indicate the magnitude but also diversity of the problem and confirm the dominance of packaging and single use plastic waste in the region. Low segregation rate of mixed plastic waste further adds to the complexity of their treatment and disposal in the region.

An analysis of the solid waste as well as plastic waste institutional structure indicates that multiple agencies both at national and city level with strong presence of informal sector further exacerbate the existing regulatory compliance and management (segregation, treatment and disposal) issues in the region.

The need to conserve resources for a low carbon economy and to properly manage various waste streams for environmental protection as well as convert them as resource material, the waste hierarchy based on principles of 3Rspresents a preferential or ordered list of management practices that guides the formulation of policies and programs on waste management.

Globally, Japan is one of the countries in Asia and the Pacific region, which has demonstrated establishing a sound material society based on 3Rs. The application of this approach and beyond can address the plastic pollution & marine

litter. Reduce, also called as waste prevention, is an idea of reducing waste generation.

For example, the amount of plastic waste can be reduced through following measures: (1) a long-term use of plastic products, (2) use my bags and my bottles in place of plastic bags and PET bottles, (3) make thin PET bottles for less usage of raw materials, and (4) use heat-proof containers instead of (unnecessary) plastic wrap for microwave cooking.

Pacific island countries have also taken initiatives to measure their performance linked to four strategic goals as per their strategy "Cleaner Pacific 2025". The targets will contribute to achieving the post-2015 global sustainable development goals.

A cross-country comparison of major treatment options and 3R technologies/practices for SWM with relevance to plastic waste management in Asia and the Pacific indicate that Japan and Singapore are advanced in the level of technology interventions as well as 3R technologies/ practices in comparison to other countries in Asia and the Pacific region.

Some of the major challenges related to plastic pollution and marine litter include.

Lack of database on marine litter and plastic pollution; Collection, segregation, treatment and disposal of Plastic waste; Collection systems for wastes (including plastics) are not available for a substantial proportion of the regional population; Identifying and successfully segregating plastic waste that are mixed with MSW is technically challenging; Some additives used in primary plastics can have a detrimental effect on the physical characteristics of recycled plastics (for example, affecting brittleness, flame retardancy, oxidation) and limited collection schemes and treatment technologies exist for thermosets.

Majority of the countries are lagging in the region due to lack of policy formulation and regulatory enforcement and human, financial and institutional resources.

## Chapter 3


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# Chapter 4: Plastic Pollution and Its Impact

## 4.0 Introduction

The widespread consumption of plastics due to their industrial and domestic applications since 1950 has resulted in significant benefits to society. Major benefits result in improved health (medical application), improved food security (less wastage) and improved resource efficiency (energy and water). Further, lower costs of products (un-internalized environmental and societal costs) and their diverse applications make it an attractive commodity for consumption. However, a number of negative impacts have been identified both on account of plastic production and consumption.[1] This chapter describes the physical and chemical composition of plastics and the associated hazards due to their physical and chemical properties. This is followed by description of key pressures of plastic waste due to their impacts on terrestrial, aquatic and marine ecosystem and human health. Further, impacts on climate change, energy use in their production and consumption, resource efficiency and urban development have been described. Finally, overall implications of these impacts for Asia and the Pacific region have been described.

## 4.1 Composition of Plastics and their Application

In the current context of material intensity and plastic consumption, plastic refers to a group of synthetic polymers, composed of repeating chains of carbon-based units derived either from fossil fuels or biomass. There are two main groups of plastic: thermoplastics (capable of being deformed by heating) and thermoset, which cannot be re-moulded.[1] Currently, the market in conventional plastics is dominated by four classes of polymer, synthesised from fossil fuel sources: polyethylene (PE), polyethylene terephthalate (PET), polypropylene (PP) and polyvinyl chloride (PVC), which are majorly used for manufacturing single use plastic products.[1] The broad classification of plastics is shown in **Figure 4.1** while the most important polymers and their applications are listed in **Table 4.1**. **Table 4.1** also describes synthetic fibres derived from polyster (PES) and PET, polyacrylonitrile (acrylic, PAN), polyamide (nylon, PA), polypropylene (PP) and polyether-polyurea co-polymer (Spandex) which are used in manufacturing textiles and rope. Synthetic fibres are majorly used for manufacturing fabrics using combinations of synthetic polymers and natural fibres. Natural and synthetic fibres occur in two forms, Staple fibre and Filament fibres.[1]

Semi-synthetic fibres and films are produced from biomass, principally cellulose. Cellulose is a ‘stiff’ polysaccharide (Polymer of Carbon, Hydrogen and Oxygen) and is the main component of plant cell walls. The source of cellulose can include agricultural waste, wood chips, or crops grown specifically for use as a raw material e.g. bamboo. The term semi-synthetic is used because the raw material is transformed into fibre using a variety of chemical processes. The main materials produced include vulcanised rubber, rayon fibres, cellophane™ and cellulose acetate fibres and films. Fibres and films are produced by extrusion through spinnerets or slits. Rayon is a widely used material. There are several forms of rayon, which differ in the source of cellulose or the production process. **Table 4.2** describes the semi-synthetic products, their source, chemical processes involved and their applications.[1]

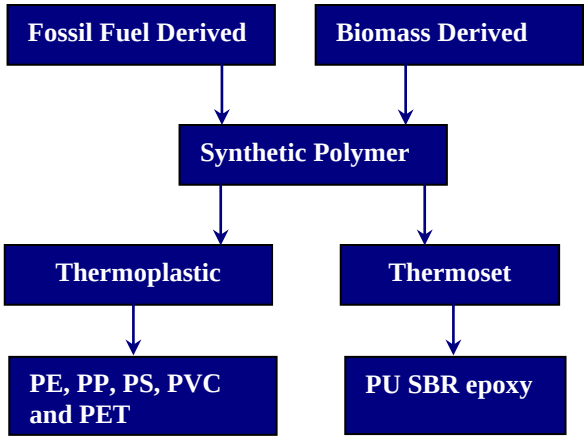



**Figure 4.1: Production of conventional synthetic plastics from fossil fuel and biomass sources[2]**

Source: UN Environment (2018); Exploring the Potential for Adopting Alternative Materials to Reduce Marine Plastic Litter

**Table 4.1: Typical applications by polymer, excluding fibres[1]**

| **Polymer** | **Applications** |
|---|---|
| Acrylonitrile butadiene styrene resin (ABS) | High impact parts in automobiles |
| Polybutylene terephthalate (PBT) | Optical fibres |
| Polycarbonate (PC) | Substitute glass in greenhouses, roofing sheets, spectacles |
| Polyethylene – low and linear low density (PE-LD - PE-LLD) | Bags, trays, containers, agricultural film, food packaging film |
| Polyethylene – high and medium density (PE-HD / PE-MD) | Toys, milk bottles, shampoo bottles, pipes, household goods |
| Polyethylene terephthalate (PET) | Bottles for water and other drinks, dispensing containers for cleaning fluids, outdoor clothing, other textiles |
| Poly(methyl) methacrylate (PMMA) | Touch screens for electronic goods |
| Polypropylene (PP) | Food packaging, snack/sweet wrappers, microwave-proof containers, automotive parts, bank notes |
| Polystyrene (PS) | Spectacle frames, cutlery, plates and cups |
| Expanded polystyrene (EPS**)** | Packaging, insulated food packaging, building insulation, buoyancy |
| Polytetrafluoroethylene (PTFE) | Telecommunication cables |
| Polyurethane (PUR) | Building insulation, insulation for fridges/freezers, foam mattresses |
| Polyvinyl chloride (PVC) | Window frames, floor and wall coverings, cable insulation |
| Other thermoset and thermoplastics | Epoxy resins, surgical devices, seals, coatings and many other diverse uses |
| **Synthetic Fibres** | **Applications** |
| Polyacrylonitrile (PAN) | Thermal clothing, fire-resistant fabrics, carpets, protective clothing, hair extensions, faux fur |
| Polyamide (aliphatic) (PA) | Nylon PA6, PA 66 – clothing, other textiles, rope, fishing line |
| Polyamide (aromatic) (PA) | Body armour, racing sails, bicycle tyres, rope e.g. Kevlar™ |
| Polyester (PES) | Clothing, other textiles |
| Polypropylene (PP) | Thermal clothing, sleeping bag filler |
| Polyether-polyurea (Spandex) | Sportswear, swimwear, under-garments e.g. Elastane, Lycra™ |

Source: UN Environment (2018); Exploring the Potential for Adopting Alternative Materials to Reduce Marine Plastic Litter

**Table 4.2: Semi-synthetic Fibres and Films (types) Source, Chemical Process and Application[1]**

| Product | Common biomass Source | Chemical process | Application |
|---|---|---|---|
| **Rayon** | | | |
| Viscose | Bamboo, cotton, hemp, wood pulp | Sodium hydroxide and hydrogen disulphide | Clothing fabrics |
| Lyocell (formerly Tencel®) | Oak and birch trees | Sulphurous acid or sulphate (kraft) process, followed by dissolution in N-methylmorpholine N-oxide | Clothing fabrics |
| Modal® | Beech wood | Sodium hydroxide and hydrogen disulphide | |
| (closed-loop in Lensing factory, Austria) | Clothing fabrics | | |
| Cupro | Cotton linter | Cuproammonium (ammonia and copper oxide) | Clothing fabrics |
| **Other materials** | | | |
| Cellophane | Cotton, hemp, wood pulp | Sodium hydroxide and hydrogen disulphide | Packaging, food contact packaging, adhesive tape |
| Natureflex™ (Cellophane) | Cotton, hemp, wood pulp | Sodium hydroxide and hydrogen disulphide | Packaging, food contact packaging |
| Cellulose acetate | Cotton, wood pulp | Acetic acid, acetic anhydride, sulphuric acid, acetone | Photographic film, clothing fabrics, cigarette filters |

Source: UN Environment (2018); Exploring the Potential for Adopting Alternative Materials to Reduce Marine Plastic Litter

A number of additives are added to the plastic polymers to improve their specific properties like resistance to fire, UV, biodegradation, heat, oxidation and acid. Further, their properties like their color, anti fogging, anti static and resistance to impact are enhanced by these additives. Common additives which are used are given below in **Table 4.3**.[2]

**Table 4.3: Additive Use in Polymers[2]**

| Additive | % Weight of the Polymer Present |
|---|---|
| Stablisers | Up to 4% |
| Plasticisers | Present in flexible PVC at levels of 20-60% |
| Mineral flame retardants | In soft PVC cables, insulation and sheathing from 5-30% |
| Fillers | Typically calcium carbonate is present in PVC flooring at very high proportion (50%) and in pipes from 0-30% or more.<br>Talc and glass fibres are used in PP for automotive applications, typically in the range of 20-40%.<br>Glass fibres are also found in engineering polymers (such as PA or PBT), for reinforcement in the range 5-70%. |
| Pigments | Titanium dioxide is present in window profiles at 4-8%. |

Source: OECD (2018); Improving Markets for Recycled Plastics – Trends, Prospects and Policy Responses

It has been reported that substances such as bisphenol A (BPA); brominated flame retardants; phthalates; and cadmium/barium and lead stabilisers have been the subject of controversy due to health concerns. Some of the additives have been banned from some products. However, the impacts of their usage is under scientific investigations.[2]

## 4.2 Key Pressures of Plastic Waste

Solid and liquid waste are the major sources of plastic waste. Their mismanagement leads to waste plastic entry into terrestrial and aquatic and marine ecosystem e.g. plastic emissions from uncontrolled dump sites and effluent discharge into water bodies like lakes, rivers seas and oceans. If not properly collected, plastic waste can decay and cause air pollution and degradation of soil, surface and groundwater, and aquatic and marine ecosystems. Degradation is the partial or complete breakdown of a polymer due to some combination of UV radiation, oxygen attack, biological attack and temperature. This implies alteration of the properties, such as discolouration, surface cracking, and fragmentation. Biodegradation is a biologically-mediated process involving the complete or partial conversion to water, $CO_2$/methane, energy and new biomass by microorganisms (bacteria and fungi). Compostable industrial plastic waste is capable of being biodegraded at elevated temperatures under specified conditions and time scales. Compostable domestic plastic waste is capable of being biodegraded at low to moderate temperatures, found in a domestic compost system. The weathering, cracking, weaking and fragmentation of plastic waste will result in their size reduction (flakes or secondary micro plastics) as well as release of additives in the environment. 'Microplastic' is a term that describes pieces of synthetic polymer of 5mm diameter or less (Joint Group of Experts on Scientific Aspects of Marine Environmental Protection 2015). 'Primary' microplastics are those that are purposefully manufactured to a particular size or shape to fulfil a specific purpose. These include plastic resin pellets used to transport the initial plastic resin between production facilities; powders used for the injection moulding of manufactured goods; abrasive powders used for industrial applications (e.g. hull cleaning); and, micro-beads used in some domestic cleaning and personal care products (e.g. toothpaste, facial scrubs). 'Secondary' microplastics represent fragments, flakes or fibres, that originated from a larger item, either before entry into the environment or afterwards.[1] Both degradation and biodegradation of plastics is extremely slow, and is delayed almost indefinitely in the marine environment (United Nations Environment Programme 2015).[3] The three possible sources of chemical contamination due to plastic degradation include:

i. monomers, or building blocks, making up the polymer. Some of the monomers are intrinsically hazardous but the degree of hazard varies substantially;
ii. Sometimes additive chemicals are not strongly bound within the plastic matrix and so will tend to leach into the surrounding environment;
iii. absorbed contaminants – many persistent organic pollutants already present in the environment (e.g. PCBs, PBDEs, DDT) are preferentially absorbed by plastics, with the potential for being desorbed into an organism after ingestion, in the (Joint Group of Experts on Scientific Aspects of Marine Environmental Protection 2016).[3]

A schematic representation of key pressures due to plastic waste, its source, degradation and impacts is shown in **Figure 4.2**. **Figure 4.2** also illustrates of impacts on terrestrial ecosystem, aquatic and marine ecosystem and human health.

### 4.2.1 Impacts on Terrestrial Ecosystem[4]

Plastic pollution has been reported to impact, air, land, soil, water and vegetation which are the integral components of terrestrial ecosystem. De Souza Machado et al., 2018 has reported about diverse sources of plastics that contaminate environments. These include domestic sewage, containing fibers from clothing and microplastic beads from personal care products. Other sources include biosolids (Carr et al., 2016;[5] Mason et al., 2016;[6] McCormick et al., 2016;[7] Talvitie et al., 2017;[8] Ziajahromi et al., 2017),[9] fertilizers (Nizzetto et al., 2016a;[10] Horton et al., 2017),[11] landfills from urban and industrial centers (Nizzetto et al., 2016b),[12] irrigation with wastewater, lake water flooding, littering roads and illegal

waste dumping (Bl€asing and Amelung, 2018),[13] vinyl mulch used in agricultural activities (Kasirajan and Ngouajio, 2012;[14] Li et al., 2014b;[15] Farmer et al., 2017;[16] Sintim and Flury, 2017)[17] and tire abrasion (Dubaish and Liebezeit, 2013;[18] Foitzik et al., 2018;[19] Wagner et al., 2018) [20].[4]

**Impact on Air**

Dris et. Al. (2016)[21] has reported the contribution of the atmospheric fallout as a potential vector of plastic pollution. His research indicates that air quality monitoring results in both urban and rural environment contain significant amount (29%) of fibers in atmospheric fallout. Therefore, it leads to hypothesis that the atmospheric compartment should not be neglected as a potential source of microplastics. These microplastics have different possible sources such as synthetic fibers from clothes and houses, degradation of macroplastics, and landfills or waste incineration.[22] Free et al., 2014[23] reported that these fibers in the atmosphere, including microplastics, could be transported by wind to the aquatic environment or deposited on surfaces of cities or agro systems. After deposition, they could impact terrestrial organisms or be transported into the aquatic systems through the runoff.[22]

Various plastics enter the soil environment, settle on the surface, and penetrate into sub soils as shown in **Figure 4.2**. Rillig (2012)[24] pointed out the problem of microplastic pollution in soil and terrestrial ecosystems. Liu et al., 2014;[25] Rochman et al., 2015;[26] Nizzetto et al., 2016a[10] have reported plastic wastes in the soil media and warned about the dangers of small plastics in the soil and terrestrial ecosystems. Rillig, 2012;[24] Liu et al., 2014;[25] Nizzetto et al., 2016a,[10] 2016b[12] have also pointed out the potential effects of widespread plastic contamination in the soil environment, emphasizing on the adverse effects of plastics and MPs in soils. Studies have reported that the synthetic fibers can be transferred to the soil and can pollute soil environments via the application of the effluent to land.[4]

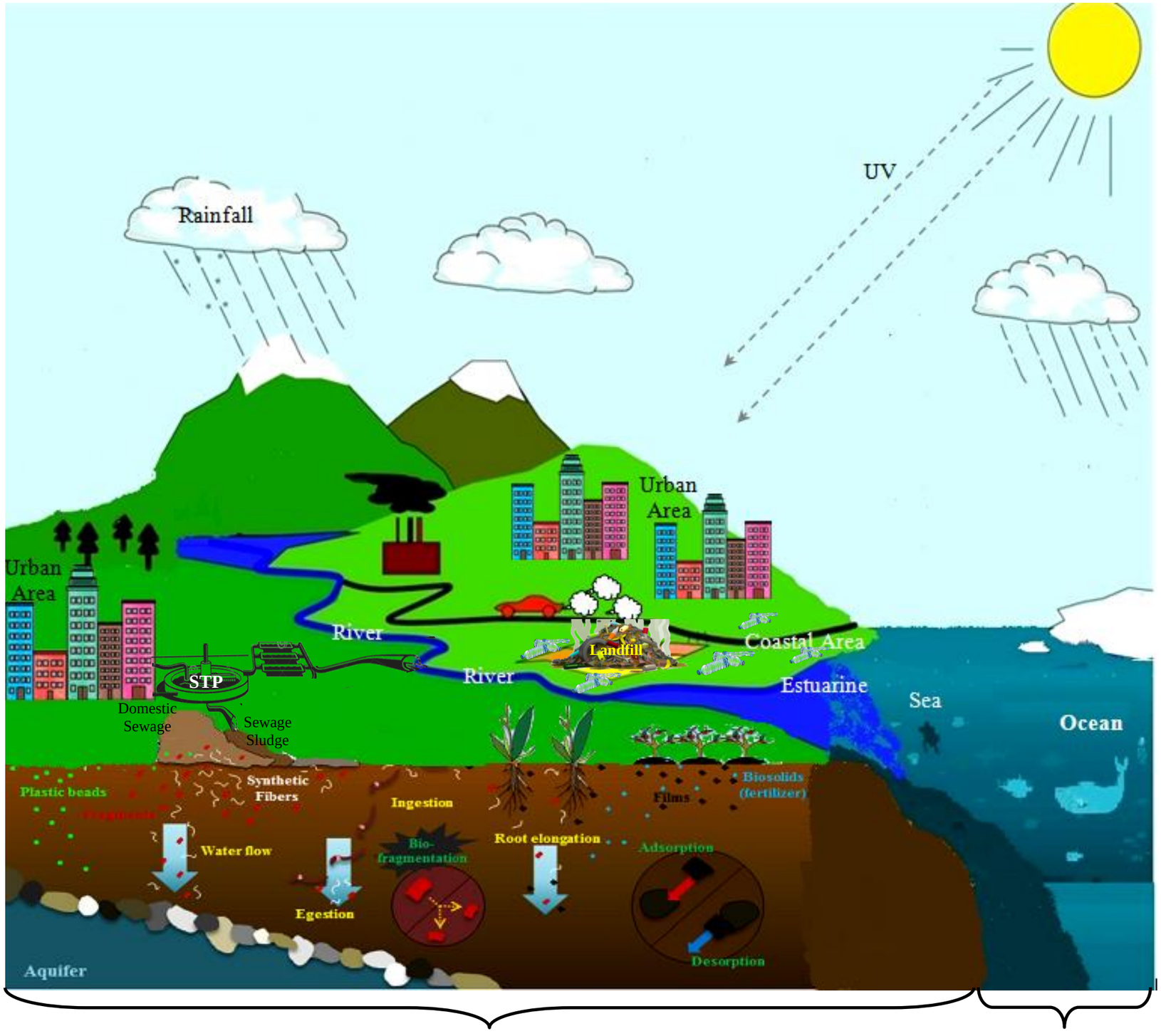



**Figure 4.2: Plastic Waste, Its Source, Degradation and Impacts[4]**

Source: Amit Jain (2019); Prepared from Current Research Trends on Plastic Pollution and Ecological Impacts on the Soil Ecosystem: A Review

**Impact on Soil Environment**

Recent studies have also reported the state of persistent plastic contamination in the soil environment.[4] Horton et al. (2017)[11] suggested that the fragmentation of plastics can occur in the surface soil by UV radiation and elevated temperature. These fragmentized plastics can be microplastics of small sizes (<5 mm).[4] Micro plastics in soils can be ingested (Peng et al., 2017)[27] and transferred (Nizzetto et al., 2016b)[12] to soil organisms, leading to unwanted effects on their bodies (da Costa et al., 2016)[28]. Different species like earthworms have been used for investigating the pollution and impact of micro plastics in soil ecosystems because they can ingest small-sized plastics, generate secondary micro plastics in their body (Rillig, 2012;[24] Huerta Lwanga et al., 2016[29]), and transport micro plastics in soil through their burrowing activities (Anderson, 1988[30]). Huerta Lwanga et al., 2016[29] have concluded their activities such as ingestion of soils and excretion of casts may be the main mechanism behind the transport of micro plastics in the soil ecosystem. PE is one of the most common plastics found in soil because of landfill with sewage sludge containing primary micro plastics from personal care products (McCormick et al., 2016;[7] Talvitie et al., 2017[8]) and PE vinyl mulch from agricultural activities (Kasirajan and Ngouajio, 2012[];[14] Li et al., 2014b;[15] Sintim and Flury, 2017[17]).

Rillig (2012[24]) assumed that plastics on the soil surface can be incorporated into the deep soil by burrowing activities of earthworms. Both plastics and microplastics in surface soils can be further transported to deeper layers of the soil by the activities of soil organisms such as collembolans, insects, and plants (Maaß et al., 2017;[31] Rillig et al., 2017a;[32] Rillig et al., 2017b;[33] de Souza Machado et al., 2018;[34] Zhu et al., 2018a[35]).[4]

Gaylor et al. (2013)[36] simulated the exposure of polybrominated diphenyl ether (PBDE) to earthworm *Eisenia fetida* with various exposure scenarios (biosolid or polyurethane foam microparticles that contain PBDEs). They found that PBDEs leached from polyurethane foam (<75 mm) were accumulated in the bodies of earthworms. Therefore, chemicals derived from micro plastics can enter the soil ecosystem and be accumulated in soil invertebrate organisms. Additives or hazardous chemicals in micro plastics such as PBDEs can be transferred to other environments and organisms (Chen et al., 2013;[37] Hong et al., 2017)[38] in the soil ecosystem.[4]

Huerta Lwanga et al. (2016)[29] exposed earthworm *Lumbricus terrestris* to low density polyethylene (LDPE) MPs (<150 mm) for 60 days, and investigated their mortality, growth, tunnel formation, position in mesocosm, and micro plastic ingestion after 14 and 60 days of exposure. In addition, the mortality, growth rate, ingestion rate, and accumulation were investigated after 4 days of exposure. The authors suggested several possibilities from their results: i) the health of earthworms was affected when they were exposed to high concentrations of micro plastics (28, 45, and 60% w/w microplastics in litter), ii) micro plastics have the potential of being preferentially retained in the earthworms and transferred to other organisms in the soil ecosystem through the food chain, and iii) micro plastics concentrated by earthworms could be transported to deeper layers of the soil and leached to groundwater.[4]

Hodson et al. (2017[39]) prepared micro plastics using high density polyethylene (HDPE) bags and exposed them to *L. terrestris* with metal, zinc (Zn) for 28 days. Before exposure, the adsorption and desorption of Zn on micro plastics were analyzed. Zn was less adsorbed on the micro plastics compared to other soil particles (arable and woodland soil), whereas much more Zn was desorbed from micro plastics than from other soil particles. Therefore, it was inferred that micro plastics may serve as the pathway of bio available metals, including Zn, in the soil ecosystem.[4]

Maaß et al. (2017)[31] confirmed the horizontal transport of plastic particles by soil microarthropods. They used two collembolan species, *Folsomia candida* and *Proisotoma minuta*, and observed the transport of ureaformaldehyde particles (200e400 mm). They transport of particles was strongly dependent on the type of particle, size of particles, and size of organisms. Rodriguez- Seijo et al. (2017) investigated the effects of PE micro plastics (250e1000 mm) on the survival, growth, reproduction, histopathological damages, and immune system response of *Eisenia andrei*. They observed histopathological damages and immune system responses of earthworms exposed to micro plastics. Micro plastics were also observed in the gut and middle intestinal tract of the earthworms. Increases in the contents of proteins, lipids, and polysaccharides in earthworms were also observed. They confirmed that these increases of nutrients are caused by multiple stress-response mechanisms of the immune system of *E. andrei* to micro plastic exposure.[4]

Zhu et al. (2018a)[35] investigated the transport of commercial polyvinyl chloride (PVC) micro plastics using relationships of predator (Hypoaspis aculeifer) and prey (F. candida). The authors concluded that micro plastics are transported longer when predators and preys exist together than when they exist alone. Therefore, movements of micro plastics in soils can be influenced depending on soil biota including different trophic levels or food chains. In another research, Zhu et al. (2018b)[40] investigated the growth, reproduction, isotope composition, and gut microbiota of *F. candida* after exposure to PVC micro plastics for 56 days. The indicators like bacterial diversity, microbiota in the gut, growth, reproduction, and isotope composition were affected by micro plastic exposure. These results indicate that micro plastics can impact non-target species in soil biota.[4]

**Impact on Ground Water**

Several researchers have warned off the potential distribution and transportation of micro plastics into groundwater and the hyporheic zone based on previous studies about their transportation. Rillig et al. (2017)[32] commented that microplastics can migrate through the soil profile and reach the groundwater. Bl€asing and Amelung (2018)[13] also warned of the potential of nanoplastics or colloids to pass through macropores and coarse soil. Scheurer and Bigalke (2018)[41] suggested the probability of microplastics to be transferred to groundwater in areas with high groundwater table and coarse soils.[4]

In another study by Huerta Lwanga et al. (2017a)[42], similar experiments were conducted using *L. terrestris* for 2 weeks. The burrowing activities of the earthworms and distributions of micro plastics in the soil were analyzed. A mesocosm study was conducted for 14 days using LDPE with sizes of 50 mm (40%) and 63-150 mm (60%) based on previous aquatic studies and representativeness in soil (Huerta Lwanga et al., 2016)[29]. *L. terrestris* was exposed to micro plastics with dried Populus nigra under dark conditions. The results showed that micro plastics were transported into the burrows via the movement of earthworms and the authors explained that this may cause the pollution of groundwater by micro plastics and affect other organisms in the soil ecosystem. Additionally, the concentration of organic matter within the burrows of soil with high concentration of micro plastics was also high and this may be related to the stress response of earthworms exposed to them.[3]

**Impact on Terrestrial Food Chain**

Huerta Lwanga et al. (2017b)[43] conducted the first study on the trophic transfer of micro plastics in the terrestrial food chain, in which they investigated the concentrations of micro plastics in home garden soil, earthworm casts, and chicken (Gallus gallus domesticus) feces. The concentrations increased along the trophic levels and the highest concentration of micro plastics was confirmed in chicken feces (129.8 ± 82.3 particles g_1). In particular, chicken

gizzards also contained micro plastics (10.2 ± 13.8 micro plastics per gizzard), and this suggested the evidence of transfer of micro plastics to humans through food because gizzards are used for human consumption in several countries.[4] Bottom ash produced from burned plastics in open dumps also contaminates the soil and water resources in the Asia and the Pacific region **(Box 5)**.[44]

**Box – 5: Open Burning of Waste in Asia and the Pacific**

Globally about 970 million tons per year of waste, which is 41% of the total waste is treated by open burning. Wiedinmyer et al., 2013[45] Open burning is characterized by burning at low temperatures (between 250°C and 700 °C) in an oxygen-deprived environments leading to incomplete combustion of waste. Open burning in landfills and open dumpsites usually involves burning large quantities of unsegregated waste, which may contain hazardous medical and industrial wastes. Large, visible clouds of black smoke accompany these landfill/dumpsite fires, and the fires generally burn very slowly, lasting over substantial periods of time and allowing the quantity and concentration of pollutants to build up. In addition to fumes from landfill/dumpsite fires, open burning in landfills and open dumps leaves residue in the form of particulate matter or ash. This ash has two parts two it: bottom ash and fly ash. Bottom ash accumulates from leftover solid material after burning, while fly ash accumulates from exhaust gases rising upward during the combustion process. Bottom ash distributes its toxins by polluting the soil. Fly ash, on the other hand, is carried by the wind and disperses its toxins.

In East Asia and the Pacific (EAP) barring Japan and Republic of Korea, majority of countries have similar overall MSW collection coverage of just under 80%. Cambodia's capital city, Phnom Penh, has over one million inhabitants and it is also home to a large MSW open dump. The soil surrounding the dump was tested and it had dioxin levels that were higher than safe WHO standard levels. This was most likely due to the indiscriminate open burning of plastics (which equaled about 5.5% of all generated waste) along with other waste. Similarly, in the Pacific region, studies done in Bandung, Indonesia showed that waste collection was a serious problem and that the dominant method of disposal of uncollected MSW was open burning.

Source: Alexander Cogut (October 2016); R20 Regions of Climate Action; Open Burning of Waste: A Global Health Disaster

All the above mentioned research indicates: i) micro plastics may have adverse effects on and can be accumulated in soil organisms, ii) additives derived from micro plastics can be accumulated in soil organisms, iii) micro plastics can cause changes in the chemical contents of soil organisms, iv) responses of soil organisms exposed to micro plastics can cause changes in soil characteristics, v) chemicals adsorbed on micro plastics can enter the soil ecosystem, vi) micro plastics can move horizontally and vertically, (vii) plastic and micro plastics impact atmosphere and (viii) plastics and micro plastics can impact ground water.

### 4.2.2 Impacts on Aquatic and Marine Ecosystem

Researchers started studying the occurrence and consequences of macro plastic debris in coastal and marine environments during the 1970s. Carpenter and Smith 1972,[46] Derraik 2002,[47] Barnes et al. 2009,[48] Ivar do Sul and Costa 2013[49] have reported that plastics degrade and fragment into smaller pieces in marine environment and pose a substantial threat to marine biota[51].

Sheavly and Register 2007[50] have reported that sources of plastic pollution are extensive and are generally categorized as being either ocean or with land-based debris.[51] Pruter 1987,[52] Wilber 1987,[53] Karau 1992,[54] Williams and Simmons 1997,[55] Santos et al. 2005,[56] Corcoran et al. 2009,[57] Ryan et al. 2009,[58] Campbell 2012,[59] O'Shea et al. 2014[60] indicates that land based debris generally originates from urban and industrial waste sites, sewage and storm-water outfalls, and terrestrial litter that is transported by river systems or left by beach users[51]. (Box 6 and Image 1 )

**Image 1:** A man washes plastic for recycling in a murky pond at Payatas district, Quezon City, Metro Manila, The Philippines January 21, 2018
**Source:** https://asiancorrespondent.com/2018/03/how-are-asian-countries-tackling-plastic-pollution/

**Box – 6: Coastal and Marine Ecosystem and Impact from Plastic Pollution – The Philippines[61]**

The Pasig River in the e Philippines is experiencing a severe plastic pollution crisis. According to a recent study in the Netherlands and the United States, the Passig River alone dumps the equivalent of 63,700 tons in volume of plastic into the Pacific Ocean every year[61]. Based on reports by WWF-The Philippines, the country's National Solid Waste Management Commission, and the World Bank, about 74% of plastic leakage comes from waste that has actually been collected and dumped at poorly located dumps situated near waterways. Marine debris also have negative impacts on revenue-generating nature-based tourism, as well as the fishing industry. Fishermen in WWF-The Philippines project sites have commented that plastics are smothering coral reefs. This results in ecosystem-wide impacts, which also affect their yield[62].

Source: Albert Garcia ( March 27, 2018); The Philippines, David in Size, Goliath in Plastic Pollution; http://savethewater.org/2018/03/27/The Philippines-david-in-size-goliath-in-plastic-pollution/ https://wwf.panda.org/knowledge_hub/where_we_work/coraltriangle/?329831/The-scourge-of-single-use-plastic-in-the-The Philippines

Therefore, large urban coastal populations are the main source of debris entering the marine environment. Martinez et al. 2009[63] indicated that these marine debris are advected elsewhere by ocean currents. Jones 1995[64], Santos et al. 2005[56] reported that ocean-based marine debris is material either intentionally or unintentionally dumped or lost overboard from vessels (including offshore oil and gas platforms) and includes fishing gear, shipping containers, tools, and equipment. Cottingham 1988[65] and Jones 1995[64], Ivar do Sul et al. 2011[55] indicated specific fishing-related debris includes plastic rope, nets (responsible for 'ghost fishing', monofilament line, floats, and packaging bands on bait boxes.[51]

The diverse physical nature of plastic polymers affects buoyancy and, thus, influences the transport and distribution of plastics in the marine water column.[51] **Table 4.4** and **Figure 4.3** describe the physical property of plastics to float in a water column based on their density.[1] Therefore, plastics are distributed throughout the world's oceans, deposited on most coastlines, and found in very remote areas including the deep sea (Convey et al. 2002[66], Eriksson and Burton 2003[66], Barnes et al. 2009[48]).

**Table 4.4: Common Synthetic and Semi-synthetic Polymers and Applications, together with their tendency to Float or Sink in the Aquatic Environment[1]**

| Polymer | Common applications | Density | Behaviour |
|---|---|---|---|
| Polyethylene | Plastic bags, storage containers, | 0.91–0.95 | Float |
| Polypropylene | Rope, bottle caps, gear, strapping | 0.90–0.92 | Float |
| *Pure* water | | 1.00 | |
| Polystyrene (expanded) | Cool boxes, floats, cups | 0.96 –1.05 | Float |

| Polymer | Common applications | Density | Behaviour |
|---|---|---|---|
| *Average seawater* | | 1.025 | |
| Polystyrene | Utensils, containers | 1.04–1.09 | Sink |
| Polyamide or Nylon | Fishing nets, rope | 1.13–1.15 | Sink |
| Polyacrylonitrile (acrylic) | Textiles | 1.18 | Sink |
| -Polyvinyl chloride | Film, pipe, containers | 1.16–1.30 | Sink |
| Cellulose Acetate | Cigarette filters | 1.22–1.24 | Sink |
| Poly(ethylene terephthalate) | Bottles, strapping | 1.34–1.39 | Sink |
| Polyester resin + glass fibre | Textiles, boats | >1.35 | Sink |
| Rayon | Textiles, sanitary products | 1.50 | Sink |

Source: UN Environment (2018); Exploring the Potential for Adopting Alternative Materials to Reduce Marine Plastic Litter

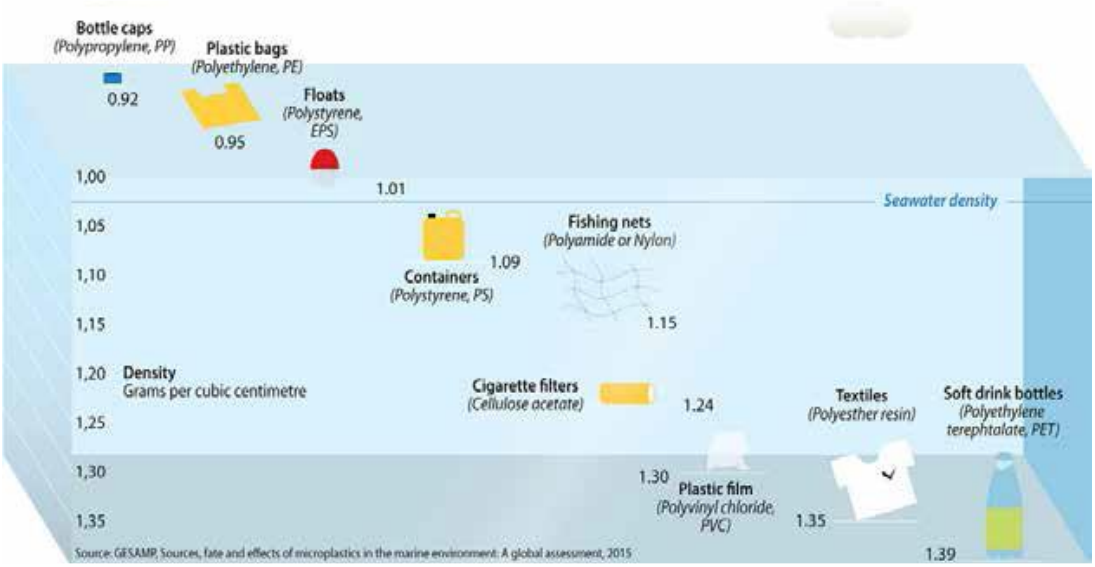



**Figure 4.3: Schematic of which synthetic polymers tend to float and which tend to sink in the ocean[1]**

Source: UN Environment (2018); Exploring the Potential for Adopting Alternative Materials to Reduce Marine Plastic Litter

The physical phenomena of floatation of plastic makes them a source of ingestion or a carrier of other species or chemicals in the marine environment. Broadly marine wildlife is impacted by plastic pollution through entanglement, ingestion, bioaccumulation, and changes to the integrity and functioning of habitats. While macroplastic debris is the main contributor to entanglement, both micro and macrodebris are ingested across a wide range of marine species. Lusher et al. 2017[68] reported concern of the potential harm caused by the ingestion of microplastics by marine organisms, both to the organism and potentially to human consumers of seafood. Microplastics can cause direct physical damage or indirect damage through an inflammatory response to an ingested particle. Alternatively, there may be a satiation effect where the organism feels full, but the 'food' lacks nutrition and cannot be readily digested. In addition, there is the potential for harm due to the leaching of chemicals from within the polymer. Further, they may act as vectors for the transfer of chemical contaminants through the food chain[69].

The recent attention has started to focus in more detail on the physical and chemical characteristics of different categories of microplastics. Browne et al. 2011[70], Lusher et al. 2013[71], Woodall et al. 2014[72] have reported the presence of microfibers composed of a number of common polymers. The main sources of these microplastics appear to be textiles and ropes/nets, with synthetic and semi-synthetic fibres[71].

The impacts due to the physical and chemical characteristic of plastics to marine wildlife are now well established for many taxa, including mammals (Laist 1987, 1997[73] [74], Page et

al. 2004[75]), seabirds (Laist 1997[74], van Franeker et al. 2011[76]), sea turtles (Beck and Barros 1991[77], Tomás et al. 2002[78], Wabnitz and Nichols 2010[79], Guebert Bartholo et al. 2011[80], Lazar and Gra an 2011[81], Schuyler et al. 2014[82]), fish (Boerger et al. 2010[83], Possatto et al. 2011[84], Ramos et al. 2012[85], Dantas et al. 2013[86], Choy and Drazen 2013[87]), and a range of invertebrates (Chiappone et al. 2005[88]). Müller et al. 2012[89] has reported that over 170 marine species have been recorded to ingest human-made polymers that could cause life-threatening complications such as gut impaction and perforation, reduced food in take, and transfer of toxic compounds.[6]

**Impacts on Marine Habitats**

Plastic pollution impacts all marine and coastal habitats to varying degrees. In particular, there are substantial empirical data identifying, and in some cases quantifying, the impacts of plastic and other debris in oceanic waters, on the sea floor, on sandy beaches, and in other coastal environments. Willoughby et al. 1997[90], Ribic et al. (2010)[91] and Eriksen et al. (2013)[92] have reported that effects on habitat condition are not uniform and depend on the ecological, economic, and social value attributed to the habitat, the physical environment, and the type, size, accumulation, and/or degradation rates of plastic. In addition, there is substantial spatial and temporal variation in accumulation patterns, polymer type, and source of plastics. Goldberg (1997)[93] and Carson et al. (2011)[94] have reported that accumulation of plastic debris in inter tidal habitats alters key physico-chemical processes such as light and oxygen availability, as well as temperature and water movement.[51]

Uneputty and Evans (1997)[95] and Aloy et al. (2011)[96] reported alterations in macro- and meiobenthic communities and the interruption of foraging patterns of key species. Carson et al. (2011)[94] reported that the occurrence of micro - plastics on sandy beaches may change the permeability and temperature of sediments, with consequences for animals with temperature-dependent sex-determination, such as some reptiles. Further, Smith 2012 has reported that heavy fouling can lead to loss of important biogenic habitat, which may have considerable flow-on effects to broader ecosystem processes. Katsanevakis et al. 2007[97] indicated that large plastic debris may change the biodiversity of habitats locally by altering the availability of refugia and providing hard surfaces for taxa that would otherwise be unable to settle in such habitats. Watters et al. 2010[98] and Schlining et al. 2013[99] have reported similar observations in sub tidal habitats, including the deep sea.[51]

Yoshikawa and Asoh (2004)[100] and Richards and Beger (2011)[101] have reported in tropical and subtropical shallow-water coral reef habitats, a decline in the condition of corals due to progressive fouling caused by entangled fishing line, as well as direct suffocation, abrasion, and shading of fouled colonies caused by nets. This may contribute to ecological phase-shifts at heavily affected sites. Asoh et al. (2004)[100], Yoshikawa and Asoh (2004) [100], Richards and Beger (2011)[101] have reported that taxa with branching morphologies (e.g. gorgonians, sponges, milleporid and scleractinian corals, macroalgae, and seagrass) are most likely to be affected by entanglement.[51]

**Impacts of Plastic Pollution on Food chain / Trophic linkages**

Studies conducted by Wright et al. (2013),[102] Boerger et al. (2010)[83] and Choy and Drazen (2013)[87] indicate that microplastics are ingested at every level of the marine food web, from filter-feeding marine invertebrates, to fishes, seabirds, sea turtles, and marine mammals.[51]

Thompson et al. (2004)[103] and Browne et al. (2011)[70] reported presence of plankton and plastic particles <333 μm and (<100 μm) diameter polymer fibers in marine system and in sediments, suggesting that plastics exposure is occurring at the base of the food web.

Wegner et al. (2012)[104] and Besseling et al. (2013)[105] have identified impacts to marine invertebrates are associated with foraging on nano- and micro particles of polystyrene. De Mott (1988)[106], Bern (1990)[107] and Cole et al. (2013)[108] has demonstrated and examined plastic ingestion by zooplankton at laboratory scale. Farrell and Nelson (2013)[109] has reported recent evidence that ingested micro plastics can bridge trophic levels into crustaceans and other secondary consumers. Lavers et al. (2013)[110], (2014)[111] and Tanaka et al. (2013)[112] have detected plastic-derived compounds in the tissues of seabirds that had consumed plastics.[51]

**Contribution of Plastic Pollution to the Transfer of Non-native Species**

Ye and Andrady (1991)[113] and Artham et al. (2009)[114] have reported that a wide range of species are known to foul debris, and the level and composition of fouling of debris varies spatially and temporally with the type of substrate and the distance from source areas (and hence residence time at sea). Whitehead et al. (2011)[115] have reported that stranded debris in South Africa, kelp and plastics were the most frequently colonized (33 and 29%, respectively). In contrast, Widmer and Hennemann (2010)[116] reported that only 5% of marine debris was biofouled in southern Brazil, of which 98% of the items were plastic. Orensanz et al. (2002),[117] Hewitt et al. (2004a,b)[118] [119], Haydar (2012)[120] have reported about existence of a number of transport mechanisms for the transfer of marine species to non-native environments, such as hull fouling, ballast water, aquaculture, dry ballast, rafting, and the aquarium trade. Whitehead et al. (2011)[115] have reported that introduced species have a higher propensity to foul man-made substrates, such as plastics Wyatt et al. (2005),[121] Glasby et al. (2007)[122], Tamburri et al. (2008)[123] than native species. The likelihood of plastics transporting non-native species increases substantially due to the combination of this propensity with the durability and persistence of plastics. Therefore, species that have a propensity to foul plastic will have a greater likelihood of dispersing further by rafting or hitchhiking on debris.[51]

**Species-level Impacts of Plastic Pollution**

Laist (1987),[73] Passow and Alldredge (1999),[124] Jacobsen et al. (2010)[125] have reported impacts of plastic pollution marine species of all trophic levels, ranging from zooplankton to whales. Day et al. (1985),[126] Laist (1987),[73] Moore (2008),[127] Ceccarelli (2009),[128] Kaplan Dau et al. (2009)[51] and Schuyler et al. (2012)[129] have reported that both macro- and microplastic debris can affect individual species either through ingestion or entanglement (including entrapment). Carr (1987),[130] Laist (1987),[73] Bjorndal et al. (1994),[131] Derraik (2002),[132] Ceccarelli (2009),[128] Boerger et al. (2010)[83], Jacobsen et al. (2010),[125] Baulch and Perry (2012),[133] Fossi et al. (2012),[134] Schuyler et al. (2012),[129] Besseling et al. (2013)[105] have reported that large plastic debris items, such as rope, cargo straps, fishing line, fishing pots and traps, and net, are the main contributors to entanglement, while both whole and fragmented micro- and macroplastic debris is ingested across at least 170 marine vertebrate and invertebrate species. Ramos et al. (2012)[135] and Dantas et al. (2013)[136] have reported the degree of impact due to ingested plastic is likely related to the size, shape, and quantity of the ingested items and a range of physiological, behavioral, and geographical factors. Ryan (1988a),[137] Bjorndal et al. (1994),[131] McCauley and Bjorndal (1999),[138] Mader (2006),[139] Teuten et al. (2009),[140] van Franeker et al. (2011),[76] Gray et al. (2012),[141] Tanaka et al. (2013)[112] have reported effects due to plastic ingestion in marine species which include gut perforation, gut impaction, dietary dilution, toxin introduction, and inter ference with development. Bjorndal et al. (1994)[131] has reported that swallowed plastic does not need to be large in quantity to cause serious injury to an animal. Day et al. (1985),[126] Jüngling et al. (1994),[142] McCauley and Bjorndal (1999),[138] Cadée (2002),[143] Guebert-Bartholo et al. (2011)[80] have reported that gastrointestinal perforation caused by

swallowed hooks and hard plastic can cause chronic infection, septicaemia, peritonitis, gastrointestinal motility disorders, and eventual death. Mader (2006)[139] has reported the likely chain of causes which result in impaction of the gastrointestinal tract in many species. These includes the offending blockage can paralyze the gastrointestinal tract, inhibit the digestive process, and result in symptoms such as bloating, pain, necrosis, and mechanical abrasion or blockage of absorptive surfaces in the digestive tract.[51]

Wyneken (2001)[144] has reported that some species are more susceptible than others to the ingestion of marine debris. For example, sea turtles are particularly susceptible due to their mistaken habit of considering floating debris as jellyfish. Further, their downward facing papillae on their esophageal mucosa that have evolved to allow efficient ingestion of food but that inhibit the ability of sea turtles to regurgitate. Ryan (1988a,b[137, 145]), Cadée (2002),[143] Moore (2008),[127] Ryan (2008),[146] van Franeker et al. (2011),[76] Kühn and van Franeker (2012)[147] and Verlis et al. (2013)[148] have reported that seabirds, especially those that feed in oceanic convergence zones, consume plastic debris directly, but also feed it to their chicks.[51]

**Population-level Impacts of Plastic Pollution**

Mato et al. (2001),[149] Ashton et al. (2010),[150] Holmes et al. (2012)[151] and Rochman et al. (2014)[152] have reported potential toxicological effect of plastic on growth rates, survivorship, and reproduction, all of which are important areas for population stability as major area of concern. Plastic marine debris contains not only potentially harmful plasticizers incorporated at manufacture (Meeker et al. 2009),[153] but plastics can adsorb and accumulate additional toxic chemicals such as polychlorinated biphenyls (PCBs) and heavy metals from seawater. Tagatz et al. (1986)[154] showed that high concentrations of dibutyl phthalate, a commonly used plasticizer, significantly affected the composition and diversity of macrobenthic communities. Teuten et al. (2009),[155] Tanaka et al. (2013)[156] and Lavers et al. (2014)[157] reported that, while chemicals can leach into the tissues of wildlife that ingest plastic, quantification of population-scale effects warrants further research. Talsness et al. (2009)[158] have reported that animals exposed to compounds such as phthalates and bisphenol-A (BPA) showed adverse impacts on re productive functionality, particularly during developmental stages. Rochman et al. (2013a)[159] have reported that exposure to chemicals in ingested plastic has led to hepatic stress in fish. Azzarello and VanVleet (1987)[160] have reported that adsorbed chemicals from ingested plastics such as dichlorodiphenyltrichloroethanes (DDTs), PCBs, and other chlorinated hydrocarbons may decrease steroid levels and lead to delayed ovulation. Van Franeker et al. (2011)[76] and Bouland et al. (2012)[161] have reported the potential function of plasticizers as endocrine disruptors hypothesized to have resulted in a disproportionately high level of mortality in female fulmars *Fulmarus glacialis*. However, the links between plastic ingestion and population drivers, such as reproductive timing and female survivorship, have yet to be shown conclusively.[51]

**Impacts of Wildlife Entanglement**

Shomura and Yoshida 1985,[162] Gilardi et al. (2010),[163] Allen et al. (2012)[164] have indicated marine debris entanglement as an internationally recognized threat to marine taxa. Laist (1997),[74] Possatto et al. (2011)[84] and Udyawer et al. (2013)[165] have reported that at least 135 species are ensnared in marine debris, including sea snakes, turtles, seabirds, pinnipeds, cetaceans, and sirenians. Wildlife gets entangled in everything such as monofilament line and rope to packing straps, hair bands, discarded hats, and lines from crab pots. Wegner and Cartamil (2012)[166] has reported the presence of the entanglement effects include abrasions, lesions, constriction, scoliosis, Feldkamp (1985)[167] and Feldkamp et al. (1989)[168] have reported loss of limbs, as well as increased drag, which

may result in decreased foraging efficiency and (Gregory 1991, 2009)[169] [170] reduced ability to avoid predators. Henderson (2001),[171] Boland and Donohue (2003),[172] Karamanlidis et al. (2008)[176] have reported that entanglement is a key factor threatening survival and persistence of some species, including the northern fur seal *Callorhinus ursinus* Fowler (1987)[174] and Votier et al. (2011)[175] and endangered species such as Hawaiian and Mediterranean monk seals *(Monachus* spp.). Henderson (2001)[171] has reported that among marine mammals there are important age-class drivers of entanglement rates; for example, in pinnipeds, younger animals (e.g. seal pups and juveniles) may be more likely to become entangled in nets, whereas subadults and adults are more likely to become entangled in line. Fowler (1987),[174] Hanni and Pyle (2000),[177] Henderson (2001)[171] has reported that in general, younger, immature animals are more often reported as entangled, at least in pinniped studies for which age class is reported. Poon (2005),[178] Gunn et al. (2010)[179] and Wilcox et al. (2013)[180] have also reported that ghost nets also ensnare cetaceans, turtles, sharks, crocodiles, crabs, lobsters, and numerous other species.[51]

### 4.2.3 Impacts on Human Health

The use of plastics (conventional and semi synthetic) comes with a certain risks to human health. Some of these risks are associated with plastics manufacture and others with use or the end-of-life stage.

Lusher *et al.* (2013),[181] Woodall *et al.* (2014),[182] Obbard *et al.* (2014)[183] have reported the presence of rayon fibres in sea ice, fish guts and deep-sea sediments. Ocean Conservancy (2017)[184] has reported the widespread occurrence of cellulose acetate cigarette filters on shorelines, which implies a time-dependent rate of degradation, even if the rate has not been quantified. Park *et al.* (2004)[185] has concluded that biodegradability decreased in the order rayon > cotton >> cellulose acetate and is related to a combination of the crystallinity and hydrophilicity of the fibres. Blanc (2016)[186] has reported the production of viscose using carbon disulphide continues to have significant health impacts for the workforce and local inhabitants, especially in parts of Asia. Impacts of plastic on human health has been described below both on the upstream (plastic production) and downstream (plastic consumption) side in terms of the exposure of workers.[51]

Lithner *et al.* (2011)[187] has described many unwanted consequences resulting in impacts on human society due to chemical hazards associated with plastics production. Ruder *et al.* (2016)[188] and Christensen *et al.* (2017)[189] have reported the increased incidence of certain cancers amongst workers exposed to styrene monomer in the reinforced plastics industry. Wang *et al.*2011[190] have also reported a number of conditions in workers exposed to vinyl chloride monomer (VCM) such as genotoxicity, liver cancer and neurological dysfunction, collectively called VCM disease. Lithner *et al.* (2011)[187] have summarized the hazard rankings for selected polymers **(Table 4.5)**.[1]

**Table 4.5: Ranking of Selected Polymers Based on the Hazard Classification Component Monomers[1]**

| Polymer | Monomer(s) | Hazard level | Hazard score |
|---|---|---|---|
| Polyurethane (PUR) | Propylene oxide, ethylene Oxide | V | 13,844 |
| Polyacrylonitrile (PAN) | Acrylamide | V | 11,521 |
| Polyvinyl chloride (PVC) – plasticized | Vinyl chloride | V | 10.551 |
| Acrylonitrile–butadiene–styrene (ABS) Terpolymer | Styrene, acyonitrile | V | 6,552 |
| Epoxy resin DGEBPA) | Bisphenol A | V | 4,226 |
| Polycarbonate (PC) | Bisphenol A, phosgene | IV | 1,177 |
| Polymethyl methacrylate (PMMA) | Methyl methacrylate | IV | 1,021 |

| Polymer | Monomer(s) | Hazard level | Hazard score |
|---|---|---|---|
| Polyamide 6 (PA) (nylon 6) | ε-caproamide | II | 50 |
| Expanded polystyrene (EPS) | Styrene | II | 44 |
| Polystyrene (PS) | Styrene | II | 30 |
| High-density polyethylene (HDPE) | Ethylene | II | 11 |
| Low-density polyethylene (LDPE) | Ethylene | II | 11 |
| Linear-low-density polyethylene (LLDPE) | Ethylene | II | 10 |
| Polyethylene terephthalate (PET) | Dimethyl terephthalate, ethylene glycol | II | 4 |
| PP | Propylene | I | 1 |
| PVAc | Vinyl acetate | I | 1 |

**Note:** The hazard score for some polymers will vary depending on the plasticiser used (e.g. PVC) or the incorporation of another monomer (e.g. PAN)

Source: UN Environment (2018); Exploring the Potential for Adopting Alternative Materials to Reduce Marine Plastic Litter

Maqbool *et al.* (2016)[1] have reported the association of endocrine disorders (EDC) with a range of environmental stressors. The chemicals with endocrine disrupting (EDCs) properties include a range of pesticides, additives in plastics **(Table 4.6)** and Persistent Organic Pollutants (POPS) such as PCBs. Yang *et al.* (2011)[192] has reported very significant impacts due to exposure to EDCs. Halden 2010,[193] Brophy *et al.* (2012),[194] Mariana *et al.* (2016)[195] and Velmurugan *et al.* (2017)[196] have been reported epidemiological evidence of the link between endocrine-disrupting chemicals and the incidence of breast cancer, diabetes, metabolic syndrome, cardiovascular and reproductive health. Kobrosly *et al.* (2014)[197] have reported that foetal brain development is influenced by the maternal endocrine system. Bergman *et al.* (2013)[198] has reported that the exposure to certain phthalates in late pregnancy is linked to a range of neurobehavioural problems in boys and abnormal sexual maturation, including low sperm quality. Koch and Calafat (2009)[1] and Meeker *et al.* (2009)[199] have reported the ubiquity of EDCs in the environment such as its presence in home provides a ready source for potential low-level but persistent exposure, which may occur via a variety of routes including ingestion and inhalation.[1]

**Table 4.6: Examples of common plastic additives, associated functions, potential effect and status under the Stockholm Convention[1]**

| Additive | Function | Effect | Listing under Stockholm Convention[a] |
|---|---|---|---|
| Phthalates | Plasticiser used to soften plastics, especially PVC | Endocrine disruptor | |
| Nonylphenol | Antioxidant and Plasticizer | Endocrine disruptor | |
| Bisphenol A (BPA) | Antioxidant and plasticiser (PP, PE, PVC) | Oestrogen mimic | |
| Brominated flame retardants (BFR) | Reduce flammability | Endocrine disruptor | |
| Hexabromobiphenyl | Reduce flammability | Endocrine disruptor | Elimination |
| Hexabromocyclododecane | Reduce flammability | Endocrine disruptor | Elimination[b] |
| commercial penta, octa and decabromodiphenyl ether | Reduce flammability | Endocrine disruptor | Elimination |
| Short-chain chlorinated paraffins (SCCP) | Plasticiser, reduce Flammability | Carcinogenic | Elimination |
| Pentadecafluorooctanoic acid (PFOA) | Surfactant in production of fluropolymers and as water and stain protection on textiles | Carcinogenic | Under consideration |

[a]as of October 2017; [b]special exemption for the production and use of HBCD in EPS for buildings

Source: UN Environment (2018); Exploring the Potential for Adopting Alternative Materials to Reduce Marine Plastic Litter

Brophy *et al.* (2012)[194] have reported that exposure from EDCs may be expected to occur in occupational settings, where exposure may be prolonged over many years.[1]

### 4.2.4 Other Health Impacts

Mismanagement of waste often with significant plastic contents leads to the spread of infectious diseases, higher instances of respiratory illnesses and increased rates of food chain contamination **(Box – 7)**.

**Box – 7: Impact from Plastic Pollution in Coastal and Marine Ecosystem of Malaysia**

In Malaysia, data from 2009 to 2013 indicate that the percentage of plastic waste found in coastal areas of Malaysia increased from 44.5% to 78.14%. It has been reported that quality of Malaysia's coastal areas characterized by a rich diversity of natural, environmental, cultural and economic resources has deteriorated as a result of marine debris. Further, plastic leakages are seen as one of the key factors contributing to the killing of wild live and beach pollution, and a threat to food security. Considering ability of plastic in marine debris to accumulate chemicals and fertilizers, it poses potential threat to poison marine wild life and health of population as 60% of protein intake among Malaysians is sourced from marine resources.

Source: http://www.mima.gov.my/

Waste disposal sites can be breeding grounds for mosquitos, which spread diseases such as Zika virus, dengue fever and malaria. An example of spread of diseases in Southeast Asia is given in **Box – 8**.

**Box – 8: Dengue Occurrence in Southeast Asia**

Dengue fever is the most common infectious disease transmitted by a mosquito, and is a major economic and disease burden in endemic countries. An annual average of 2.9 million (m) dengue episodes and 5,906 deaths has been reported over the decade of 2001–2010 in Southeast Asia. Further, it accounted to an annual economic burden (with 95% certainty levels) of US$950m (US$610m–US$1,384m) or about US$1.65 (US$1.06 – US$2.41) per capita. The annual number of disability-adjusted life years (DALYs), based on the original 1994 definition, was 214,000 (120,000–299,000), which is equivalent to 372 (210–520) DALYs per million inhabitants in Southeast Asia.

Source: UN Environment (2017); Reducing Marine Litter by Addressing the Management of the Plastic Value Chain in Southeast Asia

In Indonesia, it has been reported that in areas where households burn or dump their waste in their yards, instances of occurrence of diarrhea are twice as high, and acute respiratory infections are six times higher than in areas where waste is regularly collected. It has also been reported that crude methods of waste collection also affect the health of waste pickers, who may suffer from high rates of disease.[200]

## 4.3 Impacts on Climate Change, Energy Production and Consumption and Ecosystem Services and Natural Capital

In general, the impacts of climate change will vary temporally and spatially, and will affect the environment in a variety of ways in Asia and the Pacific region. These include changes to sea level, atmospheric and sea-surface temperatures, ocean pH, and rainfall patterns. These changes are expected to alter biophysical processes that, in turn, will influence the source, transport, and degradation of plastic debris in the ocean. Changes in precipitation

patterns could alter the rate and periodicity of plastic pollution transport into the sea. This trend could alter the functionality and efficiency of storm water filters and trash guards in drainage stems thereby reducing their ability to remove solid debris before it enters the ocean. A rise in the sea level and the increased frequency and duration of severe weather events may inundate waste disposal sites and landfills. Further, storms and rising sea levels also release litter buried in beaches and dune systems. These factors could lead to larger amounts of plastic debris being deposited into the marine ecosystem through runoff, and may introduce toxic materials into the marine environment.

Lebreton et al. (2012)[201] have reported that ocean currents and gyres play a significant role in the distribution and concentration of floating marine plastics. Variation in the sea-surface temperatures, precipitation, salinity, terrestrial runoff, and wind are likely to influence the speed, direction, and upwelling or downwelling patterns of many ocean currents. This can influence areas of plastic accumulation and spread plastics to regions / areas, which were previously less affected thereby altering the exposure rates of marine wildlife. For example, Ivar do Sul et al. (2011)[202] concluded that changes in the currents interacting with the Southern Ocean may lead to the transport, establishment, and spread of plastics and/or invasive species into areas such as Antarctica. Further, Goldberg (1997)[93] inferred that changes to ocean circulation could cause further damage to benthic environments through increased deposition of plastic onto the sea floor, altering the composition of normal ecosystems and causing anoxic or hypoxic conditions. Overall, the pattern of impacts due to climate change is expected to change, potentially affecting the transfer of plastic pollution and, possibly, non-native, invasive species.[51]

### 4.3.1 Energy Production and Consumption and GHG Emissions

The majority of the climate change potential associated with the plastics lifecycle results from the production of virgin polymer. Large amounts of energy are required to refine the oil, crack the distilled constituents into monomers, and then synthesise input plastic raw material. Therefore, energy consumption and GHG emissions due to virgin plastic production in Asia and the Pacific region has been assessed in the overall context of energy supply, intensity and GHG emissions in the region.

The region's total primary energy supply (TPES) has increased more than fourfold and accounted for 45% of the world's TPES in 2015. The demand for electricity, gas and transport fuel in the region also increased more than fourfold between 1970 and 2015 (UNEP 2015).[203] Energy use has grown by 5.7% per year on average, from about 43 000 petajoules in 1975 to around 277 000 petajoules in 2015, and is largely dependent on non-renewable energy sources, mainly coal, for example in China and India. Per person energy use varies across sub-regions and the regional differences in 2015 are significant: 222 gigajoules per person per year in Australia and New Zealand, 124 in Northeast Asia but only 44.5 in Southeast Asia and 26.6 in South Asia.[204]

Due to the shift of production from Japan to China and other emerging economies, and increased energy use in these countries, the energy intensity of the Asia and the Pacific region has remained stagnant over the past four decades.[204] The importance of stakeholders collaboration web could be explored for its applicability to waste minimization, energy recovery and other treatment technologies [205]. The energy intensity in South and Southeast Asia has improved significantly in recent decades, but is still more than double the world average in 2015. Energy intensity in Northeast Asia combined has increased since 2000. Only Australia and New Zealand have an energy intensity lower than the world average **(Figure 4.4)**.[204]

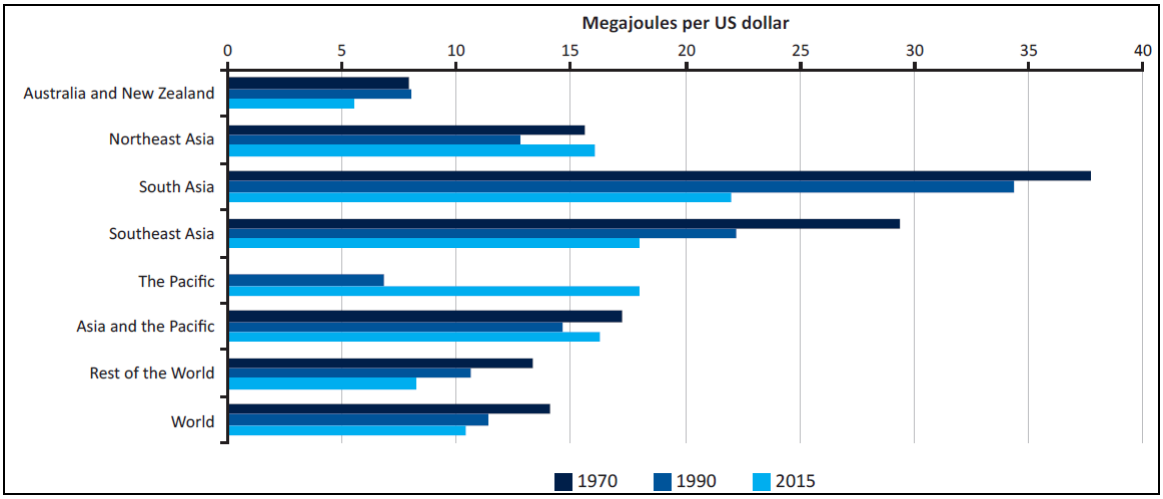



**Figure 4.4: Asia and the Pacific, sub-regions and world, energy intensity, megajoules per USD, 1970, 1990 and 2015[204]**
Sources: UNEP (2016); GEO – 6 Regional Assessment for Asia and the Pacific

Fossil fuels (coal, oil and natural gas) dominate TPES in Asia and the Pacific, accounting for 85% in 2015. Aside from the slight decrease in North and Central Asia and the Pacific, the share of fossil fuels in the TPES increased in the other sub regions. Still, >90% of TPES in North and Central Asia and >88% in the Pacific came from fossil fuels in 2015 **(Figure 4.5)**.[204]

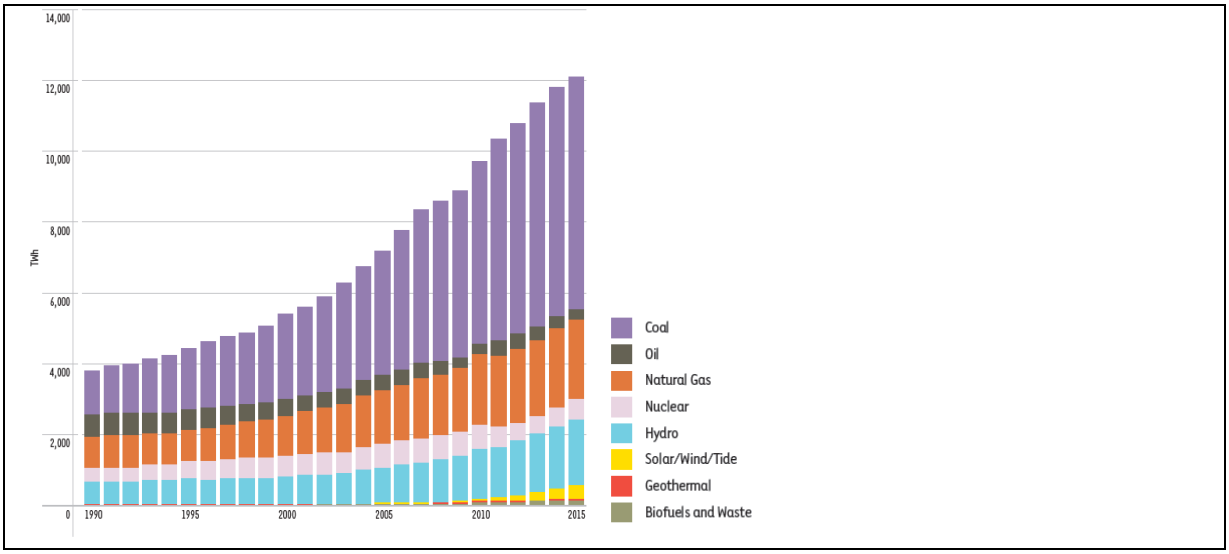



**Figure 4.5: Electricity Production by Product in Asia and the Pacific, 1990-2015[206]**
Sources: UN ESCAP (2018); Sustainable Energy in Asia and the Pacific, A Statistical Overview of Energy and Development

As per 2013 data, the traditional biofuel sector of biomass, timber and waste still accounts for the largest share of renewable energy in Australia (3.9%), China (7.1%), India (24.3%), Indonesia (25.7%), and Japan (2.5%).[204]

Energy accounts for approximately 68% of global emissions. Within the energy sector, carbon dioxide resulting from fuel combustion dominates total greenhouse gas emissions. From 1990 to 2014, the growth rate of carbon dioxide emissions from fuel combustion in Asia and the Pacific was more than double the global growth rate. Global carbon dioxide emissions from fuel combustion have been steadily increasing, growing from 20.623 billion tons in 1990 to 32.381 billion tons in 2014, out of which the Asia- Pacific region contributed 38.2% in 1990 and 54.2% in 2014, while the regional share in global total gross domestic product (GDP) grew from 27.3 to 31.8%.[204] Waste management is the major generator of

GHG emissions in the region. With rising waste generation and prevalent uncontrolled dumping, the absolute value of greenhouse gas emissions from the Asia and the Pacific from the waste sector rose from nearly 370 million tonnes of carbon dioxide equivalent in 1990 to 500 million tonnes in 2010, accounting 33% of global emissions from the waste sector. **Figure 4.6** illustrates GHG emissions from the waste sector in the Asia and the Pacific region.[204]

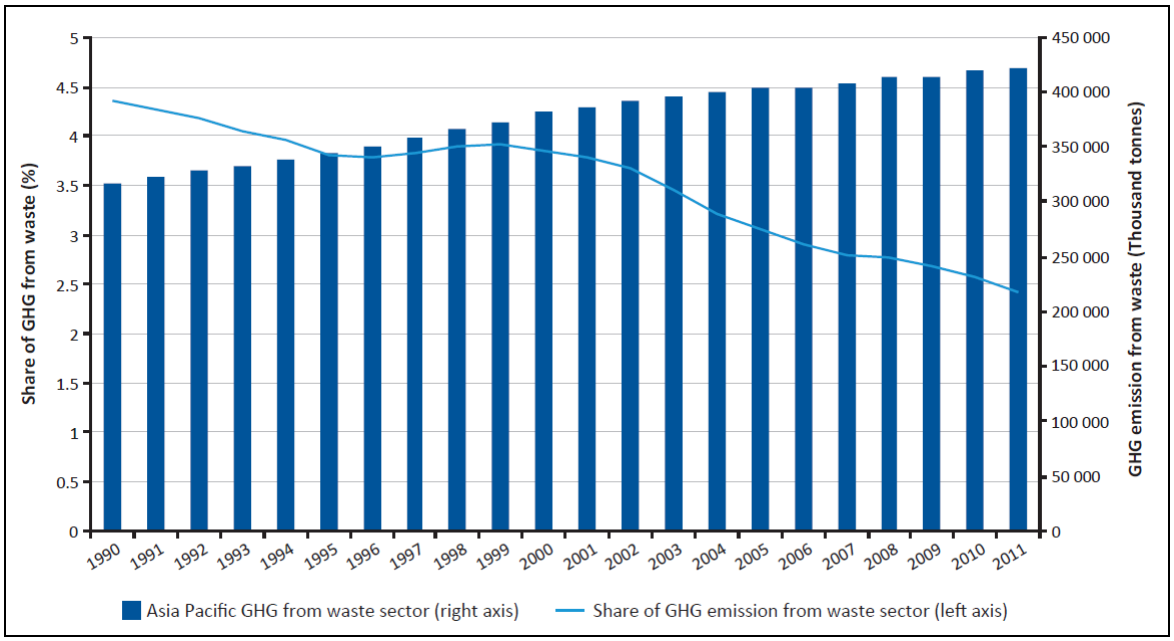
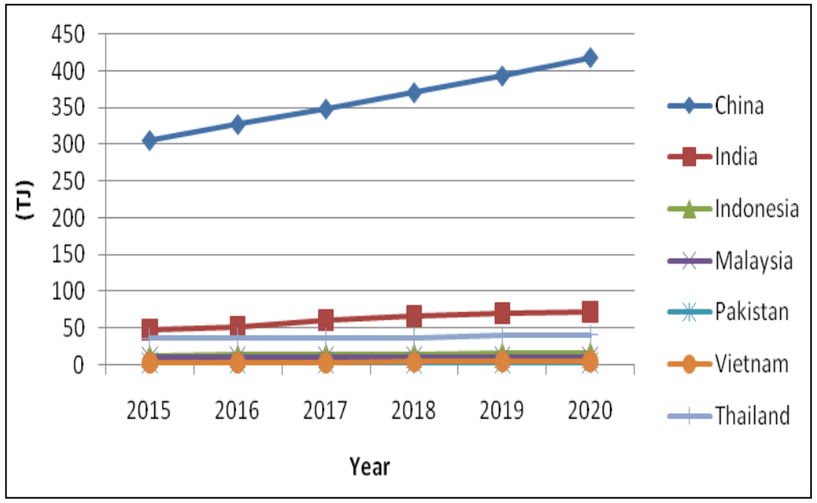


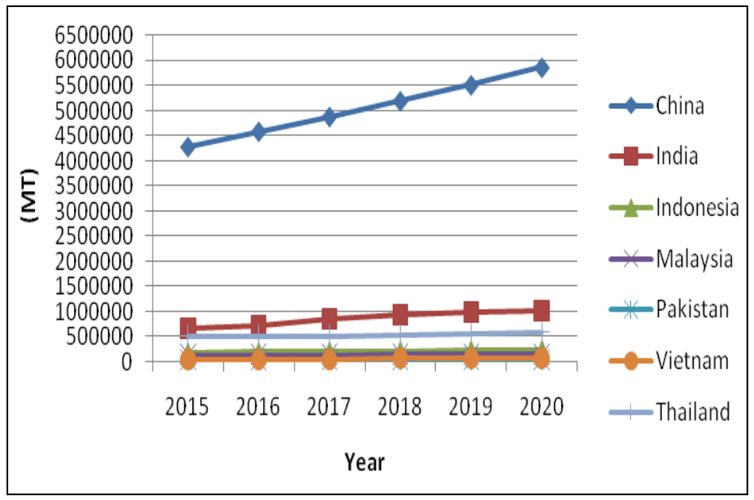

**Figure 4.6: Greenhouse gas emissions (GHG) from the waste sector in Asia Pacific, thousand tonnes of carbon dioxide equivalent, 1990–2011[204]**
Source: UNEP (2016); GEO – 6, Regional Assessment for Asia and the Pacific

Plastic production is growing in the region with China as the largest producer of resin, the raw material for plastic production. In the absence of data on plastic recycling rate, it has been assumed that about 80% of the plastic produced is virgin plastic in the region. A snapshot of energy consumption and atmospheric emission ($CO_2$) due to plastic production in the region has been estimated and shown in **Figure 4.7**. **Figure 4.7** indicates that China has the highest energy consumption for plastic production followed by India and other countries. Similar trends have been observed for $CO_2$ emissions. These trends justify the indirect emissions due to energy consumption for plastic production considering energy mix used (coal, oil and natural gas) in the region. Further, climate change impacts of different end-of-life options versus recycling of plastics clearly indicate plastic recycling as the best option. **Figure 4.7** also indicate relative energy intensity of recycled plastic production is about one third of the virgin plastic. Therefore, a need arises to increase the plastic recycling rate in order to reduce GHG footprint due to plastic production in the Asia and the Pacific region.



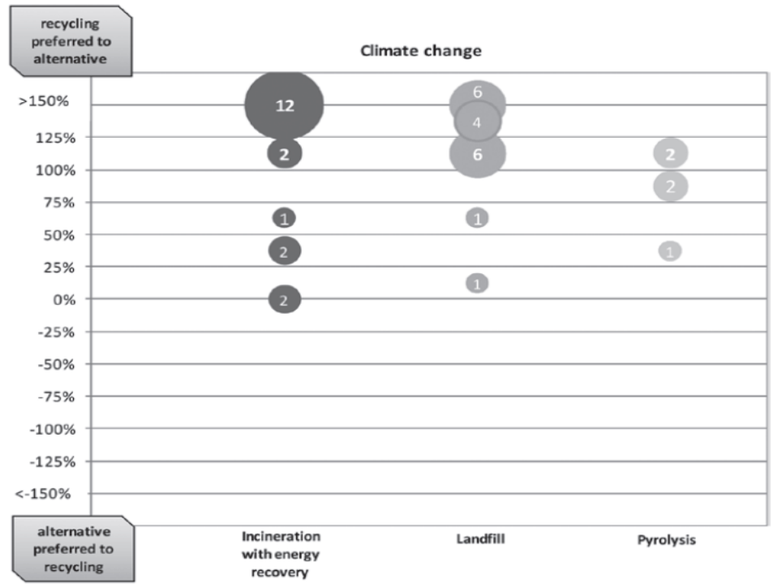

**Atmospheric Emission ($CO_2$) due to Plastic Production in Asia – Pacific (Estimated)**

**Source:** Derived from EUROMAP (2016); Country Cluster Plastics Resin Production and Consumption in 63 Countries Worldwide (2009-2020)



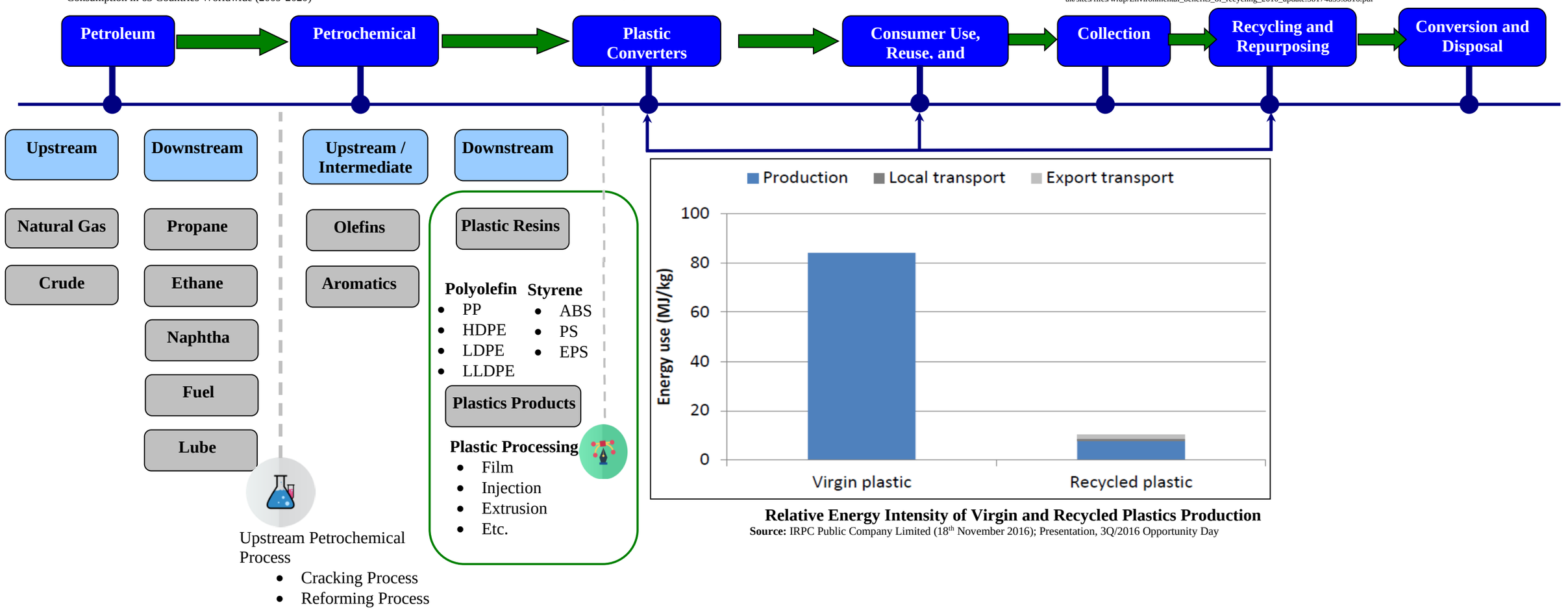

**Energy Consumption due to Plastic Production (TJ) in Asia – Pacific (Estimated)**

**Source:** Derived from EUROMAP (2016); Country Cluster Plastics Resin Production and Consumption in 63 Countries Worldwide (2009-2020)




**Relative difference between the climate change impacts of different end-of-life options vs. recycling for plastics**

**Source:** Michaud, Farrant and Jan (2010[19]), "Environmental benefits of recycling", *WRAP*, www.wrap.org.uk/sites/files/wrap/Environmental_benefits_of_recycling_2010_update.3b174d59.8816.pdf




**Relative Energy Intensity of Virgin and Recycled Plastics Production**

**Source:** IRPC Public Company Limited (18th November 2016); Presentation, 3Q/2016 Opportunity Day

**Figure 4.7: Estimated GHG Emissions and Energy Consumption during Plastic Production, Relative Energy Intensity of Virgin and Recycled Plastics Production and Climate Change Impacts of Different End-of-Life Options vs Recycling for Plastics**

**Source:** EUROMAP (2016); Country Cluster Plastics Resin Production and Consumption in 63 Countries Worldwide (2009-2020) / IRPC Public Company Limited (18th November 2016); Presentation, 3Q/2016 Opportunity Day/ Michaud, Farrant and Jan (2010[19]), "Environmental benefits of recycling", *WRAP*, www.wrap.org.uk/sites/files/wrap/Environmental_benefits_of_recycling_2010_update.3b174d59.8816.pdf

### 4.3.2 Impacts on Ecosystem services and natural capital

An emerging concept in the field of ecosystem services is the concept of natural capital accounting. "Natural capital valuation" attributes monetary value to physical environmental impacts such as uncontrolled disposal of wastes, effectively putting a price on pollution. As per UN Environment the natural capital costs of plastics waste in the consumer goods sector is US$ 75 billion per year **(Figure 4.8)**. This estimate only includes the revenue loss to fisheries and aquaculture and the marine tourism industries, plus the cost of cleaning up plastic litter on beaches. The cost associated to impacts on marine ecosystems could be estimated to be at least 8 billion dollars per year. The food, beverage, retail, non-durable household goods, and personal care products are the top five sectors/ product categories responsible.

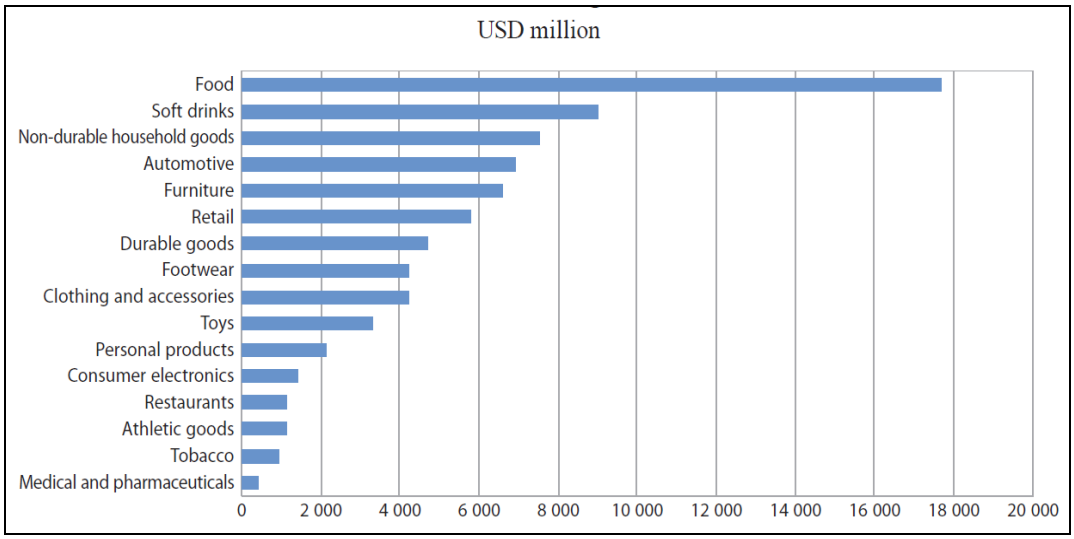



**Figure 4.8: Estimated natural capital cost of plastics production and disposal by sector of origin**

*Note:* The "estimated natural capital cost" shown in this graph represents the sum of the environmental damages resulting from plastics production and end-of-life management (but not those associated with plastics transport or use). Damages resulting from greenhouse gas emissions, plastics and chemical pollutants, and the consumption of water resources are included. Both the market costs (the impact of marine plastics litter on fisheries for example) and non-market costs (the disamenity generated by plastics pollution for coastal recreationalists) are aggregated together.
*Source:* UNEP (2014), *Valuing Plastics: The Business Case for Measuring, Monitoring and Disclosing Plastics Use in the Consumer Goods Industry*, http://bit.ly/2vpC6Dx.

Inadequate management of the plastic value chain including plastic in waste streams has huge economic costs. At product level, global estimates indicate that most plastic packaging is used only once, and over 95% of its value, estimated at US$ 80-120 billion annually, is lost to the economy after its initial use. Further, plastic packaging, which is particularly prone to leakage into the environment, generates negative externalities, degradation of natural systems and greenhouse gas emissions, that have been valued conservatively by UN Environment at US$ 40 billion.

Coastal tourism a subset of cultural services in the natural capital is also affected as tourists seek to avoid beaches known to have high concentrations of plastics litter. As per UN Environment, the economic cost of these impacts has been estimated at US$ 13 billion per year. McIlgorm, Campbell and Rule, 2011 has reported that Marine plastic debris has also been estimated to account for annual losses of US$ 622 million for the tourism sector in the Asia Pacific Economic Area. Asia-Pacific Economic Cooperation (APEC) forum further estimates that the cost of ocean plastics to the tourism, fishing and shipping industries is US$ 1.3 billion in the region alone **(Box – 9)**.

**Box – 9: Economic Loss Due to Marine Litter in Geojedo, Republic of Korea[207]**

In Geojedo, the principal island of Geoje City, on the southern coast of Gyeongsangnam-do province, in the Republic of Korea, the presence of marine litter on the beaches following a period of heavy rainfall is estimated to have led to between US$ 27.7 and 35.1 million of lost revenue in 2011 as a result of over 500 000 fewer visitors.

Source: UN Environment (2017); Reducing Marine Litter by Addressing the Management of the Plastic Value Chain in Southeast Asia

Marine litter also undermines many other coastal and marine livelihoods. There are obvious gender differences in terms of vulnerability to the impacts of marine litter, due to occupational roles in the small-scaled fishing sector, and to social and health impacts of waste management, often as a result of women's informal employment and lack of access to economic and natural resources.

## 4.4 Overall Implications for Asia and the Pacific Region

Key drivers of economic growth and pressures identified for plastic production and consumption result in a state leading to unmanageable plastic waste in Asia and the Pacific region. This state leads to significant environmental impacts in the region. The analysis of key environmental impacts particularly terrestrial (air, soil, food chain, ground water, terrestrial wildlife), aquatic and marine ecosystem (marine habitats, food chain / trophic linkage, non native and native species wildlife entanglement), human health, climate change and ecosystem services have described below and shown in **Figure 4.9**. Key findings of the assessment in Asia and the pacific region are:

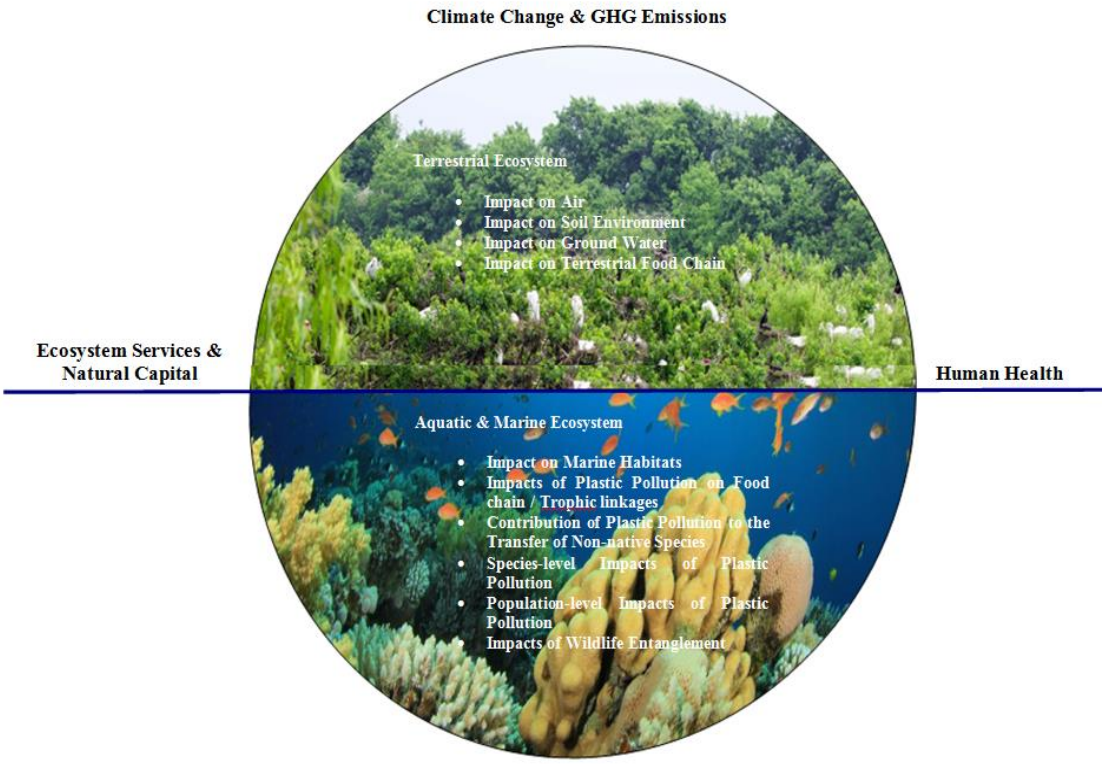



**Figure 4.9: Key Environmental Impacts**

Source: Jain Amit (2019); Prepared from https://sciencing.com/definition-aquatic-ecosystem-6307480.html

**Terrestrial Ecosystem:** The atmospheric compartment should not be neglected as a potential source of microplastics. These microplastics have different possible sources such as synthetic fibers from clothes and houses, degradation of macroplastics, and landfills or waste incineration. They could be transported by wind to the aquatic environment or deposited on surfaces of cities or agro systems. After deposition, they could impact terrestrial organisms or be transported into the aquatic systems through the runoff. The entire chain of cause and effects needs to be further investigated in Asia and the Pacific region.

Land degradation has been intensified over most of the region, with consequent displacement of indigenous people and loss of biodiversity. Land degradation has additional implications for water resources in terms of soil water content and groundwater recharge. A continuous loss of wildlife, natural forest systems, mangroves and other natural systems to urban growth in the region. This is going to further aggravate due to plastic pollution considering i) plastics and micro plastics may have adverse effects on and can be accumulated in soil organisms, ii) additives derived from micro plastics can be accumulated in soil organisms, iii) micro plastics can cause changes in the chemical contents of soil organisms, iv) responses of soil organisms exposed to micro plastics can cause changes in soil characteristics, v) chemicals adsorbed on micro plastics can enter the soil ecosystem, vi) micro plastics can move horizontally and vertically, (vii) plastic and micro plastics impact atmosphere and (viii) plastics and micro plastics can impact ground water.

**Aquatic and Marine Ecosystems:** Aquatic and marine ecosystems integrity and biodiversity are threatened throughout the region due to extensive plastic leakage in aquatic and marine environment. The coastal zone in the region is subjected to continued urbanization, with 325 million more people expected to live in the coastal zone by 2025. About 60% of the coastal mangroves in Asia and the Pacific have been cleared for development and more than 80% of the coral reefs are at risk. Severe erosion prevails on one-quarter to one third of the coastlines in Southeast Asia. Pollution caused by plastic debris and micro plastics could lead to larger amounts of plastic debris being deposited into the marine ecosystem through runoff, and may introduce toxic materials into the marine environment. Ocean may lead to the transport, establishment, and spread of plastics and/or invasive species into areas such as Antarctica is expected to further accelerate degradation of coasts and oceans. Plastic contamination of soil, ground water and fresh water sources will pose a threat to existing plant and mammal species in the region. Major rivers in Asia and the Pacific region are carriers of onland mismanaged plastic waste to the marine environment. Deteriorating water quality is a common concern in the region especially in Northeast and South Asia. As climate change impacts on water resources become more pronounced, particularly in rivers originating in the Hindu Kush Himalayas, flood and drought events will become more frequent and intensified. Contamination of water sources from plastic additives particularly in personal care products and micro materials, increase the exposure to human health risk. Already, the number of threatened mammal and plant species increased by more than 10 and 18% respectively in the last decade. Three-quarters of all threatened birds on oceanic islands are also in danger from invasive species. One fifth of marine mammal species are also threatened. In the oceanic countries and Small Island States, over 25% of hard warm-water corals are experiencing bleaching, mainly due to high thermal stress, and are impacted by dumping of plastic debris and micro-plastic hazardous waste in the oceans. Other impacts on marine ecosystem may include marine habitat, food chain / trophic linkage, transfer of non native species, wildlife entanglement.

**Human Health:** The use of plastics (conventional and semi synthetic) comes with a certain risks to human health during production. Mismanagement of waste often with significant plastic contents leads to the spread of infectious diseases, higher instances of respiratory illnesses and increased rates of food chain contamination.

**Climate Change and GHG Emissions:** Energy accounts for approximately 68% of global emissions. Within the energy sector, carbon dioxide resulting from fuel combustion dominates total greenhouse gas emissions. From 1990 to 2014, the growth rate of carbon dioxide emissions from fuel combustion in Asia and the Pacific was more than double the global growth rate. Global carbon dioxide emissions from fuel combustion have been steadily increasing, growing from 20.623 billion tons in 1990 to 32.381 billion tons in 2014, out of which the Asia- Pacific region contributed 38.2% in 1990 and 54.2% in 2014, while the regional share in global total gross domestic product (GDP) grew from 27.3 to 31.8%. China has the highest energy consumption for plastic production followed by India and other countries. Similar trends have been observed for $CO_2$ emissions. These trends justify the indirect emissions due to energy consumption for plastic production considering energy mix used (>50% coal, oil and natural gas) in the region.

Waste management is the major generator of GHG emissions in the region. With rising waste generation and prevalent uncontrolled dumping, the absolute value of greenhouse gas emissions from the Asia and the Pacific from the waste sector rose from nearly 370 million tonnes of carbon dioxide equivalent in 1990 to 500 million tonnes in 2010, accounting 33% of global emissions from the waste sector. Further, climate change impacts of different end-of-life options versus recycling of plastics clearly indicate plastic recycling as the best option.

**Ecosystem Services and Natural Capital:** As per UN Environment the natural capital costs of plastics waste in the consumer goods sector is US$ 75 billion per year. Inadequate management of the plastic value chain including plastic in waste streams has huge economic costs. Increasing per capita plastic consumption trends (Chapter 2) and plastic waste generation in Asia Pacific region (Chapter 3) is a major subset of this natural capital cost. Coastal tourism a subset of cultural services in the natural capital is also affected as tourists seek to avoid beaches known to have high concentrations of plastics litter. Asia-Pacific Economic Cooperation (APEC) forum estimates that the cost of ocean plastics to the tourism, fishing and shipping industries is US$ 1.3 billion in the region alone.

**Key Messages – Chapter 4**

Environmental impacts of plastic pollution have started emerging relatively recently though uncertainty exists about the magnitude of the damages. The magnitude of plastic waste generation and it's on land mismanagement in the region offers potential threat to both land and marine environment with linkages to livelihood issues particularly in least developed and pacific islands. Therefore, it requires an overarching framework for its management, which could address multiple issue and provide common framework for sustainable development in the region.

Plastics disposed of in landfills break down over many hundreds of years, slowly emitting methane in the process while plastics disposed off in the natural environment, breakdown at slower rates and with carbon dioxide as the by-product. In both cases, the environmental impact is often underestimated because of the timescales involved.

Microfibers add to the particulates in urban air environment further adding on to the existing severe air quality in major polluted cities in Asia and the pacific region.

Microfibers have also been reported to pollute the soil quality thereby getting transported to its deeper layers by earthworms or other species thereby polluting ground water. Such type of impact is not documented in the context of Asia and the pacific region and requires further research.

Thermal decomposition, either controlled or uncontrolled of plastics also results in GHG emissions.

Plastics which has been disposed of into waterways has a range of detrimental effects on the aquatic life, including bioaccumulation, chemical leaching, prevention of transfer of oxygen and nutrients in the benthic zone.

Coastal tourism a subset of cultural services in the natural capital is also affected as tourists seek to avoid beaches known to have high concentrations of plastics litter. As per UN Environment, the economic cost of these impacts has been estimated at US$ 13 billion per year.

Marine plastic debris has also been estimated to account for annual losses of US$ 622 million for the tourism sector in the Asia Pacific Economic Area. Asia-Pacific Economic Cooperation (APEC) forum further estimates that the cost of ocean plastics to the tourism, fishing and shipping industries is US$ 1.3 billion in the region alone.

Under business as usual scenario, an estimated 26 billion tonnes of plastics will be produced over the next ~30 years. The environmental burden associated with the production, use, and eventual disposal of these plastics will tend to increase in parallel. However, greater R&D efforts are required to assess this environmental burden (terrestrial & marine) in Asia and the Pacific region.

## Chapter 4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# Chapter 5: Major Policy Initiative and Responses

## 5.0 Introduction

The national governments in Asia and the Pacific region, recognizing the manifestation and magnitude of impacts due to plastic waste started initiating policy and regulatory responses at national, regional and global level. This response is targeted towards achieving efficiency while mitigating adverse impacts in line with their commitment to achieve sustainable development goals. The majority of these responses are targeted on single use plastics considering their short life cycle and the scale of their impacts. This chapter describes environmental laws and regulations at national level, international treaties, institutional capacity, technology interventions followed by market transforming successful case studies in Asia and the Pacific region.

## 5.1 Environmental Laws and Regulations

Summary of country specific regulations for plastic bags in Asia and the Pacific are given below:

- **Afghanistan:** Ban the import and usage of plastic bags in all shops in the cities and provinces across the country;[1]
- **Australia:** Extended producer's responsibility at national level and used packaging regulations and Regulation of plastic bags by States;[1]
- **Bangladesh:** Restrictions on manufacture, sale of all kinds or any kind of polythene shopping bag, or any other article made of polyethylene or polypropylene, imposing absolute ban on the manufacture, and sale;[1]
- **Bhutan:** Restrictions on the import of plastic bags and Extended producer responsibility for wastes;[1]
- **Brunei Darussalam:** Only regulates disposal at national level (solid waste/litter regulation);[1]
- **Cambodia:** Handle plastic bags are prohibited from importation, production, distribution and use, except for: A- the plastic bags are 0.03 mm or thicker; and B- the plastic bags have a bottom width of at least 25 cm or10 inches. All importation and local production of plastic bags in A and B above shall have permit from the ministry of environment except for non-commercial importation of less than 100 kg, Customers will pay for plastic bags from supermarkets, commercial centers, and all business and service locations and Legislation requires encouragement of use of renewable materials and minimization of waste generation;[1]
- **China:** Ban on the import of used plastic bags and single use plastic products and No free plastic shopping bags shall be provided at any commodities retail places, and the price of plastic shopping bags shall be clearly marked and charged separately from the commodity price;[1]
- **Fiji:** Environment and Climate Adaptation Levy shall be charged on plastic bags distributed by businesses. Levy charged on plastic bags is $0.10c per plastic bag and payable by the person to whom a plastic bag is provided;[1]
- **India:** Plastic Waste Management Rules, 2016 based on EPR have been enforced. Further, plastic waste management jurisdiction given to urban local bodies in their respective jurisdiction for recycling, Requirements to confirm to standards for plastic waste recycler and recycling of plastic IS 14534,

Registration of producer, recyclers and manufacturer, -from the State Pollution Control Board and Responsibility of waste generator to take steps to minimize generation of plastic waste and segregate plastic waste at source in accordance with the Solid Waste Management Rules, 2000 or as amended from time to time;[1]

- **Indonesia:** Law speaks to creation of policy directives on waste reduction, handling and minimization including the development of a road map on extended producer responsibility, Manufacturers are obliged to recycle waste by a. preparing a waste recycling program as part of its business and / or activity; b. using recyclable production raw materials; and / or c. reclaiming garbage from product and product packaging for recycling;[1]
- **Japan:** Recycling plan instituted by law and Extended producer responsibility for designated businesses who are required to reduce waste containers and packaging discharged through rationalization of use of containers and packaging by using recyclable containers and packaging and reducing the excess use of containers;[1]
- **Kiribati:** Issuance of a levy and fund on waste;[1]
- **Lao People's Democratic Republic:** General requirements to separate waste for different purposes such as recycle, reuse, reprocess as new products and elimination with methods and techniques within identified areas base;[1]
- **Malaysia:** Investment tax allowance for use of biodegradable materials;[1]
- **Maldives:** Standards set for importers and local producers of biodegradable bags;[1]
- **Marshall Islands:** Unlawful for a person to import, manufacture, sell or distribute plastic shopping bags;[1]
- **Micronesia (Federated States of):** Only regulates disposal at national level (solid waste/litter regulation);[1]
- **Mongolia:** Use of all types of plastic bags which are less than 0.025 mm thick or lesser for package use shall be prohibited in any trade and services;[1]
- **Myanmar:** Only regulates disposal at national level (solid waste/litter regulation);[1]
- **Nauru:** Only regulates disposal at national level (solid waste/litter regulation);[1]
- **Nepal:** No persons can import, produce, store, sale and distribute plastic bags of thickness less than 30 Micron, Retailers and Individual users to reduce the un necessary uses and reuse the plastic bag to the extent possible, Retailers need to collect and return all plastic bag to importers and Fines for breach of rules;[1]
- **New Zealand:** Waste Minimization Fund (WMF) provides funding for projects that improve waste management and minimization and Extended Producer Responsibility;[1]
- **Pakistan:** Prohibits not only the manufacture of conventional disposable plastic products in Pakistan, but also prevents them being imported into Pakistan. This means that all companies anywhere in the world exporting disposable plastic products to Pakistan made from or packaged in conventional or bio-based PE, or PP, or in PS must make and/or package them in future with oxo-biodegradable plastic technology from a supplier registered with the Pakistan Government;[1]
- **Palau:** Retail establishments shall not provide plastic bags except those that are bio-degradable or compostable to their customers at point of sale or prior to their exit for the purpose of transporting good. Comes into operation 2019,

Retail establishments that sell reusable bags to customers shall price re-useable bags at no greater than 25% above the at cost value and By 2018 no individual or business may import plastic product prohibited for distribution;[1]

- **Papua New Guinea:** Ban on non-biodegradable plastic bags. Biodegradable bags are allowed, and the use of bilum bags, made of organic woven material, is encouraged;[1]
- **The Philippines:** Rules on waste minimization at source and separation and No specific rules on plastic bags;[1]
- **Republic of Korea:** Prohibition of distribution of packaging for free and Requirements to put in place a recycling plan for specified products;[1]
- **Samoa:** General obligations to regulate wastes. No specific bans;[1]
- **Singapore:** Mandatory requirement to submit waste report and waste reduction plan;[1]
- **Solomon Islands:** Only regulates disposal at national level (solid waste/litter regulation);[1]
- **Sri Lanka:** Prohibit the manufacture of polythene or any polythene product of 20 microns or below in thickness for in country use. Polythene or any polythene product of 20 microns or below in thickness can be permitted to be used with the prior written approval of the Central Environmental Authority for (a) the use of specified material for laminating and (b) the use for medical and pharmaceutical purposes in the absence of other suitable alternatives;[1]
- **Thailand:** Only regulates disposal at national level (solid waste/ litter regulation);[1]
- **Timor-Leste:** Only regulates disposal at national level (solid waste/litter regulation);[1]
- **Tonga:** Levy on plastic bags on importation. Exemptions provided and Waste Management requirements;[1]
- **Tuvalu:** Only regulates disposal at national level (solid waste/litter regulation);[1]
- **Vanuatu:** Prohibit the import of non-biodegradable plastic single-use bags, Obligation for local manufacturers of plastic bags to use only biodegradable plastics as of January 31, 2018 and Prohibition of the Manufacture, sell, give or otherwise provide single use bags other than to contain, wrap or carry meat or fish, single use of plastic bags are shopping bags that are made out of polyethylene less than 35 microns thick;[1]
- **Viet Nam:** Environmental protection tax issues against use of plastic bags and Requirements for reduction and waste minimization;[1]

## 5.2 Bans and Restriction for Regulatory Plastic Bags

The two main mechanisms employed by national governments are bans or restrictions on supply and distribution of the single use plastics (bags and other single use plastic items and microbeads and market-based instruments such as taxes or levies. **Table 5.1** disaggregates countries according to the different types of bans or restrictions. **Figure 5.1** provides the information on the type of ban (total or partial) in terms of a visual overview of the distribution of market entry restrictions across the Asia and the Pacific.[1]

**Table 5.1: Plastic Bag Bans or Restrictions[1]**

| Type of Restriction | Countries |
|---|---|
| Manufacture, Retail Distribution and Importation | Bangladesh, Cambodia, China*, Nepal*, Marshall Islands, Mongolia, Pakistan, Papua New Guinea*, Samoa, Sri |

| Type of Restriction | Countries |
|---|---|
| (*levy collected on Retail Distribution) | Lanka and Vanuatu |
| Retail Distribution (*with Levy) | Fiji* and Republic of Korea* |
| Manufacture and Importation | N/A |
| Manufacture | N/A |
| Importation | Japan |
| Retail Distribution and Importation (* with Levy on retail distribution) | Afghanistan, Bhutan and Palau |

Source: UN Environment (Dec 21 2018); Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Table No. 1; Page No. 14-15

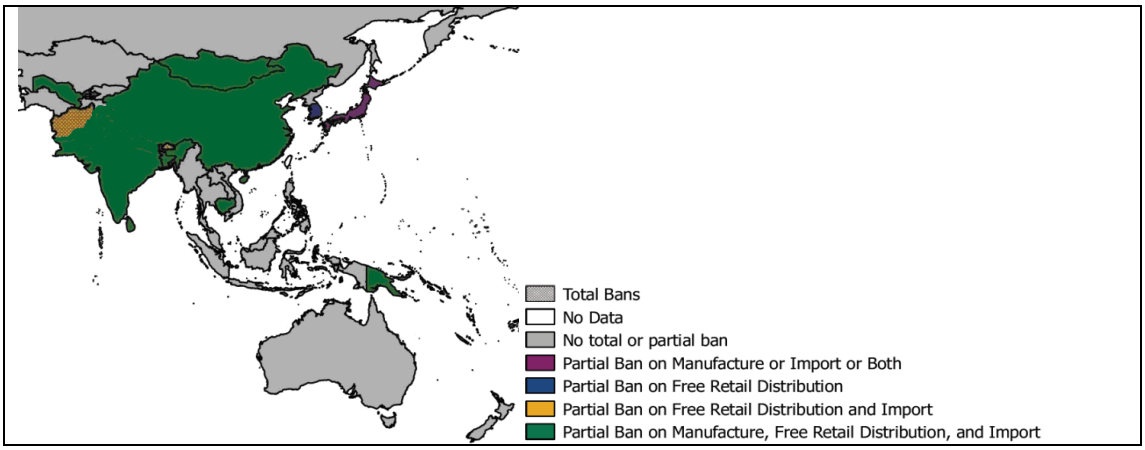



**Figure 5.1: Asia and the Pacific Overview of the Total and Partial Bans on the Manufacture, Free Distribution, and Importation of Plastic Bags[1]**

Source: UN Environment (Dec 21 2018); Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Map 1; Page No. 16

Note: The designations employed and the presentation of material on this map do not imply the expression any opinion whatsoever on the part of the Secretariat of United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Eighteen countries in the Asia and the Pacific region have imposed ban or restriction in order to regulate domestic market entry of plastic bags. Two countries (Fiji and Republic of Korea) ban free retail distribution of plastic bags. Three countries (Afghanistan, Bhutan and Palau) restrict importation and retail distribution of plastic bags.[1]

Majority of the countries have opted for partial bans or restrictions, mostly in the form of thickness requirements and material composition. **Table 5.2** describes ten countries in the region which have imposed thickness requirement of plastic bags. This table also describes nine countries with requirement of material composition. This requirement is broadly based on bio and non biodegradable characteristics of the bags. No country in the region has imposed restriction on production volume. Cambodia, Nepal, Marshall Islands, Vanuatu and Palau promote reusable bags. **Table 5.4** describes the type of mandate related to reusable bags, which includes (i) provision of reusable bags to consumers either free of charge or for a fee (ii) exemption of reusable bags from the ban on plastic bags and (iii) Obligation on retailers and / or consumers to opt for reusable bags.[1]

**Table 5.2: Regional Distribution of Countries with Thickness Requirements for Plastic Bags[1]**

| Country | Thickness Threshold |
|---|---|
| Bangladesh | Ban on plastic bags 20 $\mu m$ (microns) or less |
| Cambodia | Ban on plastic bags except for plastic bags 0.03 mm or thicker and with a bottom |

| Country | Thickness Threshold |
|---|---|
| | width of at least 25 cm or 10 inches, subject to permit from the ministry of environment |
| China | Ban on plastic shopping bags less than 0.025 mm in thickness (ultrathin plastic bags) |
| India | Minimum of 50µm (microns), except for bags made of compostable plastic |
| Mongolia | Ban on all types of plastic bags 0.025 mm thick or lesser (full ban effective March 1, 2019) |
| Nepal | Ban on plastic bags less than 30 microns for small bags (7" X 14") and 40 microns for bigger bags (20 Inches X 35 inches) |
| Pakistan | Minimum thickness of oxo-biodegradable plastic products of at least 50 microns |
| Sri Lanka | Ban on plastic bags 20 microns or less, unless with written approval from the Central Environmental Authority |
| Vanuatu | Ban on plastic bags less than 35 microns thick |
| Vietnam | Environmental-friendly bags more than 50 microns are exempt from tax |
| **Country** | **Material Composition Requirement** |
| Cambodia | Importation and production of bag or packaging material produced from biodegradable or bioplastic substances shall have preferential tax rates |
| India | Thickness requirement (50 microns) shall not be applicable to carry bags made up of compostable plastic in conformity with the prescribed standard |
| Pakistan | Ban on plastic products which are non-degradable. Disposable plastic bags must be made with oxo-biodegradable plastic technology from a registered supplier |
| Palau | Retail establishments shall not provide plastic bags except those that are biodegradable or compostable to their customers |
| Papua New Guinea | Ban is on non-biodegradable plastic bags. Biodegradable bags are allowed, and the use of bilum bags, made of organic woven material, is encouraged |
| Republic of Korea | Biodegradable plastic bags may be distributed for free |
| Samoa | Ban on all plastic bags except biodegradable bags |
| Vanuatu | Ban on import of non-biodegradable plastic single-use bags; local manufacturers of plastic bags to use only biodegradable plastics as of January 31, 2018. |
| Vietnam | Environmentally-friendly bags with bio-decomposition ability of at least 60% in a period of up to 2 years are exempt from the environmental protection tax |

Source (Dec 21 2018): UN Environment; Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Table No. 3 - 4; Page No. 18-20

Four countries, Bangladesh, Cambodia, Pakistan and Republic of Korea in Asia and the Pacific region expressly provide for exemptions to their ban on plastic bags. The exemptions relate to certain activities and certain products. Republic of Korea exempts plastic bags ban for primary packaging for fresh, perishable or other loose food and pharmaceutical products. Bangladesh exempts them for export. Cambodia exempts from the ban of the importation of plastic bags for non-commercial purposes in small volumes of 100 kg. or less. Pakistan exempts plastic bag use for sanitation or waste storage and disposal. Country specific short summaries of the major features or approaches found in legislation in Asia and the Pacific region is given below.[1]

**Table 5.3: Countries with Mandates for Reusable Bags[1]**

| Country | Type of Reusable Bag Regulation |
|---|---|
| Palau | Provide to consumers or end-users free of charge for a fee |
| Cambodia and Nepal | Obligation on retailers and/or consumers to opt for reusable bags |
| Marshall Islands | Exemption from the plastic bag ban |

Source: UN Environment (Dec 21 2018); Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Table No. 5; Page No. 23

## 5.3 Market Based Instruments for Regulating Plastic Bags

The major regulatory approaches using market based instruments include specific national legislation on plastic bags while others have packaging laws or regulations which govern plastic bags. Other approaches include implementation of extended producer responsibility (EPR), fixing up of recycling targets, fines related to plastic bag legislation and city level regulation of plastic bags. Countries have instituted taxes on the manufacture, import or production of plastic bags. The two common

market based approaches adopted across Asia and the Pacific region include: (i) Taxes on manufacturers, Importers and Producers (ii) Levy or fee charged to consumers.[1]

India is the only country in Asia and the Pacific which has imposed a tax on manufacture / production / import of plastic bags. China, Republic of Korea, Nepal and Fiji are the other countries which have adopted general or specific legislation which set a defined fee per plastic bag type as well as more discretionary approaches which allow the retailer to determine the fee to be charged for each type of plastic bag. **Table 5.4** describes country regulations on plastic bags through levies on fees in Asia and the Pacific regions. **Figure 5.2** describes two market based regulatory approaches being adopted in Asia and the Pacific region. Malaysia and Vietnam provide fiscal incentives or tax breaks to manufactures to either recycle or produce reusable plastic bags.[1]

**Table 5.4: Specific Country Regulation on Plastic bags through Levies or Fees in Asia and the Pacific Region[1]**

| Countries | Regulation by payment of levies or fees |
|---|---|
| | Levies |
| **Fiji** | Levy paid by consumer: A levy is charged on plastic bags distributed by businesses prescribed by regulations. the Environment and Climate Adaptation Levy charged on plastic bags is $0.10c per plastic bag. The Levy on plastic bags is payable by the person to whom a plastic bag is provided. |
| **China** | Fees on the sale of plastic bags: No exact fee requirement is provided by the law, this is determined by the retailer, but the fee for plastic shopping bags cannot be lower than the manufacturing cost or have any discount or be free. No free plastic shopping bags shall be provided at any commodities retail places, and the price of plastic shopping bags shall be clearly marked and charged separately from the commodity price." |
| **Republic of Korea** | Fee on the sale of plastic bags: Act on the promotion of saving and recycling of resources – For Single- use plastic bags and shopping bags -5 cent/bag. |
| **Nepal** | Consumer fee: Retailers, super Market and Shopping malls are entitled to charge fee for alternate bag they provided. 0.30 cent to 50 cents |

Source: UN Environment (Dec 21 2018); Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Table No. 17; Page No. 38-39

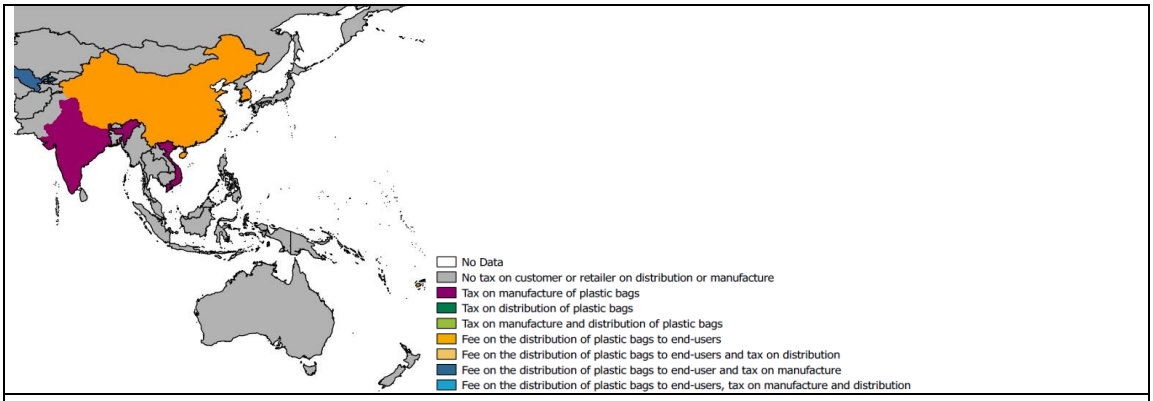



**Figure 5.2: Countries which use taxes, or fees to regulate the manufacture, distribution/use or trade in plastic bags[1]**

*Note: * Countries fee systems are not yet in force but regulations were passed this year.*

Source: UN Environment (Dec 21 2018); Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Map 3; Page No. 36

Note: The designations employed and the presentation of material on this map do not imply the expression any opinion whatsoever on the part of the Secretariat of United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

### 5.3.1 Return, Collection, Recycling and Disposal of plastic

The disposal phase of plastic bags in Asia and the Pacific region has been addressed by adopting three approaches: (i) extended producer responsibility (ii) recycling

targets and (iii) fines related to disposal of plastic bags. All the three approaches are on the responsible collection and disposal by manufacturers or producers of plastic, retailers and distributors and in some cases the consumer. **Figure 5.3** indicates nine countries, Australia, Bhutan, India, Indonesia, Japan, Republic of Korea, Togo, Tonga and Vanuatu which have implemented EPR based regulation in Asia and the Pacific region.[1]

**Box – 10: EPR in Australia**

EPR is part of lifecycle management of a range of products and can include management of the potential environmental impacts of a product in all stages of production, distribution, use, collection, re-use, recycling, reprocessing and disposal of that product.

Source (Dec 21 2018): UN Environment; Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Page No. 41

For example, in India, Plastic Waste Management Rules 2016 and in Japan, Containers and Packaging Recycling Act 1995 describe institutionalization of EPR based regulations.[1]


**Figure 5.3: Countries with Extended Producer Responsibility to Regulate Plastic Bags in Asia and the Pacific Region[1]**

Source: UN Environment (Dec 21 2018); Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Map 4; Page No. 43

Note: The designations employed and the presentation of material on this map do not imply the expression any opinion whatsoever on the part of the Secretariat of United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Seventeen countries Asia and the Pacific have instituted recycling targets in various forms. These countries are Australia, Bhutan, Cambodia, India, Indonesia, Japan, Lao PDR, Mongolia, The Philippines, Republic of Korea, Samoa, Togo, Tonga, Tuvalu and Vanuatu. Some countries have set targets on the number of plastic bags to be collected and recycled while have others set targets for local authorities to create waste management plans that include recycling components e.g. India. Most countries have solid waste and litter legislation to regulate plastics and plastic bags in Asia and the Pacific region. However, Nepal under Environmental Protection Act 1997,

Section 19, imposes a fine of up to NRs 50000 (US$ 500) for breaching the Plastic Bag Monitoring and Control Guideline 2011.[1]

Australia, Brazil, and India have regulations at the sub national / city level. 59 cities and municipalities, mostly in and around the national capital region in the The Philippines have enacted local ordinances that ban or charge a levy on plastic bags.[1]

## 5.4 Bans and Restrictions for Single Use Plastics

Single use plastics are regulated by targeting bans or restrictions on the manufacture, use, distribution, sale, or trade along their material flow chain in eight countries in Asia and the Pacific region. These countries have enacted bans of some type on the manufacture, distribution, use, sale, and/or import of single-use plastics. **Table 5.5** describes the type of ban or restriction and legislation related to single use plastics. All types of bans do not apply to all types of disposable plastic products. **Figure 5.4** and **Figure 5.5** illustrate bans or single use plastics and bans on specific products. The most commonly targeted polymers are polystyrene and expanded polystyrene and the most commonly targeted products are for the packaging, carrying and consumption of food. Bans on specific products are most commonly focused on those associated with food service and delivery. This include cup, plates, stirrers, PET bottles, food containers, egg cartons, lunch wrappers, spoons and horticulture nettings.[1]

**Table 5.5: National bans and restrictions on single-use plastics[1]**

| Country | Type of ban or restriction | Legislation |
|---|---|---|
| China | Material/product ban: Ban on the import of used plastics for use as raw materials, including plastic bags, films, and nets, and polyvinyl, styrene polymer, PET | Notice on adjusting the managing category of imported wastes" (02/26/2014) Exhibit 1 Prohibited Wastes, No. 80; 2 |
| Fiji | Production/distribution restriction: Facilities must have a plastic bottle permit from work permit committee in order to manufacture or import plastic bottles. Application for permit must include measures taken to collect and recycle bottles. | Environmental Management (Waste disposal and recycling) Guidelines 2007 |
| Marshall Islands | Material/Product ban: a ban on the importation, manufacture, sale and distribution of polystyrene cups and plates, disposable plastic cups and plates and plastic shopping bags | Styrofoam and Plastic Products Prohibition Act 2016, S. 3 |
| Pakistan | Product ban: Ban on the manufacture, import, sale, and use of non-biodegradable plastic products in the Islamabad Capital Territory | Environment Protection Act 1997 of Pakistan, SRO No 5 (KE) 2013 |
| Republic of Korea | Ban on free distribution: Disposable products, including PET bottles, plastic plates, utensils, cups and other disposable packages cannot be provided free of charge | Article 10 of Act on the promotion of saving and recycling of resources (Control etc., of use of disposable products); 2015 |
| Samoa | Product Ban: Prohibits the import, manufacture, export, sale and distribution of plastic shopping bags, packaging bags and straws effective from the 30th January 2019. Plastic shopping bags under the regulations means a bag made in whole or partly of thin plastic film and contains starch (such as biodegradable bags) or full petroleum or additive used as shopping bags and packing bags used for re packing and storage of products. Exemption have been made for the purposes of food safety and in consideration of food items where plastic and packaging is necessary. The following therefore exempted from the prohibition plastic bag used exclusively to pack or repack cream ice cubes locally produced chips locally produced kekesaica, ava, local buiscuits, repacked coffee, tea, sugar, flour and cacoa. | Waste (Plastic Bag) Management Regulation 2018 |
| Sri Lanka | Material/product ban: 1) Ban on the manufacture, distribution and use of food containers, plates, cups, and spoons made from polystyrene and lunch wrappers (a commonly used item in Sri Lanka) made from polyethylene. Separately, 2) the import of disposable polystyrene boxes and polymers of ethylene, styrene and vinyl chloride are controlled. | Executive Order as gazetted No. 2034/34 of September 1, 2017 provided for by Article 51 of the 19th Amendment to the Constitution and the National Environmental Act No. 47 of 1980 as amended, S. 23. 2) Imports and Exports Control Act No. 1, 1969; Gazetted 2044/40 and 2044/41 of September 11, 2017. |
| Tuvalu | Material/product ban: The manufacture, sale, distribution of | Ozone Depleting Substances |

| Country | Type of ban or restriction | Legislation |
|---|---|---|
| | plastic foam products (including polystyrene foam, board stock, egg cartons, food containers, disposable plates and cups, and horticulture netting) is banned. | Regulations 2010. |
| Vanuatu | Material/product ban: The manufacture, distribution, use, and import of plastic straws and polystyrene products, including takeout boxes, food packaging, disposable plates and cups, and horticultural netting | Waste Management Act 24 of 2014 |

Source: UN Environment (Dec 21 2018); Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; https://www.mnre.gov.ws; Table No. 23; Page No. 51

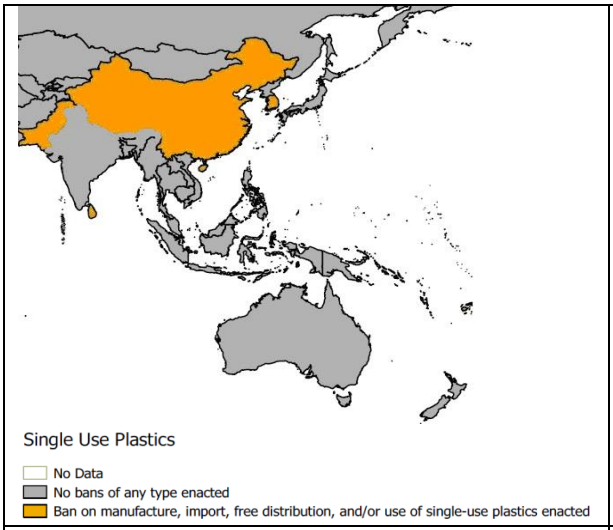



**Figure 5.4: Bans on Single-Use Plastics[1]**

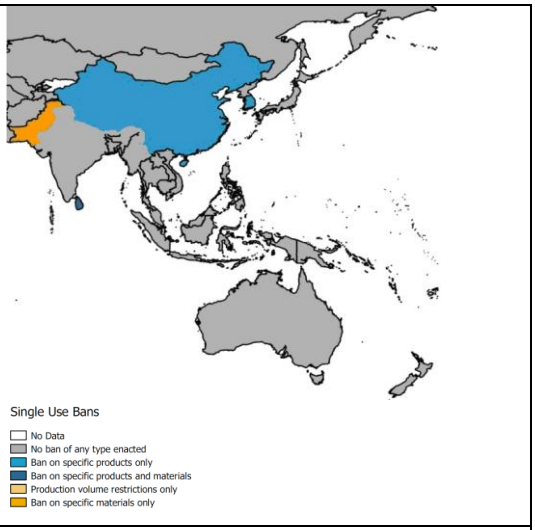



**Figure 5.5: Bans on specific Products[1]**

Source: UN Environment; Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Map 5 and Map 7; Page No. 48-50

Note: The designations employed and the presentation of material on this map do not imply the expression any opinion whatsoever on the part of the Secretariat of United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

**Table 5.6** indicate the type of ban, the countries have imposed in Asia and the Pacific region. Four countries, Marshall Islands, Pakistan, Sri Lanka, Vanuatu have imposed ban on manufacture, free distribution and import of single use plastics. China has imposed ban on import while Republic of Korea has imposed ban on free distribution. Bans may target the production, distribution or sale, use, or import of single-use plastics. Tuvalu has imposed ban on both free distribution and import of single use plastic.[1]

**Table 5.6: Bans and Restrictions in Asia and the Pacific Region[1]**

| Region/Country | Ban on Manufacture | Ban on Free Distribution | Ban on Import |
|---|---|---|---|
| China | | | ✓ |
| Marshall Islands | ✓ | ✓ | ✓ |
| Pakistan | ✓ | ✓ | ✓ |
| Rep. of Korea | | ✓ | |
| Sri Lanka | ✓ | ✓ | ✓ |
| Tuvalu | | ✓ | ✓ |
| Vanuatu | ✓ | ✓ | ✓ |

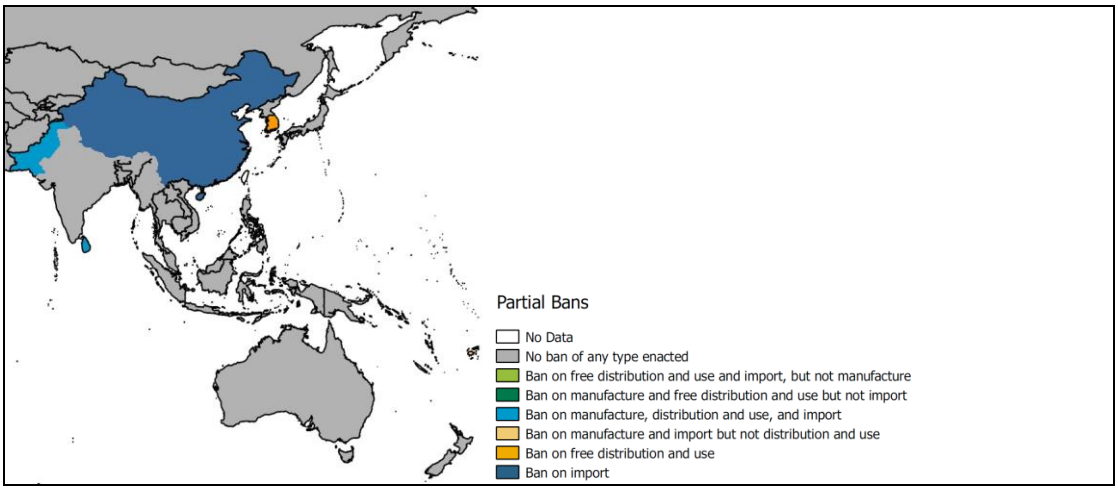



**Figure 5.6: Partial Bans on Single-Use Plastics[1]**

Source: UN Environment; Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Table No. 24; Map 6; Page No. 49

Note: The designations employed and the presentation of material on this map do not imply the expression any opinion whatsoever on the part of the Secretariat of United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

**Box 10: Selected Example of Sub-national Action (Maharashtra, India)**

The Indian state of Maharashtra has banned the manufacture, usage, distribution, sale, storage, and import of plastic bags and disposable products made from plastic (including polystyrene). This includes cups, utensils, plates, glasses, containers, and plastic packaging. There are exceptions for use in the medical, agricultural, waste, food storage, and export fields. Fines have been set at the equivalent of US$68 for first offenders, which doubles for a second offense. Third offenses may result in a fine of the equivalent of US$340 and possible imprisonment.

Source: https://indianexpress.com/article/india/plastic-ban-in-maharashtra-mumbai-from-june-23-what-is-allowed-what-is-banned-all-you-need-to-know-5228307/

## 5.5 Market Based Instruments (MBI) for Single Use Plastics

Market based instruments for single use plastics are applied both on the upstream and downstream side of consumption.[1]

### 5.5.1 Market Based Instruments (MBI) Upstream of Consumption

Three (3) countries in Asia and the Pacific countries (India, Marshall Islands and Palau) have enacted some type of tax on single use plastics, as a waste disposal fees or charges, or in the form of higher excise taxes for single-use plastics. The taxes are aimed at managing plastic waste or increasing the rate of post consumer recovery or recycling, or other environmental and circular economy initiatives. **Table 5.7** summarizes the type of taxation applicable upstream of consumption.[1]

**Table 5.7: Types of taxation on single-use plastics[1]**

| Region | Country | Tax Regulation |
|---|---|---|
| Asia and Pacific | India | Excise tax at higher rates for plastic packaging and single-use products including tableware and kitchenware (compared to glass, wood and tin packaging) (Goods and Services Tax Act). |
| | Marshall Islands | Deposit beverage container fee on each deposit beverage container manufactured or imported into the country (Styrofoam cups and |

| Region | Country | Tax Regulation |
|---|---|---|
| | | plates and Plastic Products Prohibition and Container Deposit Amendment Act). |
| | Palau | Deposit beverage container fee on distributors (manufacturers and importers) of filled deposit beverage containers (The Palau Recycling Act). |

Source: UN Environment (Dec 21 2018); Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Table No. 25; Page No. 56

### 5.5.2 Market Based Instruments Downstream of Consumption

MBIs downstream consumption include EPR, deposit refund schemes and recycling mandates.[1]

**Extended Producer's Responsibility (EPR)**

Nine (9) countries (Fiji, India, Indonesia, Republic of Korea, Australia, Bhutan, Japan, Palau and Marshall Islands) in the Asia and the Pacific region have regulations for the disposal of single use plastic items that includes extended producer responsibility. Examples of the rules from Fiji and Indonesia are given in **Figure 5.7**. EPR mandate for target and obligation varies from country to country. Some countries include both producers and retailer or distributors while some countries only distributors and retailers. (4) countries (Fiji, Kiribati, Marshall Islands and Palau) in Asia and the Pacific region have requirements for taking back of single-use plastic products (mainly beverage bottles) through deposit-refund schemes.[1]

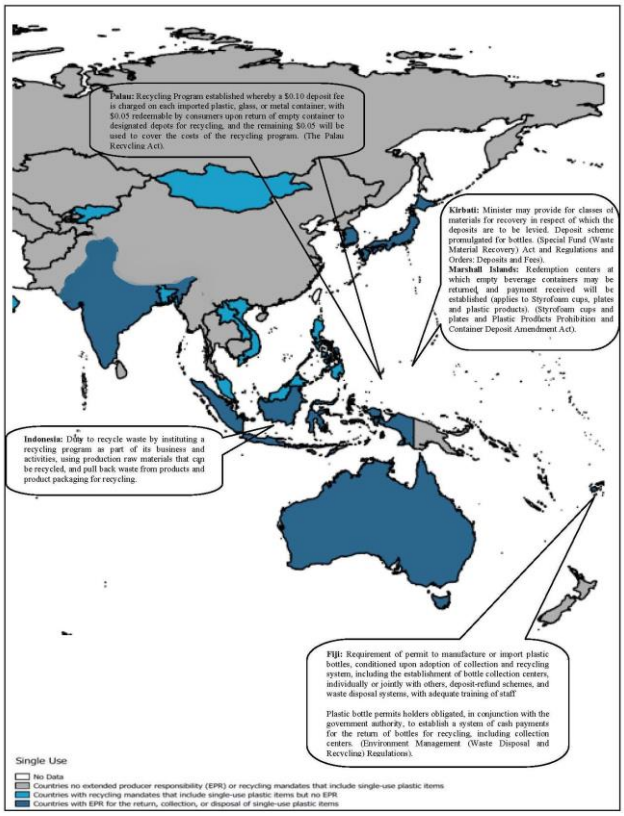



**Figure 5.7: Countries With Extended Producer Responsibility On Disposable Or Single-Use Plastics and Recycling Targets for Single Use Plastics[1]**

Source: UN Environment; Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Table No. 27-28; Map 8; Page No. 58, 60 and 61

Note: The designations employed and the presentation of material on this map do not imply the expression any opinion whatsoever on the part of the Secretariat of United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

**Recycling Mandates**

The Asia Pacific region with seven (7) countries was found to have exclusive regulatory mandates regarding recycling. These regulations vary, with most countries' regulations limited to general requirements e.g. solid waste and/or targets for plastics recycling **(Table 5.8)**.[1]

**Table 5.8: Regional Distribution of Countries with Recycling Mandates[1]**

| Country | Required | Targets | Fiscal Incentives | Description |
|---|---|---|---|---|
| Fiji | ✔ | ✔ | | Fiji's recycling mandate includes a facility that imports or manufactures plastic bottles must send returns to the Department of Environment of all import, manufacture, distribution, return and disposal of bottles. Returns must be in writing and sent every 6 months from the issue of the permit. Failure to send a return by the due date is an offence under section 44 of the Act and can lead to suspension of the permit. |
| India | ✔ | ✔ | | India's recycling mandate includes "Responsibility of producers, Importers and Brand Owners. - (3) manufacture and use of non-recyclable multilayered plastic if any should be phased out in two years' time."<br>As per Plastic Waste Management Rules, 2016, Responsibility of producers, Importers and Brand Owners.- ... (3) manufacture and use of non- recyclable multilayered plastic if any should be phased out in Two years' time. |
| Indonesia | ✔ | | | |
| Republic of Korea | ✔ | ✔ | | As per Act on the Promotion of Saving and Recycling of Resources: Mandatory Recycling Ratio applied to manufacturers, ranging from 0.442 (single- material polystyrene paper) to 0.830 (PET complex materials). Recycling due is 30/100 of the sum of expenses to be incurred in recycling non-recycled wastes out of the mandatory recycling quantity. |
| Malaysia | ✔ | | ✔ | Manufacture of biodegradable disposable packaging and household wares and waste recycling activities are listed as promoted products and activities under the Promotion of Investments Act which are eligible for pioneer status and investment tax allowance. |
| Palau | ✔ | | | Palau enacted a national recycling program in which the government administers a beverage container deposit-refund scheme. |
| The Philippines | ✔ | ✔ | | |

Source: UN Environment (Dec 21 2018); Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Table No. 29, 30, 31 and 32; Page No. 64-68

## 5.6 Microbeads

Republic of Korea and New Zealand have enacted national level laws or regulations that ban the use, sale, and/or manufacture of microbeads in personal care products which end up as marine litter. The Ministry of Health, Government of India along with different departments of the Bureau of Indian standards, have placed microbeads in a category not allowed as ingredients of various cosmetic and other such products including household laundry detergent bars, synthetic detergents for washing woolen

and silk fabrics, synthetic detergents for industrial purposes, and household laundry detergent powders. The final notification, including any modifications, will be published after inviting comments from the public. Australia, China and Singapore have taken voluntary measures to phase out or limit the use of microbeads in personal care products. **Table 5.9** provides the name of the specific microbead law or regulations, products covered prohibition.[1]

**Table 5.9: Microbead Laws and Regulations[1]**

| Country | Law or Regulations Name | Prohibition | Specific Description |
|---|---|---|---|
| **Republic of Korea** | Regulations on safety standards for cosmetics [Annex 1] {No. 2017-114, Notice, Article 3, Dec. 29, 2017, | Cannot sell or manufacture | use of raw materials cannot be used in cosmetics and restrictions on the use of cosmetics should be specified |
| **New Zealand** | Waste Minimisation (Microbeads) Regulations 2017, under section 23(1)(b) of the Waste Minimisation Act 2008. | Cannot sell or manufacture | A person must not sell a prohibited wash-off product in New Zealand. A person must not manufacture a prohibited wash-off product in New Zealand. |

Source: UN Environment (Dec 21 2018); Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Table No. 33; Page No. 72

Definition forms the basis for restriction on the size and specificity of plastic particles. For example, in Republic of Korea, microplastic are defined as solid plastic under 5 mm, contained in rinse-off, scrub, and other products while in New Zealand, microbead means a water-insoluble plastic particle that is less than 5 mm at its widest point. New Zealand provides specific exemption for microbead usage for medical device and medicine where medical device is any device, instrument, apparatus, appliance, or other article is intended to be used in, on, or for human beings for a therapeutic. Medicine is defined as any substance or article that is manufactured, imported, sold, or supplied wholly or principally for administering to 1 or more human beings for a therapeutic purpose. India proposes to have regulation on microbeads in future.[1]

**Product Type Covered**

- Cosmetics and sanitary aids
- Wash-off products including heavy- duty hand cleansers, abrasive cleaning products and car or industrial cleaning products

**Specific Description**

- Product types such as cosmetics (for rinse-off, scrub, etc) and sanitary aids (gargle, toothpaste, and teeth whitening)
- Wash-off product for 1 or more of the following purposes: exfoliation of all or part of a person's body; cleaning of all or part of a person's body; abrasive cleaning of any area, surface, or thing and visual appearance of the product.

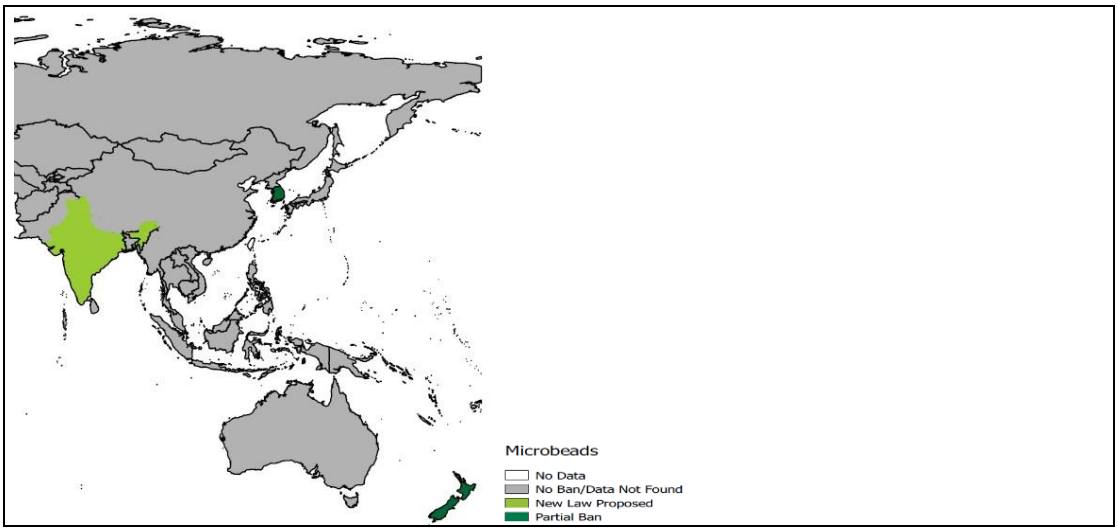



**Figure 5.8: Number of Countries with bans on Microbeads[1]**

Source: UN Environment; Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Map 9; Page No. 70

Note: The designations employed and the presentation of material on this map do not imply the expression any opinion whatsoever on the part of the Secretariat of United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The type of voluntary approach taken by Australia, China and Singapore is given in **Table 5.10**.

**Table 5.10: Summary of the Voluntary Approaches Taken by Countries in Asia and the Pacific[1]**

| Country | Type of Voluntary Measure | Voluntary Measure Description |
|---|---|---|
| **Australia** | Government and industry sector negotiations and agreements for voluntary phase-out action | The Department of the Environment and Energy is working with industry and state and territory governments to ensure a voluntary phase-out of microbeads from rinse-off, personal care, cosmetic and cleaning products by July 2018. The phase-out focusses on microbeads in rinse-off products, which would be reasonably capable of entering the marine environment through normal use.<br><br>The voluntary phase out does not include a number of products known to contain microbeads including cosmetic products that are generally wiped-off, such as make up and lipsticks, some industrial cleaning products or medicines |
| **China** | Individual company and/or trade association voluntary industry phase-out actions | Sa Sa is the first Hong Kong Special Administrative Region of the People's Republic of China retail group to release a public statement and commit to a phaseout timeline for microbeads. They state that by 31 December 2018, all exfoliating or cleansing products sold at Sa Sa under private labels will contain no microbeads in any of its formulation. They will also make an effort to ban any microbeads in their non-private label products as well. |
| **Singapore** | Individual company and/or trade association voluntary industry phase-out actions | Guardian Singapore, a health and beauty chain, has banned microbeads from its new rinse-off cosmetics and personal care products and all its own-brand products will be free of microbeads by the end of 2017. |

Source: UN Environment; Legal Limits on Single Use Plastics and Microplastics – A Global Review of National Laws and Regulations; Table No. 14; Page No. 80 and 82

## 5.7 Multilateral Environmental Agreements

Countries in Asia and the Pacific region have signed and ratified a number of multilateral environmental agreements at global and regional level. These address impact of plastic waste both on terrestrial and aquatic and marine ecosystem. These conventions include Stockholm, Basel, Waigani, Rotterdam and Minamata

Conventions.[2][3][4][5][6] Countries in the region have also signed and ratified conventions related to maritime operations[7]. A snapshot of the status of major international conventions with respect to countries in Asia and the Pacific region is given in **Table 5.11**.[8] Further, brief description of these conventions in given in **Annexure 5.1**.[8] Significant stepping stones firming up international policy background related to marine litter include: Honululu Strategy (2011): Globally framing an action plan to prevent, reduce and manage marine litter;[9] Manila Declaration (2012): Global programme of action marine litter becoming an additional major component;[9] Rio+20 Declaration (2013): Significant reduction of marine litter until 2025[9] and UN SDG 14.1 (2015): By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land based activities, including marine debris and nutrient pollution.[9] The United Nations Environment Assembly's resolutions 1/6 “Marine plastic debris and microplastics”, 2/11 "Marine plastic litter and microplastics", and the third UN Environment Assembly resolution on marine litter and microplastics (UNEP/EA.3/L.20) are major global landmarks to address marine litter and plastic pollution. The UN Environment Assembly 3 (UNEA3) resolution calls for integrated and synergistic actions to address marine litter and plastic pollution and requests the Executive Director of the United Nations Environment Programme (UN Environment), to compile the voluntary commitments as applicable targeting marine litter and microplastics and to provide an overview of their scope in support of the UN Environment Assembly’s work on this issue and to better understand progress towards achieving SDG target 14.1 and present this report to UNEA-4.[10]

Globally, a number of declarations and initiatives to tackle marine litter have been demonstrated at regional level. Some of such demonstration include: “Our ocean, our future: call for action” Declaration adopted at the UN Ocean Conference in June 2017 in New York[11] and the voluntary commitments presented there, in the G20 Summit’s momentous resolution to reduce marine litter, taken in Germany in July 2017, and its associated Action Plan, and the fourth, “Our Oceans Conference” in Malta in October 2017.[12] The Communiqué of the G7 Bologna Environment Ministers’ Meeting (Bologna, Italy), June 2017, called for further implementation of the G7 Summit Action Plan and for strengthening the coherence, efficiency and effectiveness of existing international efforts, in particular the Regional Seas Programmes (RSPs) s’ activities to address marine litter, while taking into account regional contexts, mainly through the following initiatives: a) Harmonization of science-based indicators and methodologies for monitoring and evaluation, including through research; b) Identification, development, implementation and outreach of broad and accessible databases; c)Identification and dissemination of best practices, especially on prevention and management of waste and litter from land based and sea based sources and on removal actions; d) Development of capacity building efforts; e) Identification, development and dissemination of measures for: cost-benefit assessments, partnerships to support cost recovery instruments, extended producer responsibility and promotion of investments in waste and water management infrastructures, including through cooperation with the private sector; f) Progressive reduction of single-use plastics and microplastics, including microbeads, to avoid the leakage of plastics to the marine environment, including through research on substitutes.[13] The status of progress of land based sources and activities (LBSA) under RSPs and identification of needs and opportunities are given in **Table 5.12** and **Table 5.13**.[14] The description about these RSPs are summarized in **Annexure 5.2**.[14]

Further At regional level in Asia and the Pacific region (Australia, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, People's Republic of China, Fiji, India, Indonesia, Japan, Kiribati, Republic of Korea, Lao PDR, Malaysia, Maldives, Marshall Islands, Federated States of Micronesia, Mongolia, Myanmar, Palau, Papua New Guinea, the Philippines, Samoa, Singapore, Solomon Islands, Thailand, Timor-Leste, Tonga, Tuvalu, and Viet Nam), renewed their commitment to realizing a promising decade (2013-2023) of sustainable actions and measures for achieving resource efficient society and a green economy in the Asia-Pacific region through the implementation of the 3Rs (reduce, reuse, and recycle), at the Fourth Regional 3R Forum in Asia, held in Ha Noi, Viet Nam, from 18 to 20 March 2013, Specific goals are summarized in **Annexure 5.3**.[15] Further the countries in Asia and the Pacific region (Afghanistan, Australia, Bangladesh, Bhutan, Cambodia, China, Commonwealth of the Northern Mariana Islands, India, Indonesia, Japan, Kazakhstan, Kiribati,the Republic of Korea, Lao People's Democratic Republic, Malaysia, Maldives, Marshall Islands, Mongolia, Myanmar, Nepal, Niue, Pakistan, Palau, the Russian Federation, Samoa, Singapore, Solomon Island, Sri Lanka, Tajikistan, Thailand, the Philippines, Timor-Leste, Tokelau, Tonga, Tuvalu, and Viet Nam), city government representatives, adopted Adelaide 3R Declaration towards the Promotion of Circular Economy in Achieving the Resource Efficient Societies in Asia and the Pacific under the 2030 Agenda for Sustainable Development, at the regional 3R forum held in Adelaide, Australia in 2017.[16] In 2018, city governments in Asia and the Pacific region committed and adopted Indore 3R Declaration on Achieving Clean Land, Clean Water and Clean Air in cities on 11$^{th}$ April 2018 as part of 8$^{th}$ Regional 3R Forum in Asia and the Pacific held in Indore, India.[17]

**Table 5.11: Asia and the Pacific Countries Participation in International and Regional Waste, Chemicals and Pollution Treaties[18]**

| International and regional (Pacifi Conventions | SPREP Member Countries | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cook Islands | Federated State of Micronesia | Fiji | Kiribati | Marshall Islands | Nauru | Niue | Palau | Papua New Guinea | Samoa | Solomon Islands | Tonga | Tuvalu | Vanuatu | Australia | New Zealand | Mongolia | Singapore | China | Malaysia | Vietnam | Thailand | Lao PDR | Bhutan | Japan | Maldives | Indonesia | Sri Lanka | India | Cambodia | Pakistan | The Philippines | Nepal | Myanmar | Bangladesh | Afganistan |
| Stockholm Convention | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | S | X | X | X | - | X | X | X | X | X | X | X | X | X | X | X | X |
| Basel Convention | X | X | | X | X | X | | X | X | X | | X | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Waigani Convention | X | X | X | X | | S | X | S | X | X | X | X | X | X | X | X | | | | | | | | - | | | X | X | | | | | | - | | X |
| Rotterdam Convention | X | | | | X | | | | | X | | X | | | X | X | X | X | X | X | X | X | X | - | X | X | X | X | X | X | X | X | X | - | X | - |
| Minamata Convention | | | | | | | | S | | S | | | | | S | S | X | X | X | S | AA | X | A | - | X | - | X | X | X | S | S | S | S | - | S | - |
| MARPOL 73/78 (Annex I/II) | X | | | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | A | - | - | X | X | X | X | X | X | X | X | - | X | X | - |
| MARPOL 73/78 (Annex III) | | | | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | - | - | X | - | X | X | X | X | X | X | - | X | X | - |
| MARPOL 73/78 (Annex IV) | | | | X | X | | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | | - | - | X | - | X | X | X | X | X | X | - | X | X | - |
| MARPOL 73/78 (Annex V) | | | | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | - | - | X | X | X | - | X | X | X | X | - | X | X | - |
| MARPOL Protocol 97 (Annex VI) | X | | | X | X | | X | X | | X | | X | X | X | X | | X | X | X | X | X | | - | - | X | - | X | - | X | - | - | X | - | - | X | - |
| London Convention 72 | | | | X | | X | | | X | | X | X | | X | X | X | | | X | - | - | - | - | - | X | - | - | - | - | - | X | X | - | - | - | X |
| London Convention Protocol 96 | | | | | X | | | | | | | X | | X | X | X | | | X | - | - | | - | - | X | - | - | - | - | - | - | X | - | - | - | - |
| INTERVENTION Convention 69 | | | X | | X | | | | X | | | X | | X | X | X | | | X | - | - | | - | - | X | - | - | X | X | - | X | - | - | - | X | - |
| INTERVENTION Protocol 73 | | | | | X | | | | | | | X | | X | X | X | X | | X | - | - | | - | - | X | - | - | | - | - | X | - | - | - | - | - |
| CLC Convention 69 | | | D | | D | | | | D | | | D | D | D | D | D | X | D | D | D | - | | - | - | D | X | X | X | D | X | - | - | - | - | - | - |
| CLC Protocol 76 | | | | | X | | | | | | | | X | X | X | | X | X | D | | - | | - | - | X | X | - | - | X | X | - | - | - | - | - | - |
| CLC Protocol 92 | X | | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | - | - | X | X | X | X | X | X | X | X | - | X | - | - |
| FUND Protocol 76 | | | | | X | | | | | | | | | X | X | | | | | | | | | | | | | | | | | | | | | |
| FUND Protocol 92 | X | | X | X | X | | X | X | X | X | | X | X | X | X | X | | | | | | | | | X | | | | | | | | | | | |
| FUND Protocol 2003 | | | | | | | | | | | | | | | X | | | | | | | | | | X | | | | | | | | | | | |
| OPRC Convention 90 | | | | | X | | | X | | X | | X | | X | X | X | | | | | | | | | X | | | | | | | | | | | |
| HNS Convention 96 | | | | | | | | | | X | | X | | | | | | | | | | | | | | | | | | | | | | | | |
| HNS PROT 2010 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| OPRC/HNS 2000 | | | | | | | | X | | | | | | X | X | | | | | | | | | | | | | | | | | | | | | |
| Bunkers Convention 2001 | X | | | X | X | | X | X | | X | | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | |
| Anti Fouling Convention 2001 | X | | | X | X | | X | X | | | | X | X | X | X | | | | | | | | | | | | | | | | | | | | | |
| Ballast Water 2004 | X | | | X | X | | X | X | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | |
| NAIROBI WRC 2007 | X | | | | X | | X | X | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | |
| Hong Kong Special Administrative Region of the People's Republic of China Convention | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| International and regional (Pacifi Conventions | SPREP Member Countries | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cook Islands | Federated State of Micronesia | Fiji | Kiribati | Marshall Islands | Nauru | Niue | Palau | Papua New Guinea | Samoa | Solomon Islands | Tonga | Tuvalu | Vanuatu | Australia | New Zealand | Mongolia | Singapore | China | Malaysia | Vietnam | Thailand | Lao PDR | Bhutan | Japan | Maldives | Indonesia | Sri Lanka | India | Cambodia | Pakistan | The Philippines | Nepal | Myanmar | Bangladesh | Afganistan |
| Noumea Convention | X | X | X | | X | X | | | X | X | X | | | | X | X | | | | | | | | | | | | | | | | | | | | |
| - Dumping Protocol | X | X | X | | X | X | | | X | X | X | | | | | X | | | | | | | | | | | | | | | | | | | | |
| - Emergencies Protocol | | X | X | | X | X | | | X | X | X | | | | X | X | | | | | | | | | | | | | | | | | | | | |
| - Dumping Protocol (Amended) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - Oil Pollution Protocol | | S | S | | S | | | | | S | | | | | | | | | | | | | | | | | | | | | | | | | |
| - HNSP Protocol | | S | S | | S | | | | | S | | | | | | | | | | | | | | | | | | | | | | | | | |

*Legend:* X = ratification, acceptance, approval or accession; X* = Party through its metropolitan country; S = signature; D = denunciation

Source: SPREP (2016); Cleaner Pacific 2025; Pacific Regional Waste and Pollution Management Strategy 2016-2025; http://www.pops.int/; http://www.basel.int/; https://www.sprep.org/convention-secretariat/waigani-convention; http://www.pic.int/; http://www.mercuryconvention.org/; http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx

| As at 20/02/2019 | MARPOL 73/78 (Annex I/II) | MARPOL 73/78 (Annex III) | MARPOL 73/78 (Annex IV) | MARPOL 73/78 (Annex V) | MARPOL Protocol 97 (Annex VI) | London Convention 72 | London Convention Protocol 96 | INTERVENTION Convention 69 | INTERVENTION Protocol 73 | CLC Convention 69 | CLC Protocol 76 | CLC Protocol 92 | FUND Protocol 76 | FUND Protocol 92 | LLMC Convention 76 | LLMC Protocol 96 | SUA Convention 88 | SUA Protocol 88 | SUA Convention 2005 | SUA Protocol 2005 | SALVAGE Convention 89 | OPRC Convention 90 | HNS Convention 96 | HNS PROT 2010 | OPRC/HNS 2000 | BUNKERS CONVENTION 01 | ANTI FOULING 2001 | BALLASTWATER 2004 | NAIROBI WRC 2007 | HONG KONG SPECIAL ADMINISTRATIVE REGION OF THE PEOPLE' S REPUBLIC OF CHINA CONVENTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Afghanistan | | | | | | x | | | | | | | | | | | x | x | | | | | | | | | | | |
| Australia | x | x | x | x | x | x | x | x | x | d | x | x | x | x | d | x | x | x | | | x | x | | | x | x | x | x | | |
| Bangladesh | x | x | x | x | x | | | x | | | | | | | | | x | x | | | | x | | | | | x | x | | |
| Bhutan | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cambodia | x | x | x | x | | | | | | x | x | x | | x | | | x | x | | | | | | | | | | | | |
| China | x | x | x | x | x | x | x | x | x | d | d | x | | | | | x | x | | | x | x | | | x | x | x | | x | |
| Cook Islands | x | | | | x | | | | | | | x | | x | x | x | x | | x | | | | | | | x | x | x | x | |
| Fiji | x | | x | x | | | | x | | d | | x | | x | | | x | x | x | x | x | | | | | x | x | x | | |
| India | x | x | x | x | x | | | x | | d | x | x | x | x | x | x | x | x | | | x | x | | | | | x | | x | |
| Indonesia | x | x | x | x | x | | | | | x | | x | | | | | | | | | | | | | | x | x | x | | |
| Japan | x | x | x | x | x | x | x | x | | d | x | x | x | x | d | x | x | x | | | | x | | | x | | x | x | | |
| Kiribati | x | x | x | x | x | x | | | | | | x | | x | x | | x | x | | | x | | | | | x | x | x | | |
| Lao People's Dem. Rep. | | | | | | | | | | | | | | | | | x | x | | | | | | | | | | | | |
| Malaysia | x | x | x | x | x | | | | | d | | x | | x | | x | | | | | | x | | | x | x | x | x | x | |
| Maldives | x | | | x | | | | | | x | x | x | | x | | | x | x | | | | | | | | | | x | | |
| Marshall Islands | x | x | x | x | x | | x | x | x | d | x | x | x | x | x | x | x | x | x | x | x | x | | | | | x | x | x | x | |
| Micronesia (Fed. States of) | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | | |
| Mongolia | x | x | x | x | x | | | | | x | | x | | | x | x | x | x | | | x | | | | | x | x | x | | |
| Myanmar | x | x | x | x | | | | | | | | x | | | | | x | x | | | | x | | | | x | | | | |
| Nauru | | | | | | x | | | | | | | | | | | x | x | x | x | | | | | | | | | | |
| Nepal | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New Zealand | x | x | | x | | x | x | x | x | d | | x | | x | d | x | x | x | x | x | x | x | | | | x | | x | | |
| Niue | x | x | x | x | x | | | | | | | x | | x | x | x | x | x | | | x | | | | | x | x | x | x | |
| Pakistan | x | x | x | x | | x | | x | x | | | x | | | | | x | x | | | | x | | | | | | | | |
| Palau | x | x | x | x | x | | | | | | | x | | x | | x | x | x | x | x | x | x | | | x | x | x | x | x | |
| Papua New Guinea | x | x | x | x | | x | | x | | d | | x | | x | | | | | | | | | | | | | | | | |
| The Philippines | x | x | x | x | x | x | x | | | | | x | | x | | | x | x | | | | x | | | | | x | x | | |
| Samoa | x | x | x | x | x | | | | | | | x | | x | x | x | x | | | | | x | x | | | x | | | | |
| Singapore | x | x | x | x | x | | | | | d | x | x | | x | x | | x | | | | | x | | | x | x | x | x | x | |
| Solomon Islands | x | x | x | x | | x | | | | | | x | | | | | | | | | | | | | | | | | | |
| Sri Lanka | x | x | x | x | | | | x | | d | | x | | x | | | x | | | | | | | | | | | | | |
| Thailand | x | | | | | | | | | | | x | | x | | | | | | | | x | | | | | | | | |
| Tonga | x | x | x | x | x | x | x | x | x | d | | x | | x | x | x | x | x | | | x | x | x | | | x | x | x | x | |
| Tuvalu | x | x | x | x | x | | | | | d | x | x | | x | x | x | x | | | | | | x | | | x | x | x | x | cape |
| Vanuatu | x | x | x | x | x | x | x | x | x | d | x | x | x | x | x | | x | x | x | x | x | x | | | x | x | x | | | |
| Viet Nam | x | x | x | x | x | | | | | | | x | | | | | x | x | | | | | | | | x | x | | | |
| x= ratification | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| d=denunciation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Source: SPREP (2016); Cleaner Pacific 2025; Pacific Regional Waste and Pollution Management Strategy 2016-2025; http://www.pops.int/; http://www.basel.int/; https://www.sprep.org/convention-secretariat/waigani-convention; http://www.pic.int/; http://www.mercuryconvention.org/; http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx

**Table 5.12: Progress in addressing land-based sources and activities by Regional Seas Programmes[14]**

| REGIONAL SEA | Problem Identification | | Planning | | Regional regulatory framework | | |
|---|---|---|---|---|---|---|---|
| | Monitoring | LBSA Assessment | Regional programmes of LBSA | National Programme of LBSA | Voluntary codes | Regional convention | Protocol on LBSA |
| **UNEP administered Regional Seas programmes** | | | | | | | |
| East Asian Seas | AD | AD | AD | AD | AD | NN | NN |
| Northwest Pacific | AD | AD | AD | AD | AD | NN | NN |
| **Non-UNEP administered Regional Seas programmes** | | | | | | | |
| North East Pacific Region | | | | | | | |
| South Asian Seas | PP | PP | OG | OG | OG | OG | OG |
| Pacific Region | AD | AD | AD | AD | IP | AD | NN |

NONE/NOT KNOWN: **NN** IN PREPARATION: **IP** ON GOING: **OG** PREPARED: **PP** ADOPTED: **AD**
Source: United Nations Environment Programme (2018); Implementation of the Global Programme of Action by the Regional Seas Programmes and Action Plans between 2012 and 2018

**Table 5.13: Status of regional/national programmes on Land based Activities, identification of needs and opportunities[14]**

| REGIONAL SEA | Identification of needs | Identification of Opportunities | National Implementation | | | | | | | Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Management instruments | | Structural/ operational measures | | Institutional arrangements | | | |
| | | | Regulations/ Legislation | Economic/ Financial Instruments | Infrastructural Projects | Cleaner Production/ Best Practices | Institutions | Capacity Building | Awareness/ Public Participation | |
| **UNEP administered Regional Seas programmes** | | | | | | | | | | |
| East Asian Seas | AD | OG | IP | IP | IP | IP | IP | IP | IP | IP |
| Northwest Pacific | AD | OG | OG | OG | OG | OG | OG | OG | OG | OG |
| **Non-UNEP administered Regional Seas programmes** | | | | | | | | | | |
| North East Pacific Region | | | | | | | | | | |
| South Asian Seas | AD | AD | OG | OG | OG | OG | OG | OG | OG | OG |
| South-East Pacific Region | OG | NN | AD | OG | NN | OG | | OG | OG | PP |
| Pacific Region | AD | AD | OG | OG | OG | OG | OG | OG | OG | OG |

NONE/NOT KNOWN: **NN** IN PREPARATION: **IP** ON GOING: **OG** PREPARED: **PP** ADOPTED: **AD**
Source: United Nations Environment Programme (2018); Implementation of the Global Programme of Action by the Regional Seas Programmes and Action Plans between 2012 and 2018

All the member states of ASEAN have adopted "the Bangkok Declaration on Combating Marine Debris in the ASEAN Region" and "the Framework of Action on Marine Debris" in 2019. Accordingly all the member states are preparing action plans as per the framework. Thailand has developed roadmap on plastic waste management (2018-2030), where it is targeting 100% plastic waste to circular economy.[15]

## 5.8 Technological Interventions

Policy and regulatory initiatives are implemented by using applicable technology interventions in a country's context. Therefore, a number of technological interventions for addressing plastic waste have been initiated in Asia and the Pacific

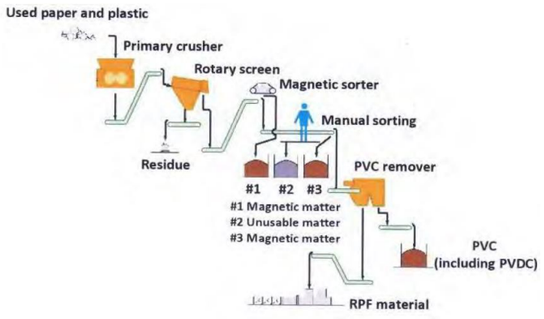
region. These include plastic waste conversion into different products by physical and chemical processes. **Table 5.14** describes technology matrix in Asia and the Pacific region. Majority of these interventions result into textile, bottles, sheets and solid and solid liquid fuels. A snapshot of the processes used to convert waste plastic into useful products is shown in **Figure 5.9**. Generally solid fuels (RDF and RPF) and liquid gaseous hydrocarbons are produced from waste plastics. [19]

**Table 5.14: Plastic Waste Technology Matrix in Asia and the Pacific Region**

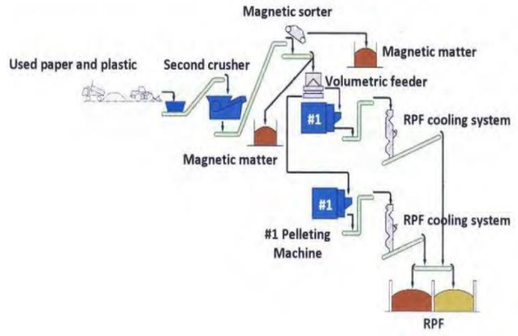
| Issues | Application | Process / Technology | Equipment | Capacity Range | Selection | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | R | P | C | |
| 1. PET waste as major component of MSW | Value addition ot raw material generation for PET | Shredding / Monomerization Plant | 1. Shredding Plants<br>2. Monomerization Plant | 1. Shredding 3600 t/year – 36000 t/year<br>2. Monomerization 3.25000 t/year – 60,000 t/year | | | √ | Scale and cost of the plant will be major factor for its implementation |
| 2. Mixed plastic waste as major component of MSW | Value addition as fuel for waste heat and energy recovery | 1. Coke oven chemical feedstock recycling<br>2. Gasification<br>3. Gasification and melting furnace power generation | Plants<br>1. Coke oven chemical feedstock recycling<br>2. Gasification<br>3. Gasification and melting furnace power generation | 30000 tons to 50000 tons per year of waste plastic | | | √ | Technology absent in Mongolia. Scale and cost of the plant will be major factor for its implementation |
| 3. Mixed plastic waste as major component of MSW | Vlue addition to road construction | Size reduction and melting Shredding, crushing, melting and mixing | Plant Shredding, crushing, melting and mixing | 20 – 350 t/hour | | | √ | Technology absent in Mongolia. Scale and cost of the plant will be major factor for its implementation |

***Note: R – Research and Development / P – Pilot Stage / C – Commercial Stage***
Source: UNEP (2012); Application of the Sustainability Assessment of Technologies Methodology: Guidance Manual

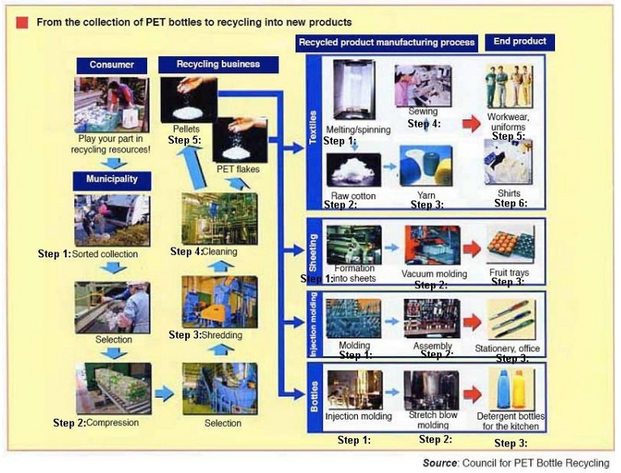
**Table 5.15** describes polymer used as feedstock for fuel productions. Pyrolysis and gasification processes and their products are described in **Table 5.16** and **Table 5.17**. The successful demonstration of these technologies as well as implementation of policy and regulation has been described in two case studies of India and Japan.




**Schematic diagram of pretreatment process**




**Schematic diagram of a pelletizing process**



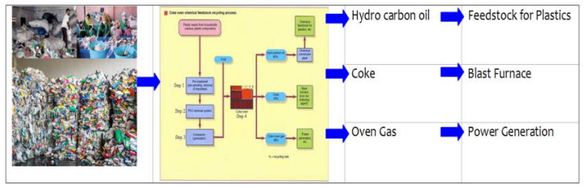

Step 1: Sorted / Collection
Step 2: Compression
Step 3: Shredding
Step 4: Cleaning
Step 5: Pellets Formation

*Textiles*
Step 1: Melting / spinning
Step 2: Raw Cotton Production
Step 3: Yarn Manufacturing
Step 4: Sewing
Step 5: Work wear uniforms Production
Step 6: Shirts Production

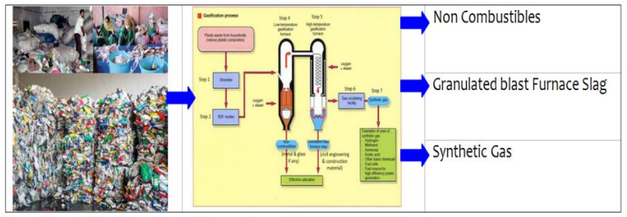
*Sheeting*
Step 1: Formation into sheets
Step 2: Vacuum molding
Step 3: Fruit trays Production

*Injection molding*
Step 1: Molding
Step 2: Assembly of molded items
Step 3: Stationery Production

*Injection molding*
Step 1: Injection Molding
Step 2: Blow Molding
Step 3: Bottles Manufacturing




**Coke oven chemical feedstock recycling**
Step 1: Pre-treatment (pre-grinding, removal of impurities)
Step 2: PVC removal system Step 3: Compactor (granulator) (20 to 30 mm)
Step 4: Granulated plastic is charged into coke ovens with coal for thermal decomposition.
Step 5: Production of 20% coke, 40% coke oven gas and 40% hydrocarbon oil.

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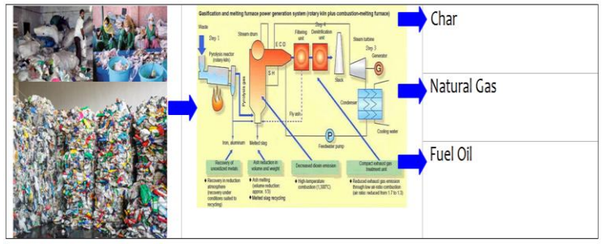



Step 1: Conversion of plastic waste into gas through pyrolysis in rotary kiln
Step 2: Combustion of pyrolysis gas at 1300ºC and removal of melted slag.
Step 3: Use pyrolysis gas and char as fuel to drive steam turbine and generate power.
Step 4: Emission cleaning system for stack emissions.

Different Steps Involved
Step 1: Plastic waste collection, segregation and storage
Step 2: Cleaning and drying of plastic wastes
Step 3: Shredding plastic wastes into required sizes (2 to 4 mm) Step 4: Stone aggregate (granite, ceramic) heated to around 160º - 170ºC
Step 5: Shredded polymer waste (5-10% w/w) is added to heated stone aggregate for 30-40 sec and mixed for uniform coating at surface of aggregate
Step 6: The coated aggregate is mixed with hot bitumen at temperature ranges from 155ºC – 163ºC
Step 7: The mix (composite) known as waste plastic aggregate bitumen mix (130ºC – 140ºC). This composite used for road laying at temperature between 110ºC – 130ºC

**Figure 5.9: Snapshot of Plastic Recycling Technology in Asia and the Pacific Region**
Source: Amit Jain (2018)

**Table 5.15: Polymer as feedstock for fuel production**

| Types of polymer | Descriptions | Examples |
|---|---|---|
| Polymers consisting of carbon and hydrogen | Typical feedstock for fuel production due to high heat value and clean exhaust gas. | Polyethylene, polypropylene, polystyrene. Thermoplastics melt to form solid fuel mixed with other combustible wastes and decompose to produce liquid fuel. |
| Polymers containing oxygen | Lower heat value than above plastics | PET, phenolic resin, polyvinyl alcohol, polyoxymethylene |
| Polymers containing nitrogen or sulfur | Fuel from this type of plastic is a source of hazardous components such as $NO_x$ or $SO_x$ in flue gas. Flue gas cleaning is required to avoid emission of hazardous components in exhaust gas. | Nitrogen: polyamide, polyurethane<br>Sulfur: polyphenylene sulfide |
| Polymers containing halogens of chlorine, bromine and fluorine. | Source of hazardous and corrosive flue gas upon thermal treatment and combustion. | Polyvinyl chloride, polyvinylidene chloride, bromine-containing flame retardants and fluorocarbon polymers. |

Source: UNEP (2009): Converting Waste Plastics into a Resource

**Table 5.16: Product types of some plastics pyrolysis**

| Main products | Type of plastics | As a feedstock of liquid fuel |
|---|---|---|
| Liquid hydrocarbons | Polyethylene (PE) | Allowed. |
| | Polypropylene (PP) | Allowed. |
| | Polystyrene (PS) | Allowed. |
| | Polymethyl metacrylate (PMMA) | Allowed. |
| Liquid hydrocarbons | Acrylonitrile-Butadiene-Styrene copolymer (ABS) | Allowed. But not suitable. Nitrogen-containing fuel is obtained. Special attention required to cyanide in oil. |
| No hydrocarbons suitable for fuel | Polyvinyl alcohol (PVA)<br>Polyoxymethylene (POM) | Not suitable. Formation of water and alcohol.<br>Not suitable. Formation of formaldehyde. |
| Solid products | Polyethylene terephthalate (PET) | Not suitable. Formation of terephthalic acid and benzoic acid. |
| Carbonous products | Polyurethane (PUR) Phenol resin (PF) | Not suitable. Not suitable. |
| Hydrogen chloride and carbonous products | Polyvinyl chloride (PVC)<br>Polyvinylidene chloride (PVDC) | Not allowed. Not allowed. |

Source: UNEP (2009): Converting Waste Plastics into a Resource

**Table 5.17: List of various gasification methods**

| Type of gasification | Conditions | Typical products |
|---|---|---|
| Pyrolysis | >700 °C under inert atmosphere | Gaseous hydrocarbons from aliphatic hydrocarbons including polyethylene and polypropylene. |
| Partial oxidation | >1000 °C under oxygen or air | Carbon monoxide from carbon, hydrocarbons and carbohydrates including wood. Hydrogen also forms from hydrocarbons and carbohydrates. |
| Steam gasification | >800 °C under oxygen or air | Methane, carbon monoxide and hydrogen |
| Hydrogasification | Around 500 – 600 °C under hydrogen | Methane, carbon monoxide and water |

Source: UNEP (2009): Converting Waste Plastics into a Resource

**Box 11: Waste Plastics to Construct Roads [20]**

India generates about 5.6 million tonnes of plastic waste is generated in country. Thermoplastics, constitutes 80% and thermoset constitutes approximately 20% of total post-consumer plastics waste generated in India. Plastic garbage that litters the country like carry bags, chip bags, chocolate bar wrappers, plastic bags, bottles, lids, etc. can be shredded and added as a limited substitute for bitumen in road construction. This method makes plastic waste a useful substitute in construction.

"Constructing roads from polythene" is a new project that the Himachal Pradesh government has embarked on to rid the state of polythene menace. After the use of polythene was banned in the state last year, there have been huge stocks in the state, which the government decided to utilize for metaling the roads. The Himachal Pradesh State Pollution Control Board in collaboration with the Public Works Department (PWD) has built three road stretches on a pilot basis by using shredded plastic waste on the outskirts of Shimla. "The results have been good as there has been no stripping or any other major damage to the roads laid by using plastic-asphalt mix. The plastic blend not only helps lowering the cost of tarring but also enhances the durability of roads because of higher binding strength of plastic,".

**Process:** At first plastic waste is cut into a size between 2.36 mm and 4.75mm using shredding machine. Bitumen is heated to 160°C, to prevent weak bonding. At the mixing chamber the shredded plastic waste is added to the hot aggregate. It gets coated uniformly within 30 seconds. Hot bitumen is then added over the plastic-coated aggregate and the resulting mix is used for road construction. The road-laying temperature is between 110°C and 120 °C.

**Cost Benefit Analysis:** "The plastic waste replaces 10 to 15% of the bitumen and thus saves approximately Rs. 35,000 to Rs. 45,000 per km of a road stretch. The state under the scheme would purchase plastic waste at Rs3/- per kg with an additional rupee as handling charges. The use of plastic in roads has also become a source of earning for rag pickers: Rs. 12/- per kg per day. This can go up to Rs. 14/- per kg for 5-10 kg and Rs.16/- per kg for quantity exceeding Rs. 10/- kg of plastic. The PWD would bill Rs. 2/- extra, Re. 1/- as handling charges and another rupee to be utilized for the welfare of rag pickers and waste workers by providing them boots, masks, gloves, free medicines and an insurance cover of Rs. 200,000 in case of any eventuality.

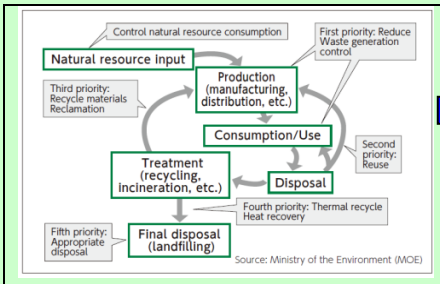
Source: Ministry of Housing and Urban Affairs, Government of India (2017); Waste to Wealth – A Ready Reckoner for Selection of Technologies for Management of Municipal Waste

**Box 12: Sound Material Cycle Society and 3R Implementation: A Case Study of Japan [20]**

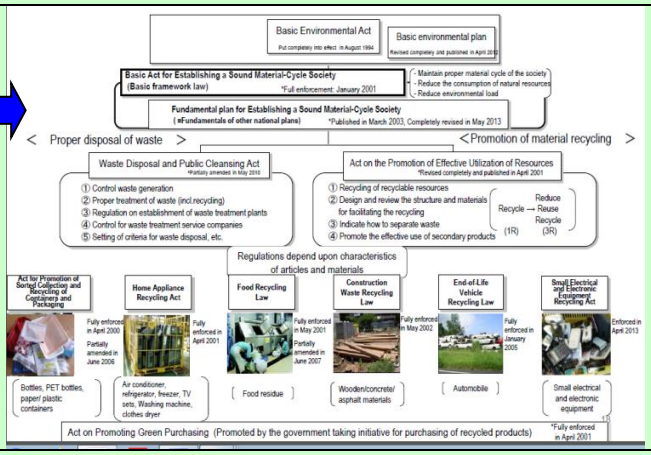
Japan has established a sound material cycle society in Asia and the Pacific region. It is based on the spirit **"Mottanai"** which encompasses the practice of treasuring and using all things as long as possible. This spirit of Mottainai restrained the generation of waste and motivated the development of technology for reuse, recycling and effective use through heat recovery in the country. Therefore, Japan has developed waste management and recycling technologies, which effectively turn waste into resources or appropriately dispose of it. The vision of sound material cycle society has led to the development of regulatory framework based on EPR **(Figure)**.

In 2000, the Basic Act for Establishing a Sound Material-Cycle Society (Basic Framework Act) was enacted to achieve: move away from the current economic system based on mass production, mass consumption and mass disposal, and to promote the establishment of a sound material-cycle society designed to ensure the implementation of 3R (Reduce, Reuse, and Recycle) and the appropriate management of waste. The Basic Recycling Act defines the vision that reduces natural resource consumption and minimizes environmental impact. The law specifies the order of priority in the management of recyclable resources as well as the roles of different entities (national and local governments, business operators, and consumers). The Basic Recycling Act also legally established, for the first time, the basic principle that recyclable resources should be processed in the following order of priority: (1) generation control, (2) reuse, (3) recycling, (4) thermal recovery, and (5) appropriate disposal. In defining the roles of different entities, this law distinguishes between the principle of waste generator responsibility, which places the responsibility for the management and recycling of waste on consumers and business operators that dispose of waste, and the principle of extended producer responsibility (EPR), which places the responsibility for the manufacture, design and post-use management of products on their manufacturers. The Containers and Packaging Recycling Act specified the respective roles of consumers, municipalities, and business operators (container manufacturers and business operators that sell products using containers and packaging). The act placed the responsibility for sorted waste disposal on consumers, the responsibility for sorted waste collection on municipalities, and the responsibility for recycling on business operators, in order for these three entities to work together to promote the recycling of containers and packaging.

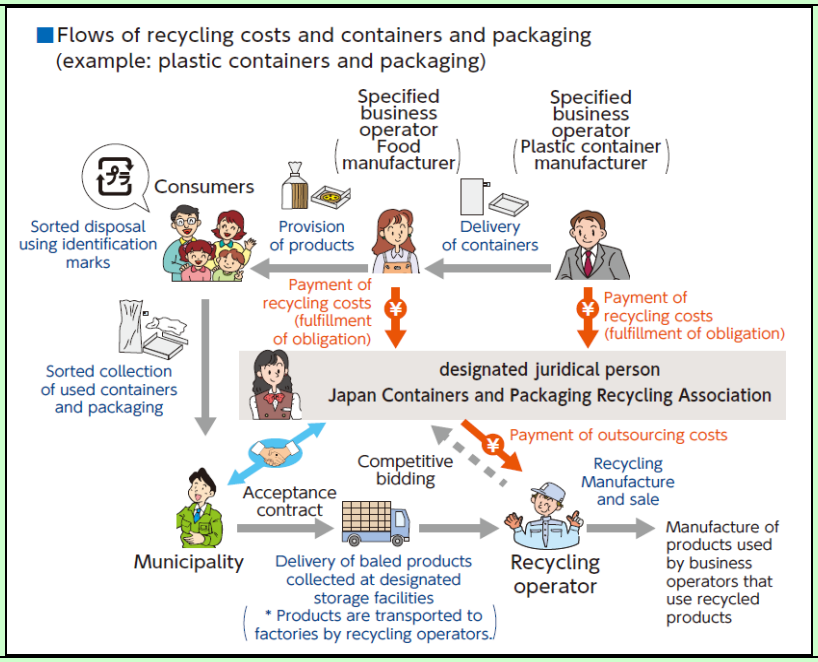
Japan intends to achieve approximately double resource productivity (GDP/input natural resources) by 2025 in comparison to 2000 by achieving 30% increase of cyclical use rate (waste base) and 77% reduction of final disposal amount during the same period. As per MOEJ, Government of Japan about 9400 kilo tons of plastic waste was generated in Japan in 2016, out of which 4260 kilo tonnes was packaging and container (PET bottles) waste. About 1040 kilo tonnes of packaging and PET Bottles waste was collected by municipal collection system. 60% of this waste underwent chemical processing (coke ovens, syngas and reducing agent) while 40% went for material recycling (PP resin, Palette, others). PET bottles were converted into shed, fibre and bottle. Japan has already provided technology transfer to a number of developing countries in the region (Thailand, Singapore and China).




Vision of Sound Material Cycle Society




Legal System for Building a Sound Material Cycle Society




Source: Ministry of Environment, Ministers Secretariat, Waste Management and Recycling Department Policy Planning Division, Office of Sound Material – Cycle Society (2014); Solid Waste Management and Recycling Technology of Japan – Towards a Sustainable Society and History and Current State of Waste Management in Japan

## 5.9 Institutional Roles and Actions

Plastic waste is generally covered under the regulation of solid waste in majority of countries in the Asia and the Pacific Region. However, many countries have specific regulations related to packaging, single use plastic, plastic bags and microbeads as described in above sections. It majorly falls under policy and regulatory jurisdiction of nodal ministry of environment and forest in Asia and the Pacific region. However, the regulations are also implemented at the sub-national and city level respectively. A number of other institutions like private sector both formal and informal and civil society organizations are also involved in the implementation of regulations. All the stakeholders are involved at each level of policy, plan / strategy program and projects development and implementation. Therefore, a number of policy, regulatory, technological, economic and institutional issues have been identified in the region. Countries like Australia, New Zealand, Japan, Republic of Korea and Singapore have minimized these issues by institutionalizing policy, regulations, programs and plan to achieve higher recycling rate and circularity of materials. Therefore, the issues summarized below are relevant in the context of developing countries.[22]

**Policy Regulatory**

- Policy and regulations are unevenly developed and lack effectiveness.
- Definition of waste is very crucial in the regulations, considering the evolution of standards and later enforcement. For example concern over environmental standards for recycling.
- Lack of EPR based policy and regulations for plastic waste. Therefore, EPR based regulatory mechanism is yet to evolve. Currently, there is no specific and comprehensive policy and regulation in place in the region to address the issue of plastic wastes in coastal and marine environment. These also include local ordinances on the regulation on the use of plastics and study on the life cycle analysis of packaging materials including plastics in relation to the prohibition on the use of Non-environmentally acceptable products and packaging materials.
- Countries lack in addressing significant reduction of MSW, plastic waste and approach for zero waste emissions. Though the countries supports 3R concepts, They

either lack action plan / strategy, programs and projects for complete implementation as per 3R hierarchy.

- Countries in the Asia and the Pacific also lack in comprehensive policy, program, plan and projects in resource efficiency and productivity, greening of the chain for plastic.
- Some countries have regulation and are preparing for Integrated Solid Waste Management Strategy / Plan for future development of waste management sector, their implementation at national, sub national and city level are a major challenge. Even though waste minimization and collection targets exist at the national level, they are not well adopted within the policy frameworks of local governments.
- Countries also lack better understanding of waste composition to enable the development of a holistic strategy plan for waste management.
- Emerging policy regime particularly green procurement and greening of the value chain need to be implemented through development of projects.
- Poor enforcement of regulations not only leads to uncontrolled dumping and burning of plastic waste but also illegal trafficking of waste plastics.

**Box 11: No Plastic Bag Weekend in Brunei Darussalam[23]**

Brunei Darussalam launched the *No Plastic Bag Weekend*, a nation - wide initiative, on26thMarch 2011. This initiative promoted the use of reusable and biodegradable bags as one of the ways to minimise plastic wastes. This initiative engaged a few big departmental stores, as the key players to impact the change of minimising the use of plastic bags. The *No Plastic Bag Weekend* initiative was received well by the public at large. On17th February 2012, this initiative was therefore extended to include Fridays, in addition to Saturdays and Sundays.

Source: UN Environment (2017); Waste Management in ASEAN Countries; https://www.unenvironment.org/resources/report/waste-management-asean-countries-summary-report

**Technology Issues**

- Lack of segregation of waste at source exists in each country. Further, waste collection system is not adequate in terms of geographical coverage of population.
- There is a lack of waste reduction technologies like incineration and recycling infrastructure for treatment of plastic waste. Therefore, recyclable wastes are being exported to other countries for recycling due to lack of local facilities.
- Only small recycling facilities exist in major cities within majority of countries.
- Need for capacity building exists for choosing the most adequate technologies.
- Mixed discarding of recyclable materials with other non recyclable waste makes it difficult to collect and properly utilize recyclable materials. For example plastics contaminated and mixed with other materials; biodegradable plastics mixed with other plastics and mixing of problematic additives.
- Recycling infrastructure lacks upgradation and coverage as well as linkage to upstream supply. For example limited collection schemes and treatment technologies for thermosets plastics.
- Pilot level technology demonstration existing in the country needs to be scaled up and replicated.
- Competition between recycling and energy from waste.

**Economic and Institutional Issues**

- There is lack of capacity in design, implementation and monitoring of policies, program and projects.
- There has been no major initiative related to development of financial mechanism or institutional framework for developing recycling industry in the country though examples of private sector involvement exist in treatment and disposal mechanism.

- Private sector does not find it lucrative to invest in plastic recycling infrastructure due to lack of incentive and unstable prices of the product. The long term of PPP mechanism is yet to be determined.
- Cost of collecting, sorting and processing waste plastics is significant.
- There is a considerable lack of funding at the regulatory level, causing insufficient monitoring, controlling and enforcement of plastic waste treatment and disposal.
- Global markets for recycled plastics are concentrated in small number of countries.
- Due to price volatility of virgin plastics versus recycled plastics, recycled plastic sector has limited resilience to market shocks.
- Lack of differentiated demand for recycled plastics.
- Limited awareness and behavior of people related to the concept of sustainable cities /m green cities and management of plastic waste.

**Box 12: Community Outreach Program in Singapore[23]**

Under the Community 3R Outreach Programme (CROP) all 3R community events and initiatives organised by NEA carry a common tagline: "Reduce, Reuse, Recycle. Care for Our Environment." Other examples of instilling a 3R culture in different settings and through different media are:

- 3R Pre-school Awareness Kits
- 3R information on website
- myENV app
- 3R Video for households
- Community Events
- 3R tips and guidelines
- No Waste Day Challenge

NEA has been actively working with various stakeholders on 3R outreach and to co-develop 3R guide books. Examples of guide books developed so far are for households, condominiums and private apartments, shopping malls, hotels, industries and events.

Source: UN Environment (2017); Waste Management in ASEAN Countries; https://www.unenvironment.org/resources/report/waste-management-asean-countries-summary-report

- Lack of knowledge and skill and lack of human resources for managing plastic waste stream.
- Significant opportunities exist in Asia and the Pacific region for plastic waste management. These include: Opportunity for development integrated policy, regulatory, program and projects based on 3Rs for all plastic waste streams; Opportunity for technology transfer and assimilation for plastic waste management; Opportunity for development of recycling infrastructure in the country; and Opportunity to develop integrated institutional mechanism for all types of waste streams.

**Box 13: National Recycling Programme (NRP) in Singapore[23]**

The NRP was launched in 2001 to provide a convenient means for residents living in public high-rise apartments and private landed housing estates to recycle their source segregated waste streams. It started off with the provision of recycling bags to households, with fortnightly door-to-door collection. The participation rate by households in NRP was 15 % at the start in 2001 and had increased to 71% in 2012. To further improve recycling infrastructure for residents, a recycling bin is provided for every HDB block from 2014 in place of the fortnightly door-to-door collection services. Residents find it more convenient in terms of space for storage of recyclables and they are able to deposit recyclables at any time of the day. The NRP has also been enhanced to provide private landed estates with more frequent collection as well as garden waste collection, and incentive schemes such as "Cash-for-Trash" was implemented to further encourage recycling. In addition, NEA has been promoting the adoption of dual-chute system for recyclables and residual waste. In light of the encouraging results of the trial projects, all new public high-rise residential developments will be fitted with Centralised Chutes for Recyclables (CCR) from 2014.

Source: UN Environment (2017); Waste Management in ASEAN Countries; https://www.unenvironment.org/resources/report/waste-management-asean-countries-summary-report

**Key Messages – Chapter 5**

The countries in Asia and the Pacific region have very high material footprint including plastic footprint. Except for Australia and Japan, decoupling of resource intensiry with economic growth requires policies and its enforcement in majority of the countries in the region.

A number of companies have recognized the importance of sustainability reporting, however, the data related to their number in the region is not available.

Majority of countries have policies and regulations to address onland plastic waste either as part of waste management rules or specific rules. Further, majority of the countries are signatory to international conventions both at global and regional level. Plastic waste is generally covered under the regulation of solid waste in majority of countries in the Asia and the Pacific Region.

Many countries have specific regulations related to packaging, single use plastic, plastic bags and microbeads plastic pollution. It majorly falls under policy and regulatory jurisdiction of nodal ministry of environment and forest in Asia and the Pacific region. However, the regulations are also implemented at the sub-national and city level respectively.

A number of other institutions like private sector both formal and informal and civil society organizations are also involved in the implementation of regulations. All the stakeholders are involved at each level of policy, plan / strategy program and projects development and implementation.

A number of policy, regulatory, technological, economic and institutional issues have been identified in the region. Countries like Australia, New Zealand, Japan, Republic of Korea and Singapore have minimized these issues by institutionalizing policy, regulations, programs and plan to achieve higher recycling rate and circularity of materials.

The countries in the region have also started regulation on consumption and production either through mandating bans, fines, import and export controls, and market based instruments such as extended producer responsibility (EPR) based rules, fixing up recycling rates or imposition of taxes and levees. However, these are restricted to plastic bags and single use plastics.

The implementation of the policies and regulations as well as creation of waste plastic management infrastructure coupled with capacity building through regional knowledgebase (database, experts, indicator monitoring, information sharing and awareness) are the major challenges which need to mitigated to achieve the specific targets committed under SDGs in the region.

## Chapter 5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# Chapter 6: Way Forward

## 6.0 Introduction

The status of plastic waste in Asia and the Pacific region has been described using DPSIR framework. According to the DPSIR framework there is a chain of causal links starting with 'driving forces' (economic sectors, human activities) through 'pressures' (emissions, waste) to 'states' (physical, chemical and biological) and 'impacts' on ecosystems, human health and functions, eventually leading to political 'responses' (prioritisation, target setting, indicators). The following sections summarizes each of the items including barriers and the way forward.

## 6.1 Summary of Results under D-P-S-I-R Framework

DPSIR framework related to plastic waste in Asia and the Pacific region has been shown in **Figure 6.1.**

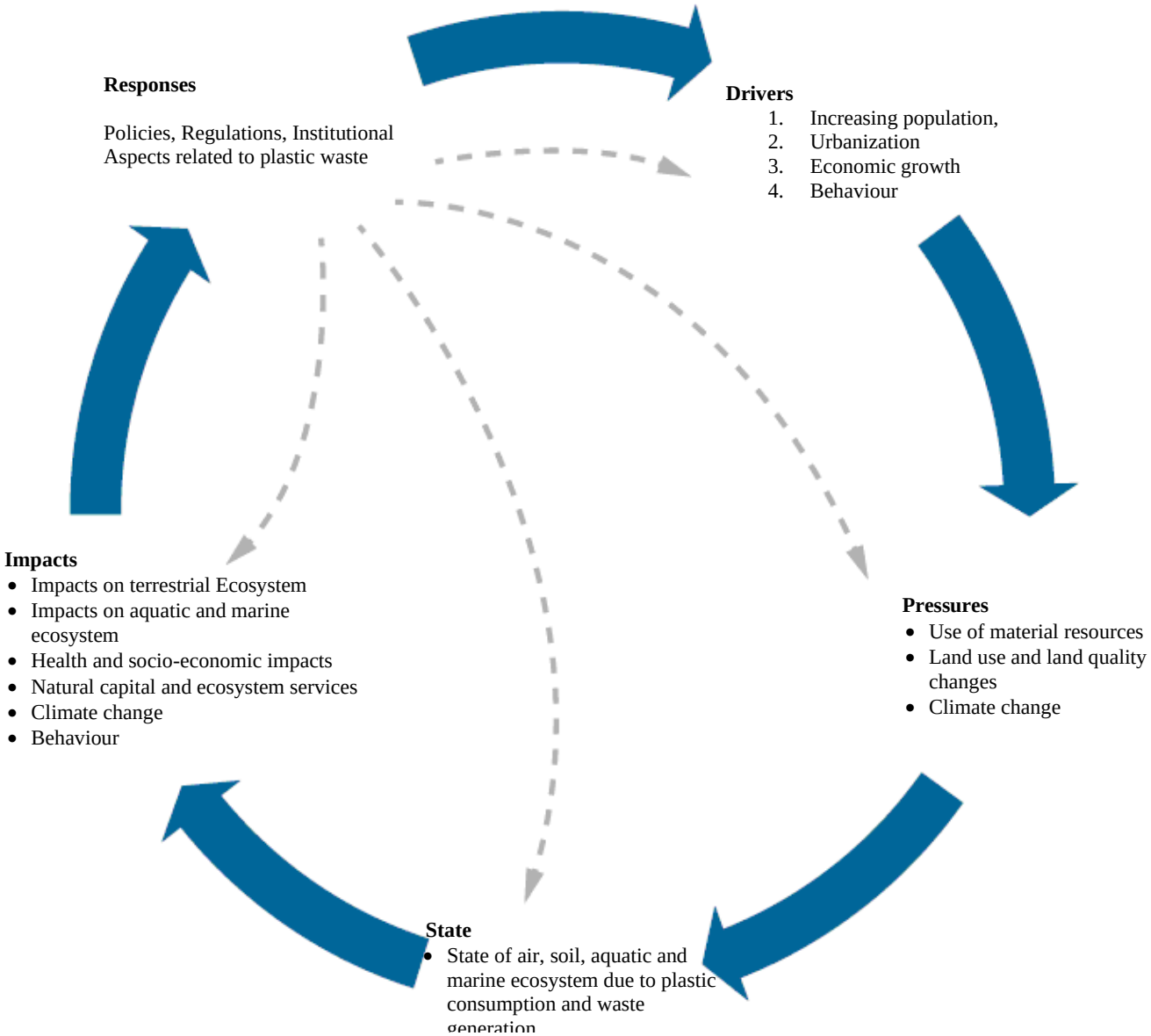


**Figure 6.1: Asia and the Pacific, summary of drivers, pressures, state and trends, and impacts[1]**

Source: UNEP (2016); GEO – 6 Regional Assessment for Asia and the Pacific 2016

**Drivers**

Major drivers include rapid growth in population, urbanization, economic growth and behavior. The region has witnessed a rapid growth in population in the past several decades. The region's population is projected to rise to 5.08 billion by 2050, which is about 60% of the world's total population[1]. China with 1.36 billion and India with 1.25 billion people account for more than half of the total population of the region. Urban population, which was 48% of the region's population in 2017 is projected to increase to about 63% of the total by 2050.[1] Regional differences include rapid population growth in developing countries and stagnation or decline in developed ones. Consequently, there was a significant growth in the proportion of the middle class in most developing Asian countries.[1] Out of 28 mega-cities with more than 10 million people in the world, 15 are in Asia and the Pacific – Tokyo (37.8 million), Delhi (25 million) and Shanghai (23 million) are the three most populous cities in the world.[1] An estimated 120 000 people migrate to cities in the region every day. The proportion of people living in urban areas is likely to rise to around 3.3 billion people, by 2050.[1] As per 2017 estimates, combined GDP of the major countries in the region was above 25 trillion ranging from US$ 583 to US$ 73,187 per capita. Over the past 45 years (1970–2015), Asia and the Pacific region has experienced rapid economic growth, leading to higher incomes, poverty reduction and the emergence of a rapidly-expanding middle class. About two thirds of the regional economies, accounting for 80% of the region's GDP, achieved faster economic growth in 2017.[2] Overall, the region has witnessed poverty reduction, access to healthcare and education, reduction in hunger and malnutrition, better transport and communication facilities and improved access to water and sanitation facilities.

Plastic waste both quality and quantity are associated with behavior of people due to plastic materials have been involved in daily life and made people get use to more than one generation. The achievement in management of plastic waste has significant relationship with behavior of people. In addition, the willingness to change behavior in 3Rs activities will support and accelerate the proper waste management which will lead to reduction of plastic waste. The regulations, market based instruments for regulating plastic bags and single use plastic and market based instruments on return, collection, recycling, and disposal of plastic bags and single use plastic will further support to transform public behavior.

**Pressures**

The population growth, industrialization and urbanization have led to a sharp increase in natural resource use in the region, which is both unsustainable and inefficient, and results in pollution, declining biodiversity and natural resource depletion. Asia and the Pacific region has been experiencing high growth and high material consumption since 1990.[3] In terms of material resource use (comprising fossil fuels, biomass, metals and non-metallic minerals), the Asia-Pacific region is the most resource-intensive region in the world, both in terms of domestic material consumption and material footprint. The Asia-Pacific region has approximately 2 Kg per US$ (domestic material consumption per dollar of economic output) in comparison to 1.2 Kg per US$ of world's average.[4] As per 2015 data, the plastic consumption ranges from 0.13% to 0.75% of material consumption in Asia and the Pacific region an indicator of variation resource in usage. The region is importer of fossil fuel, the feedstock for manufacturing plastics. A positive correlation exist between GDP growth rate and plastic consumption in Asia and the Pacific region, which indicates that as per capita income increases, the plastic consumption also increases.[5] Asia and the Pacific region are experiencing increased waste generation. Per capita MSW generation per year in the region varies from 0.21 to 0.37 tonnes. Majority of plastic waste, which comes mixed with solid waste ranges from 0.02 to 0.04 tonnes per capita per year.

About 55 to 74% of the municipal solid waste is disposed off at disposal sites with zero to 26% being incinerated and 1 to 5% composted.[6] However, the mismanagement of waste is resulting in increased pressure on land requirements, finite natural resources, terrestrial, aquatic and marine ecosystem of Asia and the Pacific region.[7]

**State**

The current plastic waste disposal practices result in mismanagement of waste to their leakage into soil, natural drainage system and finally oceans. Estimates indicate that 1.7 to 4.6% of the total plastic waste generated on land enters the ocean and ultimately becomes marine litter. Considering this hypothesis, the amount of plastic waste entering the ocean from Asia and The Pacific region ranges from 2.3 to 6.4 million tonnes in 2030. Since Asia and the Pacific has a large ocean area it is facing a rise in marine litter, mainly plastics waste. In the waters around Australia, up to 70 per cent of the marine litter that enters the sea ends up on the seabed, while 90 per cent of floating marine litter is plastic or polystyrene. In Indonesia alone, 690 000 items were found to be present per square kilometre on the seafloor and 29.1 items per square metre on the shorelines.[8] It has been cited that uncontrolled landfilling and open burning have been the most prevalent waste disposal method in the Asia and the Pacific region.[9] Inadequate treatment of waste can cause pollution and environmental and ecosystem degradation. This results in air, water and soil pollution further exacerbating the existing pollution levels in major cities in the region.

**Impacts**

Poor plastic waste management leads to serious impacts on terrestrial, aquatic and marine ecosystem and human health (especially in the informal recycling sector and at open dumps). The natural capital cost of the impact of plastics on marine ecosystems is at least USD13 billion per year. Uncontrolled landfill sites contribute to increasing greenhouse gas emissions. With rising waste generation and prevalent uncontrolled dumping, the absolute value of greenhouse gas emissions from the Asia and the Pacific waste sector rose from nearly 370 million tonnes of carbon dioxide equivalent in 1990 to 500 million tonnes in 2010, around 33 per cent of global emissions from the waste sector.[1] The quantification of these impacts is still at R and D stage and needs further research.

All of key environmental impacts from plastic e.g. terrestrial ecosystem; aquatic and marine ecosystem, human health; climate change; energy production and consumption and ecosystem services and natural capital; socioeconomic can be counted as factors having impact on behavior of people. Besides, they can be utilized as motivation of self-efficacy accelerated for mitigation and management of plastic waste. Behavior can contribute to success of personal habit of self control. The change of behavior refer to motivational, volitional and action based on processes of 3Rs. 3R activities, such as waste segregation, abandonment of unwanted materials can be eliminated by communication which can make people, realize that the cost of plastic waste management is the money paid for their own behavior. It is not necessary to make drastic alterations to whole lifestyle of people to see benefit because benefit is reduced negative impacts without payment. The approach to change behavior is focused on communication in ways that people will make their lives better off e.g. finance, employment, healthy, value their life for society, environmental quality. Further, change in consumer's behavior due to communication also leads to better waste management.

**Response**

A number of regulations have been proposed to tackle the plastic pollution both on land as well as for aquatic and marine ecosystem. These are applicable both on the production and supply as well as for waste management. These are in the form of bans, fines, taxes, levies, EPR, recycling rate targets etc. Further, majority of them address packaging and single use plastic waste.

## 6.2 Barriers and Gaps and Potential Interventions

A number of barriers related to regulatory, economic, technology, data and information have been identified. **Table 6.1** summarizes five main categories of interventions to be implemented as a way forward.

1. Regulatory
2. Economic instruments
3. Technology
4. Data and information
5. Voluntary measures by industries

**Table 6.1: Summary of intervention assessment[10]**

| No. | Intervention | Barriers that could be addressed |
|---|---|---|
| 1 | Set statutory targets for recycling to drive supply of material, increase economies of scale, reduce costs and increase resilience. | Costs of collecting, sorting and processing waste plastics.<br>Limited resilience of the sector to market shocks. |
| 2 | Ban plastics from landfill to drive supply of material and increase economies of scale, reduce costs and increase resilience. | Costs of collecting, sorting and processing waste plastics.<br>Limited resilience of the sector to market shocks. |
| 3 | Use Extended Producer Responsibility (EPR) regulation to drive supply of material and increase economies of scale, reduce costs and increase resilience. | Costs of collecting, sorting and processing waste plastics.<br>Limited resilience of the sector to market shocks. |
| 4 | Standardise waste collection systems to increase economies of scale and reduce costs. | Costs of collecting, sorting and processing waste plastics.<br>Plastics contaminated and mixed with other materials. |
| 5 | Mandate requirement for recycled content to create demand. | Lack of differentiated demand for recycled plastics. |
| 6 | Use public sector procurement policies to create demand for recycled content. | Lack of differentiated demand for recycled plastics. |
| 7 | Introduce mandatory data reporting mechanisms for plastics recycling. | Poor data on the plastics recycling industry. |
| 8 | Ban or reduce problematic additives in primary plastics. | Problematic additives. |
| 9 | Mandate labelling for biodegradable plastics and improve associated standards. | Bio-degradable plastics mixing with other plastics. |
| 10 | Set targets (including using EPR) for recycling thermosets to drive supply. | Limited collection schemes and treatment technologies for thermosets. |
| 11 | Ban or reduce hazardous additives from primary plastics. | Hazardous additives. |
| 12 | Ban plastics from energy from waste. | Competition between recycling and energy from waste. |
| 13 | Ensure regulation is proportionate and clarify end-of-waste requirements. | Regulatory burdens of materials classified as waste. |
| 14 | Enforcement action to reduce illegal dumping, particularly in low and middle income countries where dumping is common place. | Uncontrolled dumping and burning of municipal wastes. |
| 15 | Enforcement action to reduce illegal waste trafficking. | Illegal trafficking in waste plastics. |
| 16 | Regulation and enforcement to ensure consistent environmental standards in global markets. | Concerns over environmental standards for recycling in emerging markets. |
| 17 | Mandate sellers to establish and audit end- destinations for environmental standards. | Concerns over environmental standards for recycling in emerging markets. |
| 18 | Obligate monomer manufacturers to buy back recycled plastics | Lack of differentiated demand for recycled plastics |
| 19 | Mobilise investment for developing collection, sorting and processing systems, particularly in low income contexts. | Costs of collecting, sorting and processing waste plastics.<br>Collection systems for wastes not available for a substantial proportion of the global population. |
| 20 | Use financial market mechanisms to increase the resilience of the market to fluctuations in prices (e.g. futures markets). | Limited resilience of the sector to market shocks. |
| 21 | Support development of domestic reprocessing capacity to reduce reliance on global markets. | Global markets concentrated in a small number of countries |
| 22 | Use taxes or trading mechanisms to internalise the externalities associated with primary plastics. This will | Lack of differentiated demand for recycled plastics. |

| No. | Intervention | Barriers that could be addressed |
|---|---|---|
| | support the price of recycled plastics. | |
| 23 | Direct or indirect government support for recycled plastics, e.g. through lower VAT rate | Lack of differentiated demand for recycled plastics |
| 24 | Tax additives that cause detrimental effects on recycled plastics (including degradability enhancers). | Problematic additives. |
| 25 | Incentivise recycling over energy from waste by introducing a tax to reflect the relative environmental burden/benefit. | Competition between recycling and energy from waste. |
| 26 | Introduce tax incentives to encourage use of recycled plastics (e.g. VAT exemptions). | Lack of differentiated demand for recycled plastics. |
| 27 | Charge waste producers for collection and disposal of non-recyclable waste. | Costs of collecting, sorting and processing waste plastics. |
| 28 | Support development of better and more cost- effective technologies for collecting, transporting and sorting waste plastics. | Costs of collecting, sorting and processing waste plastics. |
| 29 | Support the development and demonstration of commercially viable technologies for mixed and/ or low value plastics. | Plastics contaminated and mixed with other materials. |
| 30 | Develop alternatives to problematic and hazardous additives. | Problematic additives. |
| 31 | Develop technologies that can identify or track problematic and hazardous additives so that they can be eliminated from recycled plastics. | Problematic additives. |
| 32 | Develop purifying and stabilising technologies that can overcome the physical effects of problematic additives in recycled plastics. | Problematic additives. |
| 33 | Develop technologies for identifying biodegradable plastics | Biodegradable plastics mixing with other plastics. |
| 34 | Develop purifying and stabilising technologies that can overcome the physical effects of biodegradable plastics in waste plastics streams. | Biodegradable plastics mixing with other plastics. |
| 35 | Develop and demonstrate effective systems for collecting and recycling thermosets. | Limited collection schemes and treatment technologies for thermosets. |
| 36 | Raise public awareness in order to create demand for plastics recycling, reduce contamination, and to reduce littering and dumping. | Costs of collecting, sorting and processing waste plastics.<br>Collection systems for wastes not available for a substantial proportion of the global population.<br>Plastics contaminated and mixed with other materials.<br>Limited collection schemes and treatment technologies for thermosets.<br>Uncontrolled dumping and burning of municipal wastes. |
| 37 | Share best practice on all aspects of the collection, sorting and reprocessing supply chain. | Costs of collecting, sorting and processing waste plastics.<br>Collection systems for wastes not available for a substantial proportion of the global population.<br>Plastics contaminated and mixed with other materials. |
| 38 | Develop and share market information to allow actors to expand into new markets. A more globalised market will reduce reliance on a single actor. | Poor data on the plastics recycling industry.<br>Global markets concentrated in a small number of countries<br>Limited resilience of the sector to market shocks. |
| 39 | Enhance supply chain awareness of problematic additives so that the impact on markets for recycled plastics is understood. | Problematic additives. |
| 40 | Provide information and training to designers and manufacturers to encourage use of recycled content. | Lack of differentiated demand for recycled plastics. |
| 41 | Provide information to consumers to encourage purchase of products using recycled content and drive demand. | Lack of differentiated demand for recycled plastics. |
| 42 | Provide clear labelling and information for biodegradable plastics to encourage appropriate management by consumers. | Biodegradable plastics mixing with other plastics. |
| 43 | Reduce uncertainty over the health effects of hazardous additives. | Hazardous additives. |
| 44 | Encourage openness about standards and provide information on end-destinations. | Concerns over environmental standards for recycling in emerging markets. |
| 45 | Create voluntary standards for collection, sorting and reprocessing. | Costs of collecting, sorting and processing waste plastics. |
| 46 | Work with supply chain to encourage use of recycled content. | Lack of differentiated demand for recycled plastics. |

| No. | Intervention | Barriers that could be addressed |
|---|---|---|
| 47 | Industry-led initiative to standardise polymers and additives, and improve information on additives. | Separating polymers from other materials, other polymers and contamination. |
| 48 | Industry-led phase out of problematic and hazardous additives from primary plastics. | Problematic additives. |
| 49 | Develop effective voluntary standards for recycling sector to limit need for regulation. | Regulatory burdens of materials classified as waste. |
| 50 | Industry-led initiatives to crack down on waste crime. | Illegal trafficking in waste plastics. |
| 51 | Industry-led initiative to ensure consistent environmental standards in global markets. | Concerns over environmental standards for recycling in emerging markets. |

Source: OECD (2018); Improving Markets for Recycled Plastics – Trends, Prospects and Policy Responses

The voluntary and legally non – binding commitments under the Bankok 3R declaration recognizes the importance of monitoring marine litter. However, data & information related to plastic pollution & marine litter is a major issue in Asia & the Pacific Region. In order to streamline the existing data collection mechanism related to plastic pollution & marine litter under 3R Forum, an additional questionnaire has been developed and annexed in **Annexure 6.1**. It is recommended that the participating countries need to complete & update this questionnaire every year.

## 6.3 Plastic Economy vs. Circular Economy

While the international community are committed to the 2030 Agenda for Sustainable Development and the SDGs, the New Urban Agenda, the Paris Climate Agreement, the Addis Ababa Action Agenda, the Nairobi Mandate, and the Sendai Framework for Disaster Reduction, among others, there is an increasing need for Asian-Pacific countries to integrate 3R and resource efficiency into their national development plans and macroeconomic policy agendas. By pursuing resource efficient and circular economic development approach, countries and cities can embark on the path of low-carbon and green growth, including realizing eco-efficient infrastructures in key development sectors such as urban design and planning, building, transport, energy, water and waste systems.

As Asia-Pacific countries industrially and economically grow, financing implementation of 3R policies, programs, including infrastructure development, will be critical to reducing the volume of all waste streams – MSW, plastics, chemicals and hazardous wastes, etc. in living environment and natural ecosystem, and in mitigating negative environmental impacts, while supporting a wide range of domestic and global priorities to improve health and environment. In moving towards zero waste societies, the countries need to explore new sources of funding to finance development of appropriate 3R infrastructures (e.g., state of art waste collection and processing facilities, resource recovery facilities, recycling industries, eco-industrial zones, science parks, etc.), to promote collaboration among key stakeholders and active participation of citizens. Moving from plastics economy to circular economy could provide an important basis for new source of funding while contributing towards achieving the SDGs, in particular SDG 9, SDG 11, SDG 12 and SDG 14.

A careful assessment of plastic economy indicates the development of applications for plastics. Plastics has focussed on the part of the plastics economy that starts with the raw material and ends either at the factory gate or upon delivery to the retail outlet or customer. This excludes the downstream costs of plastics use and an almost complete absence of the social and environmental costs of plastics. The implementation of the interventions mentioned in Table 6.1 will not only extend the plastic economy to the complete material flow of plastic but also

internalize cost of plastic waste management. This is expected to boost the circularity of plastic waste as a resource and extend plastic economy to circular economy.[11]

The redefined plastic economy paradigm offers opportunities to not only deliver better system wide economic and environmental outcomes by creating an effective after-use plastics economy, thereby drastically reducing the leakage of plastics into natural systems (terrestrial & marine) in particular the air, soil, water, seas and oceans but also decoupling from fossil feedstock. Further, the new plastics economy offers an attractive opportunity for the global plastic value chain and governments to collaboratively work towards achieving the sustainable development goals. The economic recovery post COVID-19 pandemic necessitates regional cooperation and commitment to green recovery and natural resource management. On the national level, these responses can be translated to supporting measures related to SDGs and building resilient and sustainable infrastructure. In this context, Indore 3R Declaration of Asian Mayors agreed at the Eighth Regional 3R Forum in Asia and the Pacific (April'2018, India) stating complete ban of illegal disposal of plastics in eco-sensitive or eco-fragile areas, including tourist areas close to oceans, rivers, lakes, wetlands, other water bodies and mountains, to preserve coastal, marine and mountains ecosystems and resources, the Malé 3R Declaration by private resorts for the promotion of 3Rs and resource efficiency towards protection of local environment and marine ecosystem agreed at the Sixth Regional 3R Forum in Asia-Pacific (August'2015, Maldives) and the voluntary and legally non-binding Bangkok 3R Declaration for prevention of plastic waste pollution through 3R and Circular Economy agreed at the Ninth Regional 3R Forum in Asia and the Pacific (March'2019, Thailand) provide the adequate institutional mechanism and policy framework to collaboratively work towards circular economic utilization of the plastics.

**Key Messages – Chapter 6**

DPSIR framework related to plastic waste in Asia and the Pacific region consists of: Drivers (increasing population, urbanization, economic growth and behaviour), Pressures (use of material resources, land use and land quality changes and climate change), State (state of air, soil, aquatic and marine ecosystem due to plastic consumption and waste generation), Impacts (impacts on terrestrial ecosystem, impacts on aquatic and marine ecosystem, health and socio-economic impacts, natural capital and ecosystem services, climate change and behaviour) and Response (policies, regulation, institutional aspects related to plastic waste).

Evaluation through DPSIR framework has led to identification of a number of barriers related to regulatory, economic, technology, data and information. These include Costs of collecting, sorting and processing waste plastics; Limited resilience of the sector to market shocks; Plastics contaminated and mixed with other materials; Lack of differentiated demand for recycled plastics; Poor data on the plastics recycling industry; Problematic additives; Bio-degradable plastics mixing with other plastics; Limited collection schemes and treatment technologies for thermosets.; Hazardous additives; Competition between recycling and energy from waste; Regulatory burdens of materials classified as waste; Uncontrolled dumping and burning of municipal wastes; Illegal trafficking in waste plastics; Concerns over environmental standards for recycling in emerging markets; Concerns over environmental standards for recycling in emerging markets; Limited resilience of the sector to market shock; Global markets concentrated in a small number of countries; Biodegradable plastics mixing with other plastics; Collection systems for wastes not available for a substantial proportion of the global population; Plastics contaminated and mixed with other materials; Limited collection schemes and treatment technologies for thermosets; Uncontrolled dumping and burning of municipal wastes; Poor data on the plastics recycling industry. A number of interventions have been proposed as a way forward. These include interventions broadly under (1) Regulatory; (2) Economic instruments; (3) Technology; (4) Data and information and (5) Voluntary measures by industries. A number of frameworks, which have been developed under national, regional & global level provide adequate institutional mechanism to the countries in the region towards circular economic utilization of the plastics.

## Chapter 6


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**Annexure – 1.1: SDGs and their Targets**

| | |
|---|---|
| Goal 1 – end poverty in all its forms everywhere | • By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance. |
| Goal 6 – ensure availability and sustainable management of water and sanitation for all | • By 2030, the proportion of untreated wastewater should be halved |
| Goal 8 – promote sustained, inclusive and sustainable economic growth and productive employment and decent work for all | • Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services |
| Goal 9 – build resilient infrastructure, promote inclusive and sustainable industrialisation and foster Innovation | • Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets<br>• By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities |
| Goal 11 – make cities and human settlements inclusive, safe, resilient and sustainable | • By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management |
| Goal 12 – ensure sustainable consumption and production patterns | • Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries<br>• By 2030, achieve the sustainable management and efficient use of natural resources<br>• By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment<br>• By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse<br>• Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products |
| Goal 14 – conserve and sustainably use the oceans, seas and marine | • By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land based |

| | |
|---|---|
| resources for sustainable Development | activities, including marine debris and nutrient pollution<br>• By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans<br>• By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism<br>• Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries<br>• Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of The Future We Want |
| Goal 15 – protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss | • Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species |

**Annexure 2.1: Brief Profile of Plastic Industry (consumption and production) of Major Polluting Countries in Asia and the Pacific Region**

**Bangladesh**

People's Republic of Bangladesh is situated in southern Asia in the Ganges River (Padma) delta on the Bay of Bengal. Bangladesh is bordered by India in west, north and east and has a short border with Myanmar (Burma) in south east. It occupies an area of 143,998 km², with a population of about 163 million. The urban population accounts for 35% of the total population. It has a coastline of 580 kilometers along the Bay of Bengal. Bangladesh is a middle power and a developing nation. Listed as one of the Next Eleven, its economy ranks 43rd in terms of nominal gross domestic product and 29th in terms of purchasing power parity. Bangladesh, a developing country with a market-based mixed economy, is one of the Next Eleven emerging markets. Its per-capita income was US$1,754 in 2018, with a GDP of $285 billion. Bangladesh has the third-largest South Asian economy (after India and Pakistan) and the second-highest foreign-exchange reserves (after India). The service sector accounts for 51% of the country's GDP. Bangladesh. Major industries include textiles, pharmaceuticals, shipbuilding, steel, electronics, energy, construction materials, chemicals, ceramics, food processing and leather goods. Bangladesh does not produce raw materials for plastic production. It imports 824,289 metric tonnes / annum of plastic raw material. Plastic consumption is about 5 kg/capita per annum. Import of plastic resin is increasing by 10% per annum while the domestic demand is increasing by 20%.

**China**

China is a country in East Asia and the world's most populous country. It has approximately an area of 9,600,000 square kilometers. It has a population of 1.4 billion with urban population accounting for 51.27%. China has the longest combined land border in the world, measuring 22,117 km (13,743 mi) from the mouth of the Yalu River to the Gulf of Tonkin. China borders 14 nations, more than any other country except Russia, which also borders 14. China extends across much of East Asia, bordering Vietnam, Laos, and Myanmar (Burma) in Southeast Asia; India, Bhutan, Nepal, Afghanistan, and Pakistan in South Asia; Tajikistan, Kyrgyzstan and Kazakhstan in Central Asia; and Russia, Mongolia, and Democratic Republic of Korea in Inner Asia and Northeast Asia. China shares maritime boundaries with Republic of Korea, Japan, Vietnam, and the The Philippines and has a coastline of approximately 14,500 km. China is the world's largest manufacturing economy and exporter of goods. Its estimated GDP is US$ 13.45 trillion (nominal, 2018) with a growth rate of 6.9% (2017). Major contributors to GDP are services, industry (39.8%) and agriculture (8.6%). Major industries include Mining, Ore processing, Iron, Steel, Aluminum and other metals, Coal, Machine Building, Garments, Textiles, Apparel, Petroleum, Cement, Chemicals, Fertilizer, Food processing, Transportation equipment, Automobiles, Railcars, Locomotives, Ships, Aircraft, Telecommunications equipment, Space launch vehicles, Satellites, Consumer products (including footwear, toys and electronics). Plastic production in China is growing at a rate of 7.4% annually and increased from 54.5million tonnes in 2013 to 72.67 million tonnes in 2017. Plastic consumption is growing at an annual growth rate of 5.1% and increased from 70.2 million tonnes in 2013 to 88.12 million tonnes in 2017. Annual per capita plastic consumption is 63.5 kg (2017). Packaging sector consumes 42.1% of plastic resin followed by 22.4% by construction sector, 7% by automotive sector, 6.7% by electrical, electronics and telecom and 21.8% by others.

**India**

The Republic of India is a country in South Asia. It has a coastline of 7,517 km, which is bounded by the Indian Ocean on the south, the Arabian Sea on the southwest, and the Bay of Bengal on the southeast. It shares land borders with Pakistan to the west; China, Nepal, and Bhutan to the northeast; and Bangladesh and Myanmar to the east. In the Indian Ocean, India is in the vicinity of Sri Lanka and the Maldives, while its Andaman and Nicobar Islands share a maritime border with Thailand and Indonesia. Its population is 1.3 billion (2016) with urban population accounting for more than 30%. The Indian economy in 2017 was nominally worth US$2.611 trillion; it is the sixth-largest economy by market exchange rates, and is, at US$9.459 trillion, the third-largest

by purchasing power parity, or PPP. With its average annual GDP growth rate of 5.8% over the past two decades, and reaching 6.1% during 2011-12, India is one of the world's fastest-growing economies. Services sector is the largest contributor to GDP (53.6%) followed by industry (29.02%) and agriculture (17.32%). India is a major exporter of IT services, business process outsourcing (BPO) and software services. Major industries include textiles, chemicals, food processing, steel, cement, mining, petroleum, machinery, software, pharmaceuticals and transportation equipment. Plastic production in India is growing at a rate of 10% annually and increased from 9 million tonnes in 2013 to 12.5 million tonnes in 2017. Plastic consumption is growing at an annual growth rate of 8.4% and increased from 10.7 million tonnes in 2013 to 15.4 million tonnes in 2017. Annual per capita plastic consumption is 11.6 kg (2017). Packaging sector consumes 45% of plastic resin followed by 21.9% by construction sector, 6.3% by automotive sector, 4.7% by electrical, electronics and telecom industry and 22.2% by others.

**Indonesia**

Indonesia is one of the largest economy in Southeast Asia. It has a population of 263.9 million (2017) with a surface area of 1910931 sq.km and a coastline of 54716 km. About 53% population live in urban areas with an average annual urban population growth rate of 2.7% while rural population growth rate is -0.4%. About 64% of the total population is the coastal population. As per 2017 estimates, country's GDP is US$ 1.016 trillion (2017) with an annual growth of above 5% at constant 2005 prices. The industry (including construction) sector is the economy's largest and accounts for 39% of GDP (2017), followed by services (20%) and agriculture (13%). The tourism sector is ranked as the 4th largest among goods and services export sectors. Indonesia's plastic industry has been estimated to be US$ 8 billion (2016). Plastic production in Indonesia is growing at 4% annually and has increased from 2.3 million tons (2013) to 2.9 million tons (2017). In addition, it imports about 40% of its total plastic demand. Plastic consumption is growing at 6% annually and increased from 4 million tons in 2013 to 4.9 million tons in 2017. Plastic consumption by sector include 49.6% packaging, 16% construction, 6.8% automotive, 5% electrical, electronic and telecom while 22.6% is consumed by other sectors. Annual plastic use in Indonesia is about 18 kg per capita (2016). Packaging industry in Indonesia is estimated to be 6.5 billion US$ (2017) with an average annual growth rate 5-6%. Plastic (products) raw material produced in the country was 5.635 million t (2016). Plastic raw material used in packaging sector was 2.254 million t (40% of total plastic production).

**Malaysia**

Malaysia is one of the open state oriented and industrialized, upper-middle income country in Southeast Asia. It has a population base of 29.90 million (2014) with a surface area of 330290 sq.km and a coastline of Malaysia has a total coastline of 4,675 kilometres out of which Peninsular Malaysia has 2,068 kilometres (1,285 mi), while East Malaysia has 2,607 kilometres (1,620 mi). About 74% population live in urban areas. Malaysia has 22.9 million coastal population with per capita waste generation of 1.52 Kg/day. Average annual urban population growth rate (2.7%) is much higher than average annual rural population growth rate (-1.2%). As per 2014 estimates, country's GDP is US$ 338.1 billion with an annual growth of above 4.7% at constant 2005 prices. Malaysian plastic market has been estimated to be US$ 3.3 billion by revenue (2017). It is expected to expand at CAGR of 5.27% (2018-2023). Plastic production has increased from 1.9 million tons in 2013 to 2 million tons in 2017. Plastic consumption is also growing at CAGR of 3.6% (2012-2016) and has increased from 2.15 million tons in 2013 to 2.5 million tons in 2017. Currently, annual plastic consumption per capita is about 78 Kg (2017). Current plastic consumption pattern indicate packaging (50.3%) industry as the major consumer followed by construction industry (17.1%), electrical electronics and telecom (6.1%), automotive (5.7%) and others (20.8%). Packaging industry in Malaysia is expected to grow at 3.6% (CAGR) in 2018. 15 stock exchange listed packaging business companies have an annual revenue base of US$ 1.4 billion with 50% of the revenue from exports.

**Myanmar**

Republic of the Union of Myanmar and also known as Burma, is a country in Southeast Asia. Myanmar is bordered by India and Bangladesh to its west, Thailand and Laos to its east

and China to its north and northeast. Myanmar has a total area of 678,500 square kilometres (262,000 sq mi) and a coastline of 1,930 km (1,200 mi) along the Bay of Bengal and the Andaman Sea. As of 2017, the population is about 54 million with about 36% of urban population. Its GDP is about US$ 69.3 billion with a growth rate of 6.7%. Services sector accounts for 39.9% followed by industry (35.4%) and agriculture (24.8%). Main industries include agriculture processing, wood and wood products, copper, tin, tungsten, iron, cement, construction material, pharmaceuticals, fertilizer, petroleum and natural gas, garments, jade and gems. Plastic industry in Myanmay processes up to 250,000 metric tonnes per year. It is expected to register a growth rate of 6.25% during 2018 to 2023. Packaging application accounts of 49% of the market share.

**Pakistan**

The Islamic Republic of Pakistan is a country in South Asia. It has an area of 881,913 square kilometres with a 1,046-kilometre of coastline along the Arabian Sea and Gulf of Oman in the south. It is bordered by India to the east, Afghanistan to the west, Iran to the southwest, and China in the far northeast. It has a population of 204.92 million with urban population accounting for 39.7% of total population. As of 2017 Pakistan's estimated nominal GDP is US$ 304.04 billion with a growth rate above 5%. Service sector accounts for 60.23 of GDP % followed by industry (20.91%) and agriculture (18.86%). Main industries include textile and apparel, food processing, pharmaceuticals, construction materials, chemicals, cement mining, machinery, steel, engineering, software and hardware, automobile, motorcycle and auto parts, electronics, paper product, fertilizer, shrimp, defence products and ship building. Plastic production in Pakistan is growing above 2.6% annually and increased from 0.42 million tonnes in 2013 to 0.46 million tonnes in 2017. Plastic consumption is also growing at 7.4% annually and increased from 0.9 million tonnes in 2013 to 1.4 million tonnes in 2017. Currently, annual plastic use per capita per year is about 7.3 (2017). Packaging sector is the largest consumer (49.9%) of plastic automotive (6.0%), electronics, electrical and telecom (4.2%) and others (21%).

**The Philippines**

The Philippines is one of the most dynamic economies in the East Asia region having a surface area of 300,000 sq.km., a coastline of 36,289 km. and a population of 104.9 million (2017). The population has an annual growth rate of 1.5%. It is further projected to grow to 125.4 million in 2030, with more than 60% living along the coastline. Urban population is 44.5% of total population. The country has a GDP of $313.6 billion (2017) and an average growth rate of 6.7%. The service sector (31%), industry (30%) and agriculture (10%) are the major contributors to GDP. Industries such as tourism and business process outsourcing have been identified as areas with some of the best opportunities for growth for the country. Plastic market in The Philippines is above 1283.71 million US$ (2016). It has been reported that compounded annual growth rate of plastic industry is 6.11% (forecast for period 2018-2023). Plastic production in 2013 was 1920 MT out of which Polyvinyl Chloride (PVC) was 640 MT, Polystyrene (PS) was 520 MT, Polypropylene (PP) was 480 MT and Polyethylene (PE) was 280 MT. There are 1,088 firms through-out the The Philippines. Majority of the local plastic manufacturers are situated in the National Capital Region (NCR) with 642 firms. This is followed by CALABARZON area with 176 firms. While Central Luzon registered 87 firms. Central Visayas have 87 firms. Northern Mindanao and Davao regions registered 68 firms. Annual plastic use is about 8 kg/person (2013). Plastic used for packaging is about 48% (2017).

**Sri Lanka**

Democratic Socialist Republic of Sri Lanka, is an island country in South Asia, located in the Indian Ocean to the southwest of the Bay of Bengal and to the southeast of the Arabian Sea. It has an area of 65,610 $km^2$ and a population of 21.6 million. It has a coastline of 1,340 km. Its urban population is 20%. It has a GDP of US$ 98.04 billion with a growth rate of 4.5% (2016). The main economic sectors are tourism, tea export, apparel, textile, rice production and other agriculture products. Plastic consumption in Sri Lanka is growing above 16% annually with the current consumption of 265,000 tonnes per annum. Currently annual plastic use per capita per year is 13.5 kg (2017). It imports 100% raw material for production. Packaging sector is the largest consumer (>50%) of plastic industry.

**Thailand**

Thailand is located at the centre of the indo-chinese peninsula in mainland South East Asia. It has a total area of 513120 sq. km. with a population of 69.03 million. Its urban population is 50.04% with an annual growth rate of 3%, which is much higher than an annual rural growth rate of -2%. It has a 3219 km long coastline along 23 provinces with approximately 12 million population. Thailand became an upper-middle income economy in 2011. GDP of Thailand is $455.2 billion with a modest growth rate of 3.9% in 2017. Its economy grew at an average annual rate of 7.5% in the late 1980s and early 1990s, creating millions of jobs that helped reduce poverty rate. Thailand's economy is export dependent contributing about 60% to GDP. Agriculture and tourism are the other sectors which contribute to the economy of the country. Tourism and hospitality sector is one of the major contributor to the income of coastal population. Plastic production in Thailand is growing at 2.9% annually and increased from 7.5 million tons in 2013 to 8.5 million tons in 2017. Plastic consumption is also growing at 4% annually and increased from 4 million tons in 2013 to 4.4 million tons in 2017. Currently per capita plastic consumption is about 64 kg (2017). As per 2014 estimates, Thailand packaging industry value is about 13.05 billion US$. Packaging industry's Compound annual growth rate (CAGR) is about 8.21% (2007-2011). Composition of packaging industry (by value in 2014) consists of paper and board packaging (largest), Plastic packaging (2nd largest), Metal packaging (3rd largest). As per 2016 estimates Thailand packaging material production consists of Plastic: 1.714 million t, Paper: 2.130 million t and Glass: 0.826 million t Metal: 0.418 milion t. Thailand occupies the 2nd place in ASEAN for the flexible packaging market. Plastic consumption by packaging sector in Thailand is 46.5%.

**Vietnam**

Vietnam is the easternmost country on the Indochina peninsula in South East Asia. It has a surface area of 330972 sq. km. and a population of 95.5 million (2017) with an annual growth rate of 3%. It has an urban population of 36%. It has a coast line of 3260 Km with 55.9 million population in coastal provinces. Vietnam's GDP is US$ 223.8 billion (2017) with an annual growth rate above 6% at constant 2005 prices. Vietnam has transformed its economy from one of the poorest in the world, with per capita income around US $100, to lower middle income status with per capita income of around US$2,170 by the end of 2017. Plastic industry in Vietnam is US$ 8.5 billion (2015). Plastic production in Vietnam is growing above 3% annually and increased from 0.6 million tons in 2013 to 0.7 million tons in 2017. Plastic consumption is also growing at 6.6% annually and increased from 2.7 million tons to 3.7 million tons in 2017. Currently, annual plastic (and plastic derived products) use per capita per year is about 40 Kg (2017). Packaging segment is the largest and fastest growing segment with a growth rate (average) of 10%. Composition of packaging industry (by type) includes Plastic packaging (4.7 billion US$, 64%), Paper and corrugated boxes (1.2 billion US$, 16%), Metal packaging (1.1 billion US$, 14%) and glass packaging (0.5 billion US$, 6%).

## Annexure - 2.2: Current Situation of Recycling Rates

| Country | Recycling rate in common | Definition | Past | | Future target for 2020 |
|---|---|---|---|---|---|
| | | | 2000 | 2015 | |
| Bangladesh | *Recycling rate* | (Recovered MSW for reuse and recycling) / (Total amount of MSW generation) | 4% (2005) | 12% | 15% |
| Cambodia | *Recycling rate* | (MSW reuse and recycling) / (Total amount of MSW generation) | 10% (estimated) | 15% (estimated) | 60 % |
| China | *Recycling rate* | N.A. | N.A. | N.A. | N.A. |
| | *Industrial Solid Waste (ISW) Compre-hensively Utilization rate* | (ISW comprehensively utilized amount) / (Total amount of ISW generation + Stock in the previous year) | 45.9% | 62.8% (2013) | 73% |
| India | *MSW Recycling rate* | (MSW reuse and recycling) / (Total amount of MSW generation) | 12.45% in 2010 | 27 % | N.A. |
| | *Industrial Hazardous Waste Recycling rate* | (*Hazardous Waste* reuse, recycling and incineration) / (Total amount of *Hazardous Waste* generation) | 19.73 % | 44.94 % | N.A. |
| Indonesia | *Recycling rate* | (MSW reuse and recycling) / (Total amount of MSW generation) | N.A. | 10% (estimated) | 30% (Based on President Regulation No. 97/2017) |
| Japan | *Recycling rate in common* | Cyclical use rate (waste base) = Amount of cyclical use / Generation of waste | 36% | 44% | 45% |
| | | Cyclical use rate (resource base) | 10% | 16% | 17% |
| Malaysia | *Recycling rate* | Collecting and separating solid waste for the purpose of producing products | 5% | 12.5% | 22% |
| The Philippines | *Recycling rate* | The amount of waste materials that were processed for beneficial use or transformed into new products or used as raw materials for the production of other goods. | 28% (2006, in Metro Manila) (Aguinaldo, 2009 as cited in Atienza, 2012) | 31% (2009, in Metro Manila) (Aguinaldo, 2009 as cited in Atienza, 2012) | N.A. |
| The Philippines | *Diversion rate* | The amount of waste diverted from waste disposal facilities through re-use, recycling and composting activities and other resource recovery activities. Each LGU plan shall include an implementation schedule which shows that within five (5) years after the effectivity of this Act; the LGU shall divert at least 25% of all solid waste from waste disposal facilities through re-use, recycling, and composting activities and other resource recovery activities: Provided, That the waste diversion goals shall be increased every three (3) years thereafter (Section 20, | 25% (target as cited from RA 9003)<br><br>22.22% (in Metro Manila) (MMDA, 2011) | 32.46% (in Metro Manila) (MMDA, 2011) | 50% SW diversion rate target for 2016, as cited in the Philippine Development Plan 2011-2016 (NEDA, 2014) |

| Country | Recycling rate in common | Definition | Past | | Future target for 2020 |
|---|---|---|---|---|---|
| | | | 2000 | 2015 | |
| | | RA 9003). | | | |
| Singapore | *Recycling rate* | Total Waste Recycled / (Total Waste Disposed + Total Waste Recycled) | 40% | 61% | 65% (70% by 2030) |
| Thailand | *Recycling rate* | (Annual total waste utilized amount) / (Annual total waste generation) | 19.55% (2003) | 25.79% (2010) | 30% (2016) |
| Viet Nam | *Recycling rate* | (Collected recyclable waste for recycling from MSW) / (Total amount of collected MSW) | N.A. | 8–15% | 85% |
| | *Recovery rate (for paper, plastics, metal)* | (Waste amount, which had been recycled) / (Total amount of collected recyclable waste) | N.A. | 90% | N.A. |
| Pacific Island Countries | *Recycling rate* | Total amount of Recycled Waste Materials (RWM*5) / Total amount of Recyclable Waste Goods (RWG*6) | N.A. | 47 (2014) | 60 (2020) 75 (2025) |
| | *Recycling rate* | Amount reused, recycled, returned / Amount recyclable | | | |

*Source: prepared by IGES based on the data and information of Country Chapters, State of the 3Rs in Asia and the Pacific*

**Annexure 3.1: Monitoring Indicators in the Current Context of Solid Waste and Plastic Waste Management (Ha Noi 3R Declaration- Sustainable 3R Goals for Asia and the Pacific for 2013-2023, Fourth Regional 3R Forum, Hanoi, Vietnam, 2013)**

| GOALS | MONITORING INDICATORS |
|---|---|
| **I. 3R Goals in Urban/Industrial Areas** | |
| a) 3Rs in municipal solid waste (MSW) | |
| Goal 1) Significant **reduction** in the quantity of **municipal solid waste** generated, by instituting policies, programmes and projects at national and local levels, encouraging both producers and consumers to reduce waste through greening production, greening lifestyle, and sustainable consumption. | • Total generation of MSW per capita.<br>• Total amount of MSW going to landfill.<br>• Number of Integrated Solid Waste Management/3Rs or other relevant policies and programmes introduced at local levels.<br>• Specific policies and mechanisms that lead to reduction of disposable plastic bags, packaging, and other single use consumer products.<br>• Annual government expenditure per capita on consumer awareness-raising.<br>• Total waste disposed per capita. |
| Goal 3) Achieve significant **increase in recycling rate** of recyclables (e.g., plastic, paper, metal, etc.), by introducing policies and measures, and by setting up financial mechanisms and institutional frameworks involving relevant stakeholders (e.g., producers, consumers, recycling industry, users of recycled materials, etc.) and development of modern recycling industry. | • Overall Recycling Rate (%).<br>• Recycling rate (%) of paper.<br>• Recycling rate (%) of plastic.<br>• Market size of recyclables.<br>• New policy/programme/system/measure introduced, or existing policy/programme/ measure/system strengthened.<br>• Number of state-of-art recycling facilities for key recyclables.<br>• Employment in recycling industries.<br>• Number of cities that have introduced successful source separation programmes. |
| Goal 4) Build **sustainable cities /green cities** by encouraging "**zero waste**" through sound policies, strategies, institutional mechanism, and multi-stakeholder partnerships (giving specific importance to private sector involvement) with primary goal of **waste minimization**. | • Number of cities adopting zero waste strategies.<br>• National policies and programmes introduced/ strengthened to support local authorities in implementing zero-waste programmes.<br>• Number of public-private-partnerships in waste management.<br>• Amount of private sector investment in waste management sector.<br>• Number of registered private sector firms with track record of providing waste management services.<br>• Number of cities that implement inclusive and integrated waste management systems that address the environmental, social, and labour (meaningful work) issues of waste, and include informal workers and organizations in their systems. |
| **III. 3R Goals for New and Emerging Wastes** | |
| Goal 12) Strengthen regional, national and local efforts to address the issue of **waste, in particular plastics** in the marine and coastal environment. | • Number of coastal cities with complete ban on use of plastics packaging materials.<br>• Issues of plastic waste considered as part of integrated coastal zone management (ICZM) plans.<br>• National policies concerning plastic waste developed or strengthened, taking into consideration the impacts of plastic waste in marine and coastal environment.<br>• Regional initiatives initiated/ strengthened to address the issue of plastic waste in the marine and coastal environment. |
| **IV. 3R Goals for Cross-cutting Issues** | |
| Goal 17) Improve **resource efficiency and resource productivity** by greening jobs nation-wide in all economic and development sectors. | • Economy-wide Material Flow Accounting indicators, such as Total Material Requirement, Direct Material Input, and Domestic Material Consumption.<br>• Energy efficiency schemes.<br>• Product standards.<br>• Guidelines on greening, including waste management businesses and jobs.<br>• Number of green jobs, taking into consideration nationally-defined indicators.<br>• Number of decent jobs, particularly in the areas of waste reduction and recycling, green product design and other green sectors. |
| Goal 18) Maximize co-benefits from waste | |

| GOALS | MONITORING INDICATORS |
|---|---|
| management technologies for local air, water, oceans, and soil pollution and global climate change. | |
| Goal 19) Enhance **national and local knowledge base and research network on the 3Rs and resource efficiency**, through facilitating an effective and dynamic linkage among all stakeholders, including governments, municipalities, the private sector and scientific communities. | • Policies introduced/strengthened, encouraging interaction between universities and private sector.<br>• Number of collaborative projects, joint conferences and seminars by universities, government, and private sector.<br>• Annual government expenditure in support of research and development on the 3Rs. |
| Goal 20) Strengthen multi-stakeholder partnerships among governments, civil society, and the private sector in raising public awareness and advancing the 3Rs, sustainable consumption and production, and resource efficiency, leading to the behavioural change of citizens and change in production patterns. | • Number of NGOs actively engaged in 3R promotion (e.g., waste reduction, recycling, composting, and green purchasing).<br>• Annual government expenditure on public extension programmes.<br>• Existence of national association of waste management and recycling professionals.<br>• Charge for garbage collection.<br>• Existence of ad-hoc multi-stakeholder committee to promote the 3Rs. |
| Goal 21) **Integrate the 3Rs** in formal education at primary, secondary, and tertiary levels as well as non-formal education such as community learning and development, in accordance with Education for Sustainable Development. | • Number of universities offering courses on the 3Rs and waste management at undergraduate or post graduate levels that include technical procedures, and environmental and social/labour impacts and opportunities.<br>• Waste management, as a social and environmental challenge and the 3Rs and waste issues integrated into school curriculum.<br>• Existence of community-based 3R activities. |
| Goal 22) **Integrate the 3R concept** in relevant policies and programmes, of key ministries and agencies such as Ministry of Environment, Ministry of Agriculture, Forestry and Fisheries, Ministry of Industry, Ministry of Trade and Commerce, Ministry of Energy, Ministry of Water Resources, Ministry of Transport, Ministry of Health, Ministry of Construction, Ministry of Finance, Ministry of Labour, Ministry of Land and Urban Development, Ministry of Education, and other relevant ministries towards transitioning to a resource efficient and zero waste society. | • Existence of a national 3R task force.<br>• Number of sectoral policies and programmes that have integrated 3R concepts.<br>• Number of cities introducing state-of-the-art 3R technologies in various sectors. |
| Goal 23) Promote **green and socially-responsible procurement** at all levels, thereby creating and expanding 3R industries and markets for environmentally-friendly goods and products. | • Number of government ministries that have adopted green procurement policy.<br>• Eco-labels / eco-labeling schemes.<br>• Labour standards, in particular safety of workers, embedded in waste management contracts.<br>• Incentives in place for large-scale contractors to employ and train informal waste workers as needed.<br>• Number of cities that have adopted green procurement policy. |
| Goal 24) **Phase out harmful subsidies that favour unsustainable use of resources (raw materials and water) and energy**, and channel the freed funds in support of implementing the 3Rs and efforts to improve resource/energy efficiency. | • Subsidies that favour unsustainable use of resources and energy are phased out.<br>• Policy instruments(s) and programmes are in place in support of 3Rs and resource/ energy efficiency. |
| Goal 25) **Protect public health and ecosystem, including freshwater and marine resources** by **eliminating illegal** activities of open dumping, including dumping into the oceans, and controlling open burning in both urban and rural areas. | • Number of cities with open dumping/open burning.<br>• Number of major rivers with open dumping and direct discharge of untreated domestic waste and industrial effluents.<br>• Biological Oxygen Demand of major rivers, lakes, etc. |
| 26) Facilitate the international circulation of re-usable and recyclable resources as well as | • Existence of framework for bilateral and multilateral cooperative activities toward efficient, legal, and appropriate |

| GOALS | MONITORING INDICATORS |
|---|---|
| remanufactured products as mutually agreed by countries and in accordance with international and national laws, especially the *Basel Convention*, which contributes to the reduction of negative environmental impacts and the effective management of resources. | trade of circulative resources.<br>• Number of facilities certified by authorized bodies for environmental standard certification.<br>• Market size of waste management and recycling industry.<br>• Number of eco-industrial parks. |
| Goal 27) Promote data collection, compilation, and sharing, public announcements and application of statistics on waste and the 3Rs, to understand the state of waste management and resource efficiency. | • Existence of basic data on wastes and the 3Rs (such as material flow, resource productivity, cyclical use rate, amount of final disposal, and amount of exports and imports of wastes and recycled materials) required for 3R policy-making, planning, implementation, and monitoring.<br>• Number of access to websites providing information on wastes and the 3Rs. |
| Goal 28) Promote heat recovery (waste-to-energy), in case wastes are not re-usable or recyclable and proper and sustainable management is secured. | • Existence of incentives to promote heat recovery.<br>• Number of facilities equipped with heat recovery system. |
| Goal 29) Promote overall regional cooperation and multi-stakeholder partnerships based on different levels of linkages such as government-to-government, municipality-to- municipality, industry-to-industry, (research) institute-to-institute, and NGO-to-NGO. Encourage technology transfer and technical and financial supports for 3Rs from developed countries to less developed countries. | • |
| Goal 30) Pay special attention to issues and challenges faced by developing countries including SIDS for achieving sustainable development. | • Number of 3R-related projects implemented.<br>• Number of 3R-related projects linked to Climate Change, Biodiversity, Disaster Management, Tourism, and Industry. |
| Goal 31) Promote 3R + "Return" concept which stands for Reduce, Reuse, Recycle and "Return" where recycling is difficult due to the absence of available recycling industries and limited scale of market in SIDS, especially in the Pacific Region. | • Number of countries that have developed the 3R (+ "Return") strategy.<br>• Number of countries that have developed and implemented economic instruments such as the container deposit programme, etc.<br>• Number of recycling companies/organizations that have been trained on basic technique for recycling (preliminary processing).<br>• Implementation of periodical review on "Return" collaboration between the Asia-Pacific countries through 3R Forum in Asia and the Pacific. |
| Goal 32) Complete elimination of illegal engagement of children in the **informal waste sector** and gradually **improve** working conditions and livelihood security, including **mandatory provision of health insurance** for all workers. | • Number of children in hazardous child labour (ILO definition) in waste sector (target set for 0).<br>• Clear policy framework for informal waste sector integration in place.<br>• Effective policy framework for integrating informal waste activities into integrated waste management schemes.<br>• Waste pickers provided with contributory social security.<br>• Landfill sites accessible only to registered waste pickers.<br>• Number of workers in informal and formal sector with access to social security and/or health care services.<br>• Number of labour inspections in waste sector. |
| Goal 33) Promote 3Rs taking into account gender considerations. | |

## Annexure 3.2: Waste management and 3R-related policies/strategies in Asia and the Pacific

| Country | Reference on waste management in its basic environmental policy | Waste management law | Framework strategy and law on resource circulation and the 3Rs | Law for recycling and take-back scheme for specific end-of-life products |
|---|---|---|---|---|
| Bangladesh | National Environment Policy 1992 | -- | National 3R Strategy 2010 | -- |
| Cambodia | Law on Environmental Protection and Natural Resources Management 1996 | Sub-decree on SWM (1999) | -- | -- |
| China | Environmental Protection Law of the People's Republic of China (2014 Revision) | Law of the People's Republic of China on the Prevention and Control of Environment Pollution Caused by Solid Wastes (2015Amendment) | Circular Economy Promotion Law of the People's Republic of China (2008) | Regulation on the Administration of the Recovery and Disposal of Waste Electrical and Electronic Products (2009, Order of the State Council of the People's Republic of China (No. 551)) |
| India | - Article 48A, directive principle, Part IV and Article 51 A(g), Part IVA, of the amendment of Constitution of India in 1976;<br>- Environmental Protection Act 1986;<br>- Factories Act 1948 and its amendment in 1987<br>- National Environment Policy (2006) | - Solid Waste Management Rules, 2016;<br>- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016;<br>- Bio-Medical Waste Management Rules, 2016;<br>- Construction and Demolition Waste Management Rules, 2016<br>- Plastic Waste Management Rules, 2016 | Waste Management Rules are based on 5Rs strategies that include resource circulation and the 3Rs principles. | E-waste (Management) Rules, 2016 |
| Indonesia | Environmental Protection and Management Act No. 32 (EPMA 32/2009) | Law no.18/2008 on MSW Management: 3R as the principle approach for waste management<br>Law no, 32/2009 on Haz. Wastes | The government regulation no. 81/2012 on 3Rs and EPR President Regulation No.97/2017 on Policy and National Strategy of MSW | -- |
| Japan | Basic Environmental Law and Plan | Waste Management and Public Cleansing Law | Basic act and fundamental plan for establishing sound material cycle society | Various recycling laws such as: Container Packaging Resource Recycling Act (1995) and Home Appliance Recycling Act (1998) |
| Malaysia | Environmental Quality Act 1974 | Solid Waste and Public Cleansing Management Act 2007 | There are 8 Regulations on 3R within the Solid waste Act | There are 8 Regulations within the Solid waste Act |
| The The | PD 1152 – | Ecological Solid | Ecological Solid | -- |

| Country | Reference on waste management in its basic environmental policy | Waste management law | Framework strategy and law on resource circulation and the 3Rs | Law for recycling and take-back scheme for specific end-of-life products |
|---|---|---|---|---|
| Philippines | Philippine Environment Code (1977)<br>RA 8749 – Philippine Clean Air Act of 1999<br>RA 9275 – Philippine Clean Water Act of 2004 (2004) | Waste Management Act of 2000 (RA 9003) | Waste Management Act of 2000 (RA 9003) | |
| Singapore | Environmental Public Health Act | Environmental Public Health (General Waste Collection) Regulations; Environmental Public Health (Toxic Industrial Waste) Regulations | Sustainable Singapore Blueprint setting waste recycling rate target of 70% in 2030 with a goal of becoming a Zero Waste Nation | -- |
| Thailand | Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992), Factory Act B.E. 2535 (1992), Public Health Act B.E.2535 (1992) | Maintenance of Public Sanitary and Order Act. B.E. 2535 (1992) and B.E.2560 (2017) | National Solid Waste Management Master Plan, Action Plan "Thailand Zero Waste, 2016" | Regulation on National Waste Management System 2007, Draft WEEE Act., Draft Waste Management Act, Draft Promotion of 3Rs and Utilization of Waste |
| Viet Nam | Law on Environmental Protection 2014 (amended in 2014) | Decree 38/2015/ND-CP on management of wastes and scrap | National Strategy on Integrated Solid Waste Management to 2025, vision to 2050 (Being revised) | Regulation for take-back and treatment of discarded products: Prime Minister Decision 16/2015/QĐ-TTg dated 22 May 2015 (Small appliances, home appliances, lubricant oils, used tyres, ELVs) |
| Pacific Island Countries | The Pacific Regional Waste and Pollution Management Strategy 2016-2025 (Cleaner Pacific 2025) is a comprehensive long-term strategy for integrated sustainable waste management and pollution prevention and control in the Pacific Region. Cleaner Pacific 2025 integrates strategic actions addressing priority waste and pollution issues in the region. Countries within the region are responsible for developing and enforcing specific laws and regulations concerning waste management guided by multi-environmental agreements. Cleaner Pacific 2025 presents the current status of waste, chemicals and pollution policies in the Pacific Island countries and territories. SPREP and J-PRISM are working collaboratively in the development and updating of country waste policies. | | | |

*Source: prepared by IGES based on the data and information of Country Chapters, State of the 3Rs in Asia and the Pacific*

## Annexure 3.3: Current situation of marine and coastal plastic in representative countries

| Country | Current situation of marine and coastal plastic |
|---|---|
| **Bangladesh** | Plastic shopping bags have been introduced in the early 1980s and quickly became widespread. The plastic shopping bags is one of major causes of flooding due to clogged rivers and drains. In 2002, the government introduced a ban on the manufacture and use of plastic bags in Dhaka, which was subsequently expanded nationwide. However, due to a lack of enforcement, there has been no significant reduction in the use of plastic shopping bags. |
| **Cambodia** | At present, study on marine and coastal plastic waste is very limited, but some activities such as public awareness to reduce the use of plastic bags at the ministry, city, and community level and media have been undertaken by government and NGOs. However the waste-particularly plastic bags and food wrappers still found at the beach of Cambodia. Three sub-decrees are applied in implementing in SWM in Cambodia that they include: (1) the sub-decree on SWM in 1999 states the disposal of waste including plastic in public sites or anywhere that is not allowed by the authorities shall be strictly prohibited; and (2) In 2015, Inter-Ministry between Ministry of Environment (MoE) and Ministry of Interior (MoI) established a sub-decree on garbage management and solid waste management at urban areas. The sub-decree aims improving proper waste management including storage, collection and disposal at urban areas. In 2017, MoE also established a draft sub-decree on plastic management to reduce plastic import, production, distribution, and uses to ensure preventing public health, aesthetics, and environment. This sub-decree also states that city and province must support, facilitate and |
| | lead to organize any event to reduce plastic waste. It also said that any super market and commercial centre must include cost for plastic users. This sub-decree will be implemented after governmental signature during this year respectively. |
| **China** | There have been some activities undertaken at the city level such as the campaign to reduce the use of plastic bags during the time of the Beijing Olympic Games. A set of national laws limiting the production and consumption of plastic bags came into effect in 2008, which mandated that all retailers stop providing complimentary heavy plastic bags or charge a fee for these plastic bags. This law has had a positive result even after the conclusion of the Olympic games. |
| **India** | As per available information, consumption of plastics in the country during 2013-14 was 11 million tonnes. Plastic Waste (Management) Rules 2016 bans plastic carry bags with a thickness of less than 50 micron. The total quantity of plastic waste generated in the country from 60 major cities is estimated to be 3501 tonnes/day. The cities of Delhi, Chennai, Kolkata, Mumbai, Bengaluru, Ahmadabad and Hyderabad are generating maximum quantities of plastic waste. No primary or secondary data is available on marine and coastal plastic waste. |
| **Indonesia** | Based on Kellen (2014), research shows that of the 285 million tonnes of plastics produced in 2014, 4.76 million tonnes entered the marine environment as beach litter, depositions on the seafloor and microplastics in the gyres. The main flows towards the gyres were identified as<br>0.4 million tonnes/year extra-gyral input of beach litter as well as 0.3 million tonnes/year inflow from anthropogenic pre-and postconsumer plastic stocks in the case of a tsunami. The flow of litter towards the beach stemmed mainly from uncollected plastics, amounting to 0.56 millon tonnes/year, and dumpsite leaking, equaling 4.19 million tonnes/year as of 2014. |
| **Japan** | Japan's *Law concerning the Promotion of Handling of Coastal Drift, etc. related to the Maintenance of Good Landscape and Environment in the Coastal Areas to Preserve the Rich and Beautiful Nature* entered into effect in July 2009.<br>The quantity of coast flotsam (quantity at the beginning of the year) in Japan has estimated by calculating the consumption rate based on the recovery performance by clean-up activities according to the study carried out by the Ministry of the Environment, the Secretariat at the Promotional Council.<br>Japan's Ministry of Environment also conducted a survey on marine litter in 7 power plants across the country in the five year period spanning FY 2010 and FY2014. In addition, the Ministry of Environment conducted a survey in FY 2014 on the buoyant density by visual inspection of the drifting garbage and compared to the average values in each ocean for the total density of plastic films, polystyrene foam and other petrochemical products. Micro plastics were also collected with a plankton net and those of sizes 1~5mm were compared with the buoyant density for each ocean.<br>A levy system for plastic shopping bags collected at grocery stores, super market, drug stores etc. is becoming an increasingly common approach to reduce the consumption of plastic bags. |
| **Malaysia** | In 2009, it was found that 44.50% of the collected marine litters in Malaysia were comprised |

| Country | Current situation of marine and coastal plastic |
|---|---|
| | of plastics. The number of plastic wastes in marine and coastal areas increased to 62.76% in 2012. Specific marine and coastal plastic wastes collected include plastic bags, food wrappers, bait packaging, plastic tarps, beverage bottles, straws, cleaner bottles, tobacco packaging, caps/lids, toys and oil bottles. The high level of marine and coastal plastic waste detected can likely be attributed to human activities such as picnic.<br>Some local municipalities have made efforts to encourage reductions in the use of plastic bags. For example, the state of Penang implemented the levy system of 20 Sen (6¢) per plastic bag to shoppers.<br>Malaysia has also prepared Plastic Waste Management Plan in October 2018. |
| **The Philippines** | Plastics released to the marine environment are of increasing concern because of its negative effects on the oceans, wildlife, and humans. Plastic bags are the most common type of garbage found in Manila Bay. Of the1,594 liters of garbage collected, 23.2% are plastic bags.<br>Consistent with this finding, the same environmental groups found that 75.5% of wastes in the bay were plastic discards in 2010. Of this, 27.7% were plastic bags.<br>Given this situation, several NGOs and decision makers in the The Philippines have called for the banning the use of plastics in the country. Many LGUs have started creating local ordinances banning the use of plastics in households and commercial establishments. |
| **Singapore** | There is less statistical data on marine litters readily available.<br>In 2013, the non-profit organization International Coastal Cleanup Singapore (ICCS) conducted its annual beach and mangrove cleanup and published the resulting data on marine trash in Singapore. For the ICCS 2013 study alone, 3,473 volunteers covered 19,476 meters of coastline and collected 14,448 kg (153,147 pieces) of marine trash. Examining this data, the average weight of marine trash collected by each volunteer increased by 32% from 3.1 kg/person in 2002 to 4.2 kg/person in 2013. The average weight of marine trash collected for each meter of coastline also increased by 194% from 0.25 kg/m in 2002 to 0.74 kg/m in 2013. In addition, the data indicated that the majority of the waste, other than cigarette butts, are related to plastic products.<br>Marine plastic waste in Singapore waters and along Singapore's coastline could be caused by both tidal conditions and inland sources.<br>The Maritime and Port Authority of Singapore (MPA) enforces strict regulations on pollution of the sea from ships within its port waters for ships visiting Singapore. MPA also monitors the ships in port to ensure compliance to the regulations. Under Singapore's Prevention of Pollution of the Sea Act, it is an offence for any person to throw or deposit into Singapore waters any refuse, garbage, plastics or waste matter. If convicted, offenders are liable to be fined up to a maximum of S$10,000 or imprisoned for up to 2 years or both.<br>The MPA also employs a contractor to collect garbage from ships to ensure proper disposal and flotsam retrieval. This ensures that the waters are clean and safe for navigation. Garbage collection and flotsam retrieval operations are conducted on a daily basis by a fleet of nine craft (four for garbage collection, 5 for flotsam retrieval). In 2015, a total of 4257.89 tonnes of flotsam and garbage waste was collected. |
| **Thailand** | According to Central Database System and Data Standard for Marine and Coastal Resource, Department of Marine and Coastal Resource, MONRE, the accumulative number of marine and coastal trash collected in Thailand from 2009 to 2012 was 216,691 pieces, weighing 20,947.16 kilograms. There were 29,994 pieces of plastic (13.84 %), secondly 24,416 pieces of rope (11.27 %), and thirdly cover and lid (10.15%). |
| **Viet Nam** | There are no official statistics on marine and coastal plastics waste in Viet Nam at present. At the same time, there has not been much effort and progress on controlling waste in the marine and coastal environment, most especially for plastics. In 2010, the Law on Environmental Tax imposed taxation on plastic bags. There is also a program on control of waste from plastic bags issued by the Decision 582/QD-TTg in 2013. A Law on Marine and Islands Natural Resources and Environment was adopted by the National Assembly in 2014. The Law contains a chapter outlining regulations on pollution control, oil spill responses and sea dumping. According to the Law, discharged sources are required be controlled, with all wastes effectively treated to meet environmental standards before being discharged into the sea, instructing that all floating waste should be collected and treated in a proper manner. However, plastic waste was not specifically mentioned in the regulations. |
| **Pacific Island Countries** | While marine litter can be found everywhere in the Pacific region, there is often very little awareness of this problem as an environmental and socioeconomic issue or about its impacts upon local communities. Raising awareness of the marine litter issue among Pacific islanders can create incentives for greater investment in, and prioritization of this issue among a variety |

| Country | Current situation of marine and coastal plastic |
|---|---|
| | of stakeholders including governments, industry, academia, NGOs and citizens.<br>Very little research has been done on land- and sea-based sources, outcome and impacts of marine litter in the Pacific region, which can be used to inform regional and national strategies and policy making. Of particular relevance is the need for modelling and monitoring; investigations into ALDFG including Fish Aggregating Devices; and identification of major marine litter accumulation and hot spot areas in the region to allow for targeted recovery and clean-up efforts. |

*Source: IGES based on the data and information of Country Chapters, State of the 3Rs in Asia and the Pacific*

## Annexure 5.1: Miltilateral Environmental Treaties

| Treaty (short name) | Entry into force | Main provisions |
|---|---|---|
| Treaties related to waste and chemicals management | | |
| Basel Convention | 24 February 2004 | **Basel Convention on Control of Transboundary Movements of Hazardous Wastes and Their Disposal**<br>The overarching objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as 'hazardous wastes' based on their origin and/or composition and their characteristics, as well as two types of wastes defined as 'other wastes' – household waste and incinerator ash. |
| Minamata Convention on Mercury | Not yet in force (adopted on 19 January 2013) | **Minamata Convention on Mercury**<br>A global treaty to protect human health and the environment from the adverse effects of mercury. Highlights of the convention include a ban on new mercury mines, the phase-out of existing ones, control measures on air emissions, and the international regulation of the informal sector for artisanal and small-scale gold mining. |
| Montreal Protocol | 1 January 1989 | **Montreal Protocol on Substances That Deplete the Ozone Layer**<br>Protects the ozone layer by phasing out the production and consumption of a number of substances responsible for ozone depletion. The current emphasis (for Pacific Parties) is to phase out the import and use of HCFCs, which are primarily used in refrigeration and air-conditioning servicing. |
| Rotterdam Convention (2004) | 24 February 2004 | **Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade**<br>Provides an early warning system on hazardous chemicals, and enables monitoring and controlling trade of chemicals, giving Parties power to decide which they wish to import and exclude those they cannot manage safely. There are 47 chemicals, out of which 33 are pesticides, and four are severely restricted hazardous substances. |
| Stockholm Convention (2001) | 17 May 2004 | **Stockholm Convention on Persistent Organic Pollutants**<br>Aims to protect human health and environment from the adverse effects of 23 identified toxic chemicals (POPs) that, when released, persist in the environment and can lead to serious health effects, including certain cancers, birth defects, neurological effects and greater susceptibility to disease. |
| Waigani Convention | 21 October 2001 | **The Waigani Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement of Hazardous Wastes within the South Pacifi Region**<br>Constitutes the regional implementation of the Basel Convention in the Pacific, however, coverage extends to radioactive waste, and to the EEZ (200 nautical miles) of Parties. |
| Treaties related to marine pollution | | |
| MARPOL 73/78 | 2 October 1983 | **International Convention for the Prevention of Pollution from Ships, 1973, as modifi by the Protocol of 1978 relating thereto**<br>This is the main international Convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. |
| – Annex I | 2 October 1983 | Regulates the prevention of pollution by oil and governs the discharges, except for clean or segregated ballast, from all ships. Requires ships to be |

| Treaty (short name) | Entry into force | Main provisions |
|---|---|---|
| | | fitted with pollution prevention equipment to comply with the stringent discharge regulations. |
| – Annex II | 6 April 1987 | Regulates the control of pollution by noxious liquid substances in bulk and sets out a pollution categorisation system for noxious and liquid substances. |
| – Annex III | 1 July 1992 | Sets out regulations for the prevention of pollution by harmful substances in packaged form and includes general requirements for the issuing of detailed standards on packing, marking, labelling, documentation, stowage, quantity limitations, exceptions and notifi for preventing pollution by harmful substances. |
| – Annex IV | 27 September 2003 | Regulates the discharge of sewage into the sea from ships, including ships' equipment and systems for the control of sewage discharge, the provision of port reception facilities for sewage, and requirements for survey and certification. |
| – Annex V | 31 December 1988 | Prohibits the discharge of all garbage into the sea, except as provided for food waste, cargo residues, cleaning agents and additives and animal carcasses. |
| MARPOL PROT 1997 (Annex VI) | 19 May 2005 | **Protocol of 1997 to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modifi by the Protocol of 1978 relating thereto**<br>Limits the main air pollutants contained in ships' exhaust gas, including sulphur oxides and nitrous oxides, and prohibits deliberate emissions of ODSs. Also regulates shipboard incineration, and the emissions of volatile organic compounds from tankers. |
| London Convention 1972 | 30 August 1975 | **Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972**<br>Its purpose is to control all sources of marine pollution and prevent pollution of the sea through regulation of dumping into the sea of waste materials. It prohibits the disposal at sea of specific 'black- list' items, and prescribes the conditions for dumping at sea of permitted 'grey-listed' items. |
| London Convention Protocol 1996 | 24 March 2006 | **1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972**<br>The purpose of this protocol is similar to the London Convention, but it is more restrictive and adopts a 'reverse list' approach, which implies that all dumping is prohibited unless explicitly permitted.<br>Incineration of wastes at sea and export of wastes for the purpose of dumping or incineration at sea are prohibited. |
| INTERVENTION Convention 1969 | 6 May 1975 | **International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969**<br>Affirms the right of a coastal state to take such measures on the high seas as may be necessary to prevent, mitigate or eliminate danger to its coastline or related interests from pollution by oil or the threat thereof resulting from a maritime casualty. |
| INTERVENTION Protocol 1973 | 30 March 1983 | **Protocol relating to Intervention on the High Seas in Cases of Pollution by Substances other than Oil, 1973**<br>Extends the regime of the 1969 INTERVENTION Convention to specific substances or substances with substantially similar characteristics. |
| CLC Convention 1969 | 19 June 1975 | **International Convention on Civil Liability for Oil Pollution Damage, 1969** |

| Treaty (short name) | Entry into force | Main provisions |
|---|---|---|
| | | Ensures that adequate compensation is available to persons who suffer oil pollution damage resulting from maritime casualties involving oil-carrying ships. It applies to all seagoing vessels actually carrying oil in bulk as cargo (i.e. laden ships), but only ships carrying more than 2,000 tons of oil are required to maintain insurance in respect of oil pollution damage. It places the liability for such damage on the owner of the ship from which the polluting oil escaped or was discharged. |
| CLC Protocol 1976 | 8 April 1981 | **Protocol to the International Convention on Civil Liability for Oil Pollution Damage, 1969**<br>Provides for the applicable unit of account used under the convention to be based on the Special Drawing Rights (SDR) as used by the International Monetary Fund. |
| CLC Protocol 1992 | 30 May 1996 | **Protocol of 1992 to amend the International Convention on Civil Liability for Oil Pollution Damage, 1969**<br><br>Widens the scope of the CLC Convention to cover pollution damage caused in the exclusive economic zone or equivalent area of a State Party, and to cover spills from laden and unladen tankers. It limits environmental damage compensation to costs incurred for reasonable measures to reinstate the contaminated environment.<br><br>From 16 May 1998, Parties to the 1992 Protocol ceased to be Parties to the 1969 CLC due to a mechanism for compulsory denunciation of the 'old' regime established in the 1992 Protocol. However, there are a number of States which are Party to the 1969 CLC and have not yet ratified the 1992 regime, which is intended to eventually replace the 1969 CLC. |
| FUND Convention 1971 | 16 October 1978<br>Ceased to be in force on 24 May 2002 | **International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971**<br>Established an international fund that provided compensation to States and persons who suffered pollution damage, if such persons were unable to obtain compensation from the owner of the ship from which the oil escaped or if the compensation due from such owner is not sufficient to cover the damage suffered. |
| FUND Protocol 1976 | 22 November 1994 | **Protocol to the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971**<br>Superseded by the FUND Protocol 1992. |
| FUND Protocol 1992 | 30 May 1996 | **Protocol of 1992 to amend the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971**<br>Establishes an international fund to cover claims for oil pollution damage that exceed compensation available under the CLC Protocol 1992. Compensation is available up to SDR 135 million. To be a Party to this protocol, a country must first be a Party to the CLC Protocol 1992. |
| FUND Protocol 2003 | 3 March 2005 | **Protocol of 2003 to the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1992**<br>Establishes an International Oil Pollution Compensation Supplementary Fund to supplement the compensation available under the 1992 CLC and 1992 FUND Protocols with an additional, third tier of compensation. |

| Treaty (short name) | Entry into force | Main provisions |
|---|---|---|
| OPRC Convention 1990 | 13 May 1995 | **The International Convention on Oil Pollution Preparedness, Response and Cooperation, 1990**<br>Provides a framework designed to facilitate international cooperation and mutual assistance in preparing for and responding to major oil pollution incidents and requires States to plan and prepare by developing national systems for pollution response in their respective countries, and by maintaining adequate capacity and resources to address oil pollution emergencies. |
| HNS Convention 1996 | Not yet in force | **International Convention on Liability and Compensation for Damage in connection with the Carriage of Hazardous and Noxious Substances by Sea, 1996**<br>Provides for compensation to victims of shipping accidents involving hazardous and noxious substances (HNS), depending on the tonnage of the ship. Ship-owners are liable for up to 100 million SDR in damage, with an additional 150 million available under an HNS fund in cases where full compensation is not available under the first tier. The convention covers pollution damage as well as the risks of fire and explosion; loss of life or personal injury; and loss of or damage to property. |
| HNS PROT 2010 | Not yet in force | **Protocol of 2010 to the International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, 1996**<br>Addresses practical problems that hinder the entry into force of the HNS Convention. |
| OPRC/HNS 2000 | 14 June 2007 | **2000 Protocol on Preparedness, Response and Cooperation to Pollution Incidents by Hazardous and Noxious Substances**<br>Establishes national systems for preparedness and response and provides a global framework for international cooperation in combating major incidents or threats of marine pollution. Parties are required to establish measures for dealing with pollution incidents, either nationally or in cooperation with other countries. Ships are required to carry a shipboard pollution emergency plan to deal specifically with incidents involving hazardous and noxious substances. |
| BUNKERS Convention 2001 | 21 November 2008 | **International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001**<br>Ensures that adequate, prompt and effective compensation is available to persons who suffer damage caused by spills of oil, when carried as fuel in ships' bunkers. The Convention applies to damage caused in the territory, including the territorial sea, and in exclusive economic zones of States Parties, and requires ships over 1,000 gross tonnage to maintain insurance or other financial security. |
| Anti-Fouling Substances Convention 2001 | 17 September 2008 | **International Convention on the Control of Harmful Anti-Fouling Substances on Ships, 2001**<br>Prohibits the use of harmful organotin compounds in anti-fouling paints used on ships and establishes a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems. Parties are required to prohibit and/or restrict the use of harmful anti-fouling systems on ships flying their flag, as well as ships not entitled to fly their flag but which operate under their authority and all ships that enter a port, shipyard or offshore terminal of a Party. |

| Treaty (short name) | Entry into force | Main provisions |
|---|---|---|
| BWM Convention 2004 | Not yet in force | **International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM 2004)**<br>Once in force, it will regulate the introduction of invasive species via ballast water and sediments. It will require ships to implement a ballast water management plan; carry a ballast water record book; and to carry out ballast water management procedures to a given standard. |
| Nairobi WRC 2007 | 14 April 2015 | **Nairobi International Convention on the Removal of Wrecks, 2007**<br>The Convention provides a legal basis for States Parties to remove, or have removed, wrecks that pose a danger or impediment to navigation or that may be expected to result in major harmful consequences to the marine environment, or damage to the coastline or related interests of one or more States. The Convention also applies to a ship that is about, or may reasonably be expected, to sink or to strand, where effective measures to assist the ship or any property in danger are not already being taken. |
| Hong Kong Special Administrative Region of the People's Republic of China Convention (2009) | Not yet in force | **Hong Kong Special Administrative Region of the People's Republic of China International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009**<br>The purpose of this Convention is to ensure that ships being recycled after reaching the end of their operational lives do not pose any unnecessary risks to human health and safety, or the environment.<br><br>It addresses concerns about hazardous substances (asbestos, heavy metals, hydrocarbons, ODSs and others) that may be present on ships sent for recycling, and also addresses concerns about the working and environmental conditions at many of the world's ship recycling locations. |
| Noumea Convention (1990) | 22 August 1990 | **The Convention for the Protection of Natural Resources and Environment of the South Pacific Region**<br>Obliges Parties to endeavour to take all appropriate measures to prevent, reduce and control pollution from any source and to ensure sound environmental management and development of natural resources, using the best practicable means at their disposal and in accordance with their capabilities. |
| – Dumping Protocol | | **Protocol for the Prevention of Pollution of the South Pacific Region by Dumping**<br>Promotes a coordinated regional approach to the issue of dumping consistent with the 1972 London Dumping Convention. |
| – Emergencies Protocol | | **Protocol Concerning Cooperation in Combating Pollution Emergencies in the South Pacific Region**<br>Establishes a framework for cooperation to protect the marine and coastal environment from the threat of pollution resulting from the presence of oil or other harmful substances in the marine environment as a result of maritime emergencies. |

| Treaty (short name) | Entry into force | Main provisions |
|---|---|---|
| – Oil Pollution Protocol (2006) | Not yet in force | **Protocol on Oil Pollution Preparedness, Response and Cooperation in the Pacific Region**<br>Establishes a framework for regional cooperation in responding to pollution emergencies. It supports the establishment of oil pollution emergency plans for ships, ports and oil-handling facilities, as well as national and regional contingency plans. The Convention encourages all States to develop and maintain adequate capability to deal with oil pollution emergencies |
| – HNSP Protocol | Not yet in force | **Protocol on Hazardous and Noxious Substances Pollution, Preparedness, Response and Cooperation in the Pacific Region**<br>Constitutes the regional implementation of the OPRC/HNS 2000 in the Pacific region. |

## Annexure 5.2: Description of Conventions

## East Asian Seas

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|---|---|
| **Convention/ Action Plan:** | The Action Plan for the Protection and Development of the Marine Environment and Coastal Areas of the East Asian Region (the East Asian Seas Action Plan) |
| **Contracting Parties/ Member States:** | Cambodia, China, Indonesia, Republic of Korea, Malaysia, the Philippines, Thailand, Singapore and Vietnam |
| **Secretariat:** | Secretariat of the Coordinating Body on the Seas of East Asia (COBSEA Secretariat) UN, Rajadamnern Nok Av, Bangkok 10200, Thailand<br><br>The COBSEA Secretariat is hosted by Thailand and administered by UN Environment, located at the UN Environment Asia and the Pacific Office in Bangkok, Thailand. The current country hosting and location of COBSEA Secretariat was adopted by the 22nd Intergovernmental Meeting, in 2015. The Secretariat is funded by participating countries through the East Asian Seas Trust Fund, which is administered by UN Environment. |
| **Status in addressing Land based Activities at the regional level** | |
| **Regional Programme of Action (as planning tool):** | - COBSEA Strategic Directions 2018-2022<br>- COBSEA Regional Action Plan on Marine Litter<br>- Strategic Action Programme for the South China Sea<br>- Regional Programme of Action for the Protection of East Asian Seas from the Effects of Land-based Activities |
| **Adoption/ Timeframe:** | - COBSEA Strategic Directions 2018-2022, adopted by COBSEA Intergovernmental meeting in 2018<br>- COBSEA Regional Action Plan on Marine Litter adopted in 2008; under revision, process for revision adopted by COBSEA Intergovernmental meeting in 2018. This remains the only intergovernmentally adopted framework for marine litter in the region.<br>- Strategic Action Programme for the South China Sea, adopted in 2009. |
| **Legal Framework for Land Based Activities:** | N/A |
| **Adoption/Timeframe** | |
| **Regional Programme of Action (as implementation tool):** | *COBSEA Strategic Directions 2018-2022*<br>The COBSEA Strategic Directions 2018-2022 guide COBSEA participating countries and the COBSEA Secretariat in action towards development and protection of the marine environment and coastal areas of East Asian Seas, leveraging COBSEA as an intergovernmental policy mechanism towards planning, implementation and tracking of delivery of ocean-related Sustainable Development Goals, in line with the global "Regional Seas Directions 2017-2020". To this end the Strategic Directions encompass two substantive themes: Land-based marine pollution; and Marine and coastal planning and management; as well as an over-arching Governance theme. The substantive themes identify priority issues relevant to the region's<br>marine and coastal environment and sustainable development, where COBSEA has a particular mandate or comparative advantage to catalyse and deliver policy development, projects and other activities. The governance theme addresses COBSEA as a regional policy mechanism and identifies priorities in creating the necessary conditions for COBSEA and its Secretariat to efficiently deliver their mandates.<br><br>*COBSEA Regional Action Plan on Marine Litter*<br>A joint COBSEA-UN Environment regional project on reducing marine litter through management of the plastic value chain has been initiated. This USD 6.4M project is funded by Swedish International Development Agency. The project is starting with an inception phase in 2018 followed by 4 years of project implementation. COBSEA leads project components focusing on the science basis for decision-making including monitoring and reporting, as well as on regional networking, cooperation |

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| | and sharing. This will support countries implement key provisions of the Regional Action Plan on Marine Litter, and in doing so also facilitate development, planning and implementation of national commitments (including commitments made in the context of the global Clean Seas campaign and voluntary commitments related to SDG 14.1.).<br><br>*Strategic Action Programme for the South China Sea*<br>The GEF project 'Implementing the Strategic Action Programme for the South China Sea', which addresses the habitat, land-based pollution and regional coordination components of the Strategic Action Programme, is starting in 2018. The GEF project 'Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand', which implements the fisheries component of the Strategic Action Programme, started in 2016. COBSEA has an umbrella coordinating role for these projects. | |
| **Adoption/ Timeframe:** | 2018-2022 | |
| **Principal Activities** of the COBSEA Strategic Directions 2018-2022**:** | | |
| **Priority Pollutant Source Category** | **Actions Needed** | **Generic Support Needed** |
| Marine Litter | - Review and revision of the COBSEA Regional Action Plan on Marine Litter adopted in 2008;<br>- Implementation of the COBSEA Regional Action Plan on Marine Litter through a regional initiative/project. | Technical support/ collaboration in addressing land-based sources of marine plastic litter.<br><br>Financial support and technical collaboration to address sea-based sources in line with the Regional Action Plan on Marine Litter |

## Northwest Pacific

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|---|---|
| **Convention/ Action Plan:** | The Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (NOWPAP) adopted in 1994 |
| **Contracting Parties/ Member States:** | China, Japan, the Republic of Korea, and the Russian Federation |
| **Secretariat:** | Northwest Pacific Action Plan (NOWPAP) Regional Coordinating Unit, Toyama 5-5 Ushijimashin-machi, Tower 111-6F Toyama City, 930-0856 Japan<br>TEL.: +81.76.444.16.11 / FAX: +81.76.444.27.80<br><br>Northwest Pacific Action Plan (NOWPAP) Regional Coordinating Unit, Busan Office 216 Gijanghaean-ro, Gijang-eup, Gijang-gun, Busan 619-705, Republic of Korea<br>Tel: +82 51 720 3000, Fax: +82 51 720 3009<br>Homepage: www.nowpap.org |
| **Status in addressing Land based Activities at the regional level** | |
| **Regional Programme of Action (as planning tool):** | - NOWPAP Regional Oil and NHS (Hazardous and Noxious Substances) Spill Contingency Plan (RCP)NOWPAP Regional Action Plan on Marine Litter (RAP MALI)<br>- Regional Ecological Quality Objectives (EcoQOs) were adopted in 2016 and work is ongoing on the development of EQO indicators. Among LBA categories, EQOs target marine litter and nutrients/eutrophication<br>- State of the Marine and Coastal Environment in the Northwest Pacific (SOMER-2), 2014 |
| **Adoption/ Timeframe:** | RCP adopted in 2005 ongoing; RAP MALI adopted in 2008, ongoing |
| **Legal Framework for Land Based Activities:** | NN |
| **Adoption/Timeframe** | |
| **Regional Programme of Action (as implementation tool):** | NOWPAP Regional Action Plan on Marine Litter; voluntary; focused on prevention, monitoring and removal of marine litter. Annual marine litter |

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| | workshops (since 2015 are organized jointly with Tripartite Environmental Ministers Meeting), annual International Coastal Cleanup Campaigns organized each year since 2006 on a rotating basis in Member States.<br><br>RCP is being implemented through information collection and sharing, regular (led by Member States) oil and HNS preparedness and response exercises (BRAVO and DELTA).<br><br>Eutrophication assessment (with an ultimate aim to develop recommendations on reducing nutrients input). |
| **Adoption/ Timeframe:** | RCP adopted in 2005 ongoing; RAP MALI adopted in 2008, ongoing |

**Principal Activities:**

- NOWPAP Regional Oil and NHS (Hazardous and Noxious Substances) Spill Contingency Plan adopted in 2005. Regular Regional Joint Exercises on Oil Spill Preparedness and Response (BRAVO and DELTA) have been conducted by member states since 2005
- NOWPAP was the first among Regional Seas to adopt voluntary Regional Action Plan on Marine Litter in 2008 (RAP MALI). The RAP MALI is composed of prevention of marine litter input to the marine and coastal environment; monitoring of marine litter quantities and distribution; and removal of existing marine litter and its disposal. In the NOWPAP region, marine litter issues have been addressed through RAP MALI as a part of the NOWPAP programme of work, together with other environmental issues such as oil spills and harmful algal blooms. Most of the RAP MALI activities are being implemented at the national level, in cooperation with local governments and authorities in the NOWPAP countries.
- NOWPAP activities increased knowledge and public awareness about the state of the marine and coastal ecosystems, including biodiversity components in the North Pacific region;
- NOWPAP made significant progress in building capacities of technical experts and policy specialists through joint training, regular regional dialogues, seminars and expert workshops.

| **Priority Pollutant Source Category** | **Actions Needed** | **Generic Support Needed** |
|---|---|---|
| Marine Litter | · To strengthen and enhance Northwest Pacific regional node of Global Partnership of Marine Litter;<br>- To collect information on national actions on marine microplastics;<br>- Continue to maintain and update the database on marine litter<br>- Continue its work on floating marine;<br>- To conduct microplastics assessment;<br>- Continue monitoring of marine litter;<br>- Continue efforts to remove accumulated litter;<br>- Continue organizing annual NOWPAP International Coastal Clean up campaigns | Information on best practice of other regions;<br>Information on global approaches. |

## South Asian Seas

| | |
|---|---|
| **Convention/ Action Plan:** | **Action Plan: (Annex IV)**<br>- Development of strategy, including refinement of the Programme of Action, for the protection of the Marine Environment of the South Asian Seas from Land-based Activities in South Asia ;<br>- Development of a regional programme for monitoring of marine pollution in the coastal waters of the South Asian Seas and the regular exchange of relevant data and information;<br>- Development of pilot activities in countries of the South Asian Seas to control the degradation of the marine coastal environment from land-based activities; |

| | | |
|---|---|---|
| | - Training of personnel involved in these pilot projects to control the degradation of the marine and coastal environment from land-based activities, including preparation of a training manual;<br>- Development of a regional programme to identify the special problems of the largest coastal cities, each having a population of more than 10 million by the year 2000, and of the island states in the areas | |
| **Contracting Parties/ Member States:** | Bangladesh, India, Maldives, Pakistan and Sri Lanka. | |
| **Secretariat:** | SACEP, 69/4, Maya Avenue, Colombo 06, Sri Lanka. | |
| **Status in addressing Land based Activities at the regional level** | | |
| **Regional Programme of Action (as planning tool):** | - Preparation of a regional action plan on marine litter for the South Asian Seas region based on national information collection.<br>- Scoping study (Desk study) on the nutrient pollution of the coastal and marine system in south Asia, as input document for a sub-regional workshop on nutrient management.<br>- Capacity Development for the National Authorities to Formulate Nitrogen Management Policy and its Implementation at National and Regional level" in South Asia | |
| **Adoption/ Timeframe:** | • Global partnership on Marine Litter action plan report 31st December 2017.<br>• The ecosystem approach to pollution management was proved to be an excellent approach to managing the nutrient pollution in the region and agreed on a vision 'South Asian Seas free of nutrient pollution by 2020'. | |
| **Legal Framework for Land Based Activities:** | Same as above | |
| **Adoption/Timeframe** | 2017-2020 | |
| **Regional Programme of Action (as implementation tool):** | • Regional consultation to build consensus and implementation of clean sea campaign in the region<br>• Reduce and control nutrient loading into the coastal waters of the South Asian Seas | |
| | Region through development of a Regional Action Plan and Policy Framework | |
| **Adoption/ Timeframe:** | 2017-2020 | |
| **Principal Activities:** | | |
| **Priority Pollutant Source Category** | **Actions Needed** | **Generic Support Needed** |
| Marine Litter | Marine litter action plan and informed the respective governments for immediate implementation for minimizing the uses. | Support action needed for successful implementation by the member counties. |

## Pacific Region

| | |
|---|---|
| **Convention/ Action Plan:** | Convention for the Protection of the Natural Resources and Environment of the South Pacific Region and Related Protocols (Noumea Convention) 1986. Two Protocols adopted in 1990, the Protocol for the Prevention of Pollution of the South Pacific Region by Dumping (Dumping Protocol) and the Protocol Concerning Co-operation in Combating Pollution Emergencies in the South Pacific Region (Emergencies Protocol). In 2006 the Parties amended the Dumping Protocol and adopted two new protocols to replace the Emergencies Protocols. The two new protocols are the Protocol on Oil Pollution preparedness, response and cooperation in the Pacific region (Oil Protocol) and the Protocol on hazardous and noxious substances pollution, preparedness, response and cooperation in the Pacific region (HNS Protocol). Both of these new protocols are not yet in force. |
| **Contracting Parties/ Member States:** | Australia, Cook Islands, Federated States of Micronesia, Fiji, France, Marshall Islands, Nauru, New Zealand, Papua New Guinea, Samoa, |

| | |
|---|---|
| | Solomon Islands, and United States of America. |
| Secretariat: | Secretariat of the Pacific Regional Environment Programme (SPREP). Vailima, Apia, Samoa. PO Box 240, Apia, Samoa. Email: sprep@sprep.org Website: www.sprep.org |
| **Status in addressing Land based Activities at the regional level** | |
| **Regional Programme of Action (as planning tool):** | - Action Plan for managing the Natural Resources and Environment of the South Pacific<br>- Pacific Regional Waste and Pollution Management Strategy 2016-2025 (Cleaner Pacific 2025) |
| **Adoption/ Timeframe:** | - Regional Action Plan adopted first in 1982.<br>- Cleaner Pacific 2025 adopted in 2015 (10years from 2016 – 2025) |
| **Legal Framework for Land Based Activities:** | Same as above for Noumea Convention, and Protocols |
| **Adoption/Timeframe** | 1982 - 2016 - 2025 |
| **Regional Programme of Action (as implementation tool):** | Pacific Regional Waste and Pollution Management Strategy 2016-2025 Implementation Plan 2016-2019 |
| **Adoption/ Timeframe:** | Adopted in 2015. Four year timeframe for 2016-2019. |

**Principal Activities:**

- UN Oceans SDG14 work with 307 voluntary commitments from the Pacific region.
- Marine debris a key focal area of work with analysis of over 10,000 MARPOL violations from fishing vessels in the region from 2013-2015.
- Capacity building in oil spill response, EIA, MEAs, in several countries.
- Development of regional environment management framework for deep sea minerals exploration and exploitation.
- Guidelines developed for deep sea minerals scientific research.
- Drafted a deep sea mining regional legal agreement
- Development of first national guidelines for sand mining
- Establishment of 16.5% MPA's and PA's covering over 5,025,134km2
- 4 species of threatened sharks and 9 species of rays listed on Appendix II of CITES as a result of efforts by Pacific island Parties
- Over USD 6 Million has been secured for invasive species
- USD 4.3 Million has been approved to support MEA monitoring and reporting.
- Euro 52 Million has been secured for sustainable fisheries and waste and pollution management in the region.

| **Priority Pollutant Source Category** | **Actions Needed** | **Generic Support Needed** |
|---|---|---|
| Marine Litter | • Development of Marine Litter Action Plan<br>• Accelerate the development of policies to ban the use of single-use plastic bags, plastic and styrofoam packaging | Support for actions on addressing marine pollution and marine debris, to maintain the environmental integrity of the Pacific Ocean for people, planet and prosperity. |

## Annexure 5.3: Ha Noi 3R Declaration – Sustainable 3R Goals (3RGs) for Asia and the Pacific for 2013-2023, Fourth Regional 3R Forum, Hanoi, Vietnam, 2013

**I. 3R Goals in Urban/Industrial Areas**

**3Rs in municipal solid waste**

| | |
|---|---|
| Goal 1: | Significant **reduction** in the quantity of **municipal solid waste** generated, by instituting policies, programmes, and projects at national and local levels, encouraging both producers and consumers to reduce the waste through greening production, greening lifestyle, and sustainable consumption. |
| Goal 2: | Full-scale utilization of the organic component of municipal waste, including food waste, as a valuable resource, thereby achieving multiple benefits such as the reduction of waste flows to final disposal sites, reduction of GHG emission, improvement in resource efficiency, energy recovery, and employment creation. |
| Goal 3: | Achieve significant increase in recycling rate of recyclables (e.g., plastic, paper, metal, etc.), by introducing policies and measures, and by setting up financial mechanisms and institutional frameworks involving relevant stakeholders (e.g., producers, consumers, recycling industry, users of recycled materials, etc.) and development of modern recycling industry. |
| Goal 4: | Build sustainable cities /green cities by encouraging "zero waste" through sound policies, strategies, institutional mechanisms, and multi‐stakeholder partnerships (giving specific importance to private sector involvement) with a primary goal of waste minimization |

**3Rs in industrial waste**

| | |
|---|---|
| Goal 5: | Encourage the **private sector**, including small- and medium-sized enterprises (**SMEs**) to implement measures to increase **resource efficiency and productivity**, creation of decent work and to improve environmentally-friendly practices through applying environmental standards, clean technologies, and cleaner production. |
| Goal 6: | Promote the greening of the value chain by encouraging industries and associated suppliers and vendors in socially responsible and inclusive ways. |
| Goal 7: | Promote industrial symbiosis (i.e., recycling of waste from one industry as a resource for another), by providing relevant incentives and support. |
| Goal 8: | Build local capacity of both current and future practitioners, to enable the private sector (including SMEs) to obtain the necessary knowledge and technical skills to foster green industry and create decent, productive work. |
| Goal 9: | Develop proper classification and inventory of hazardous waste as a prerequisite towards sound management of such waste. |

**3R Goals in Rural Areas**

| | |
|---|---|
| Goal 10: | **Reduce losses in the overall food supply chain** (production, post harvesting and storage, processing and packaging, distribution), leading to reduction of waste while increasing the quantity and improving the quality of products reaching consumers. |
| Goal 11: | **Promote full scale use of agricultural biomass waste and livestock waste through reuse and/or recycle measures as appropriate, to achieve a number of co-benefits including GHG emission reduction, energy security, sustainable livelihoods in rural areas and poverty reduction, among others.** |

**3R Goals for New and Emerging Wastes**

| | |
|---|---|
| Goal 12: | Strengthen regional, national, and local efforts to address the issue of **waste, in particular plastics** in the marine and coastal environment. |
| Goal 13: | Ensure environmentally-sound management of e‐waste at all stages, including collection, storage, transportation, recovery, recycling, treatment, and disposal with appropriate consideration for working conditions, including health and safety aspects of those involved. |
| Goal 14: | Effective enforcement of established mechanisms for preventing illegal and inappropriate export and import of waste, including transit trade, especially of hazardous waste and e-waste. |
| Goal 15: | Progressive implementation of "extended producer responsibility (EPR)" by encouraging producers, importers, and retailers and other relevant stakeholders to fulfill their responsibilities for collecting, recycling, and disposal of new and emerging waste streams, in particular e-waste. |
| Goal 16: | Promote the 3R concept in health-care waste management. |

**3R Goals for Cross-cutting Issues**

| | |
|---|---|
| Goal 17: | Improve **resource efficiency and resource productivity** by greening jobs nation-wide in all economic and development sectors. |
| Goal 18: | Maximize co-benefits from waste management technologies for local air, water, oceans, and soil pollution and global climate change. |
| Goal 19: | Enhance national and local knowledge base and research network on the 3Rs and resource efficiency, through facilitating effective and dynamic linkages among all stakeholders, including governments, municipalities, the private sector, and scientific communities. |
| Goal 20: | Strengthen multi-stakeholder partnerships among governments, civil society, and the private sector in raising public awareness and advancing the 3Rs, sustainable consumption and production, and resource efficiency, leading to the behavioural change of the citizens and change in production patterns. |
| Goal 21: | Integrate the 3Rs in formal education at primary, secondary, and tertiary levels as well as non-formal education such as community learning and development, in accordance with Education for Sustainable Development. |
| Goal 22: | Integrate the 3R concept in relevant policies and programmes, of key ministries and agencies such as Ministry of Environment, Ministry of Agriculture, Forestry and Fisheries, Ministry of Industry, Ministry of Trade and Commerce, Ministry of Energy, Ministry of Water Resources, Ministry of Transport, Ministry of Health, Ministry of Construction, Ministry of Finance, Ministry of Labour, Ministry of Land and Urban Development, Ministry of Education, and other relevant ministries towards transitioning to a resource-efficient and zero waste society. |
| Goal 23: | Promote green and socially responsible procurement at all levels, thereby creating and expanding 3R industries and markets for environmentally-friendly goods and products. |
| Goal 24: | Phase out harmful subsidies that favour unsustainable use of resources (raw materials and water) and energy, and channel the freed funds in support of implementing the 3Rs and efforts to improve resource/energy efficiency. |
| Goal 25: | Protect public health and ecosystems, including freshwater and marine resources by eliminating illegal activities of open dumping, including dumping in the oceans, and controlling open burning in both urban and rural areas. |
| Goal 26: | Facilitate the international circulation of re-usable and recyclable resources as well as remanufactured products as mutually agreed by countries and in accordance with international and national laws, especially the Basel Convention, which contributes to the reduction of negative environmental impacts and the effective management of resources. |
| Goal 27: | Promote data collection, compilation and sharing, public announcement and application of statistics on wastes and the 3Rs, to understand the state of waste management and resource efficiency. |
| Goal 28: | Promote heat recovery (waste-to-energy), in case wastes are not re-usable or recyclable and proper and sustainable management is secured. |
| Goal 29: | Promote overall regional cooperation and multi-stakeholder partnerships based on different levels of linkages such as government-to-government, municipality-to-municipality, industry-to-industry, (research) institute-to-institute, and NGO-to-NGO. Encourage technology transfer and technical and financial supports for 3Rs from developed countries to less developed countries. |
| Goal 30: | Pay special attention to issues and challenges faced by developing countries including SIDS in achieving sustainable development. |
| Goal 31: | Promote 3R + "Return" concept which stands for Reduce, Reuse, Recycle and "Return" where recycling is difficult due to the absence of available recycling industries and limited scale of markets in SIDS, especially in the Pacific Region. |
| Goal 32: | Complete elimination of illegal engagement of children in the informal waste sector and gradually improve the working conditions and livelihood security, including mandatory provision of health insurance, for all workers. |
| Goal 33: | Promote 3Rs taking into account gender considerations. |

**Annexure 6.1: Questionnaire on Plastic Waste & Marine Litter**

**Q-1 :** What is the total plastic waste generated (tons) in the country?

**Q-2 :** How much is the percentage of single use plastic waste * out of the total plastic waste generation in the country?

**Q-3 :** How much (tons) is the single use plastic * production and sale in the country?

**Q-4 :** What is the national plastic recycling Rate?#

**Q-5 :** Number of companies operating in Asia & the Pacific publishing sustainability reports with information on Plastic Footprint covering SDG 14?

**Q-6 :** What specific policies and regulations are in place to address the issue of plastic wastes in coastal and marine environment?

**Q-7 :** What extent issue of plastic waste is considered in integrated coastal zone management (ICZM)? (Please check the appropriate box)

☐ Very much ☐ Somehow ☐ Not at all

**Q-8 :** Please provide a list of centre of excellences or dedicated scientific and research programmes established to address the impacts of micro-plastic participles (<5 mm) on coastal and marine species? If yes, please provide relevant websites.

**Q-9 :** What specific 3R policies, programmes and projects, are implemented to reduce the quantity of municipal solid waste?

*

(i) Single use plastic has been defined based on resin / polymer used for following products.

| Name of Resin / Polymer | Product |
|---|---|
| LDPE | Bags, trays, containers, food packaging film |
| HDPE | Milk bottles, freezer bags, shampoo bottles, ice cream containers |
| PET | Bottles for water and other drinks, dispensing containers for cleaning fluids, biscuit trays |
| PS | Cutlery, plates and cups |
| PP | Microwave dishes, ice cream tubs, potato chip bags, bottle caps |
| EPS | Hot drink cups, insulated food packaging, protective packaging for fragile items |

#

Definition 1: (collected recyclable plastic waste) / (estimated generation of plastic waste)
Definition 2: (volume of utilized recyclable plastic waste) / (volume of raw material)
Definition 3: (volume of utilized recyclable plastic waste ) / (volume of collected plastic waste for recycling.

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