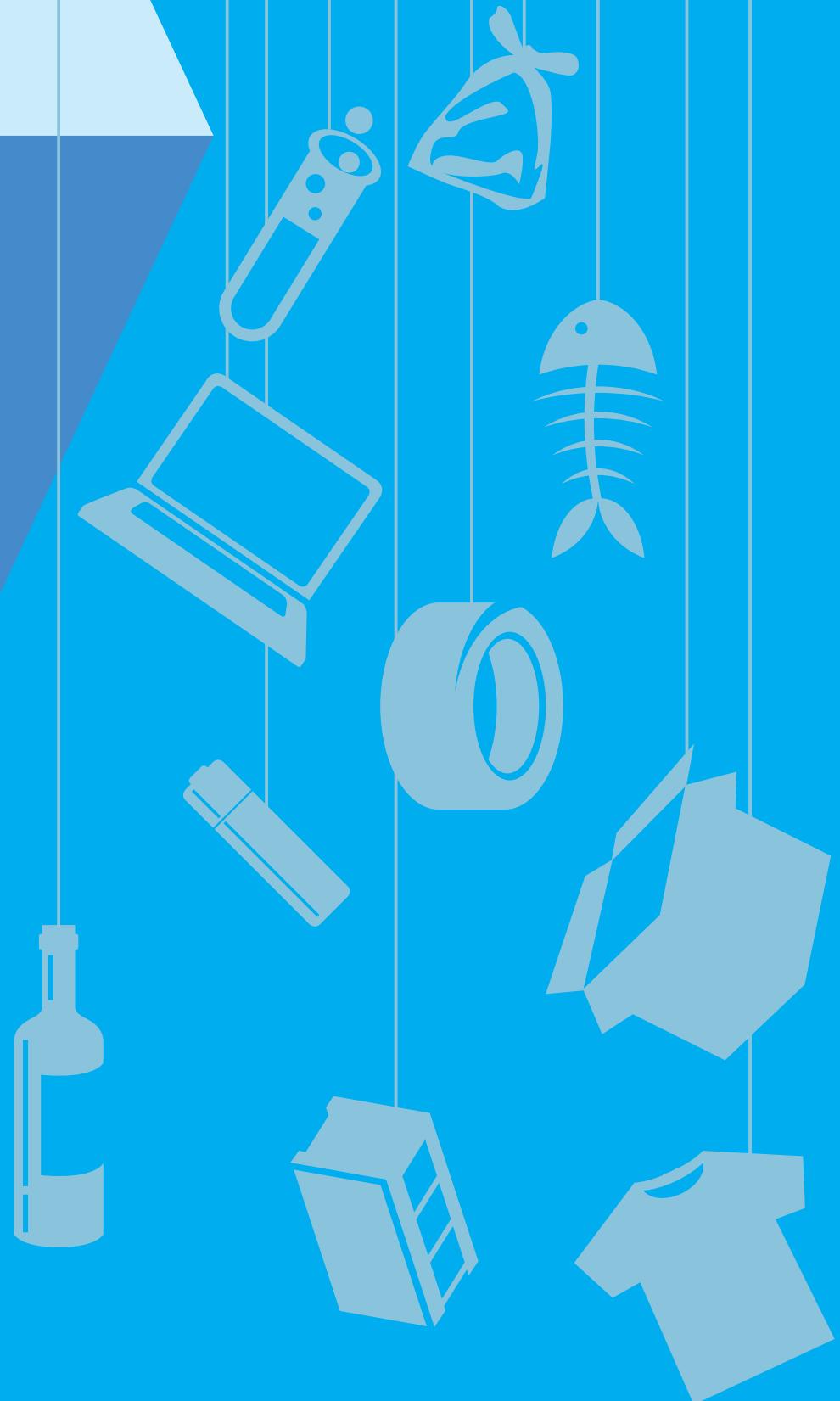


SUMMARY REPORT



**WASTE MANAGEMENT
IN ASEAN COUNTRIES**

© United Nations Environment Programme, 2017

Printed in Thailand

This publication may be reproduced in whole or in part and in any form for educational or non-profit purposes without special permission from the copyright holder, provided acknowledgement of the source is made. The United Nations Environment Programme would appreciate receiving a copy of any publication that uses this publication as a source.

No use of this publication may be made for resale or for any other commercial purpose whatsoever without prior permission in writing from the United Nations Environment Programme.

Disclaimer

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the United Nations Environment Programme concerning the legal status of any country, territory, city or area or of its authorities, or concerning delimitation of its frontiers or boundaries. Moreover, the views expressed do not necessarily represent the decision or the stated policy of the United Nations Environment Programme, nor does citing of trade names or commercial processes constitute endorsement.

Acknowledgement

Author

Amit Jain

(Consultant)

Project Team – AIT RRC.AP

Guilberto Borongan

(Programme Specialist and Coordinator)

Prakriti Kashyap

(Senior Programme Officer)

Nang Sian Thawn

(Programme Officer)

Supervision – UN Environment IETC

Shunichi Honda

(Programme Officer)

Mushtaq Memon

(Programme Officer)

Peer Reviewers and Contributors from ASEAN Member States and Experts

Mohammad Shah Rezza Nassaruddin, Rithirak Long,

Vanhxay Phiomanyvone, Nur Akmal, Ni Ni Thin,

Anuphan Ittharatana, Pornpimon Chareonsong, Vuttichai

Kaewkrajang, Pattanan Tarin, Chalalai Rungruang, Nguyen

Anh Tuan, Suneet Thapinta, Ridwan Tamin, Darren Koh,

Masnellyarti Hilman, Yulisa Djaja, Supawan Tantayanon,

Saroj Srisai, Rocky Pairunanasean, Mushtaq Memon, Prakriti

Kashyap, Shunichi Honda, and Guilberto Borongan

Cover Illustration, infographics, and layout

Lowil Fred Espada

Professional Independent Graphic Design



Abbreviation

- ASEAN** The Association of Southeast Asian Nations
ASCC ASEAN Socio Cultural Community
BAT Best Available Technologies
BLNG Brunei Liquefied Natural and Gas
BMC Brunei Methanol Company
BSP Brunei Shell Petroleum
CCQMD Composting, Compost Quality and Market Development
COMPED Cambodia Education and waste Management Organization
CSARO Community Sanitation and Recycling Organization
DEPC Department of Environmental Pollution Control
DEPR Department of Environment, Park and Recreation
DfE Design for Environment
ECD Environment Conservation Department
EEE Electrical and Electronic Equipment
EPR Extended Producer Responsibility
ESM Environmentally Sound Management
ESMS Environmental and Social Management Systems
GDP Gross Domestic Product
GHG Green House Gas
GHS Global Harmonized System
GWCs General Waste Collectors
HOAs Home Owners Association
HR Human Resources
ISWM Integrated Solid Waste Management
ITA Investment Tax Allowance
IWS Informal Waste Sector
JICA Japan International Cooperation Agency
KPIs Key Performance Indicators
KSTP Keppel Seghers Tuas Plant
LGU Local Government Unit
MASG Multi-Agency Sub-Group
MCDC Mandalay City Development Committee
MDGs Millennium Development Goals
MEPS Minimum Energy Performance Standard
MoE Ministry of Environment
MoI Ministry of Industry
MONRE Ministry of Natural Resources and Environment
MRF Material Recycling Facilities

- MSW** Municipal Solid Waste
MT Metric Tons
NAMA Nationally Appropriate Mitigation Actions
NEA Non-Environmentally Acceptable
NEA National Environment Agency
NELP-GCP National Eco-Labeling Programme- Green Choice Philippines
NGO Non Government Organization
NPT DC Naypyitaw Development Committee
NSWMD National Solid Waste Management Department
OECD Organization for Economic Co-operation and Development
PADETC Participatory Development Training Center
PCD Pollution Control Department
PEPP Philippine Environmental Partnership Programme
PPP Public Private Partnership
PWCs Public Waste Collectors
RECP Resource Efficiency and Cleaner Production
ROHS Restriction of Hazardous Substances
SDG Sustainable Development Goals
SIH Green Industry Standard
SLF Secured Landfill
SLORC State Law and Order Restoration Council
SME Small and Medium Scale Enterprises
SNI Indonesian National Standard
SWM Solid Waste Management
SWOT Strength, Weakness, Opportunities and Threat
TEST Transfer of Environmental Sound Technologies
TMTS Tuas Marine Transfer Station
ULB Urban Local Bodies
UNCRD United Nations Centre for Regional Development
UNESCAP United Nations Economic and Social Commission for Asia and the Pacific
UNU United Nations University
WAB Waste Agriculture Biomass
WACS Waste Analysis and Characterization Study
WHO World Health Organization
WM Waste Management
WTE Waste to Energy
YCDC Yangon City Development Committee

/01

II\ Introduction

/02

III\ Waste Management and Technology Profile

- 11\ Municipal Solid Waste (MSW) Generation and Composition
- 17\ Industrial and Hazardous Waste
- 22\ Policy, Regulatory and Institutional Profile
- 27\ Municipal Solid Waste (MSW)
- 36\ Industrial Waste including Hazardous Waste
- 42\ Emerging Waste Streams (Plastic, Healthcare and E-waste)

/03

49\ Recommendation

59\ References

List of Figures and Tables

Figure 1 ASEAN Population Projection and Urbanisation Rate	2
Figure 2 Annual GDP Growth (%)	3
Figure 3 ASEAN Economic Sector's Average Share in Real GDP (%)	4
Figure 4 CO ₂ emissions Per Capita for ASEAN Countries	8
Figure 5 Projected Urban Waste Generation in some ASEAN Countries	10
Figure 6 MSW Generation in ASEAN Countries	14
Figure 7 Waste generated per capita in ASEAN Countries	14
Figure 8 Composition of MSW in ASEAN Countries	15
Figure 9 Total amount of hazardous waste generated in ASEAN Countries	17
Figure 10 Annual E-Waste Generated in ASEAN Countries	18
Figure 11 Per Inhabitant E-waste Generation	19
Figure 12 ISWM Framework	54
Figure 13 Dimensions of ISWM Framework	55
Table 1 Amount of Waste Generation and Composition of MSW in ASEAN Countries	12
Table 2 Amount of E-Waste Generated in ASEAN Countries	18
Table 3 Technology – Municipal Solid Waste (MSW)	20
Table 4 Technology – Industrial Waste Including Hazardous Waste	21
Table 5 Technology - Emerging Waste Streams (Plastic, Healthcare and E-waste)	22
Table 6 National ASEAN environment strategies vary in their focus on green growth	23
Table 7 Regulatory Framework	24
Table 8 National ASEAN environment strategies vary in their focus on green growth	25
Table 9 Industrial and Hazardous Waste	25
Table 10 Emerging Waste Streams	26
Table 11 Dimensions of ISWM Framework	54

Key Highlights

This summary report examines the waste management landscape in 10 Association of Southeast Asian Nations (ASEAN) Member States. This report begins with the statistics on the trends of population growth, urbanization, and economic growth in each of the ASEAN countries, which is then followed by an overview of the waste generation, collection, treatment & recovery, and disposal statistics, and associated environmental, technical, and governance (institutions, policy, regulations) factors in the waste sector. The report also identifies the existing waste management challenges and gaps therein, and sets out recommendations.

Some of the key highlights of the ASEAN waste management landscape are summarized here, while the country specific data are detailed in the main report:

ASEAN is experiencing an increasing trend in population growth and urbanization rate

ASEAN countries have a combined population of approximately 625 million people, which account for 8.8% of the world's population. The population is projected to be increased to 650 million by 2020, more than half of this total population will be living in urban areas.

Waste generation is increasing (both in volume and composition)

The per capita Municipal Solid Waste (MSW) generation in ASEAN is **1.14 kg/capita/day**. In terms of total annual MSW generation, the order is as follows: Indonesia generates the highest quantity of municipal waste with 64 million tonnes/year, followed by Thailand (26.77 million tonnes/year), Viet Nam (22 million tonnes), Philippines (14.66 million tonnes), Malaysia (12.84 million tonnes), Singapore (7.5 million tonnes), Myanmar (0.84 million tonnes), and Lao PDR generating the lowest quantity of MSW at **0.07 million tonnes/year**. Predominantly, organic waste (about or more than 50%) is the highest fraction of MSW in all ASEAN countries, except for Singapore, where organic waste accounts for only 10.5% of the total MSW. Other waste streams such as plastic, paper, and metals are also the common sight in MSW piles. Apart from MSW, Healthcare waste, E-waste, Industrial waste, and Construction and Demolition Waste are the emerging waste streams in ASEAN countries.

Waste Management Practices (Technology and Infrastructure)

Open dumping and open burning of waste is prevalent in the majority of ASEAN countries. Composting and anaerobic digestion of organic wastes, and recovery of valuable recyclables such as plastic, metal and paper are common in ASEAN. Recycling, however, is more at the hands of the informal sector. Nevertheless, Singapore stands as an exception to other ASEAN countries, as it has a sound and well-structured waste management system in place. Singapore opts for waste to energy (WTE) through incineration as the major waste management option, due to its limited land resources.

Waste Governance (Institution, Policy and Regulatory Profile)

Most of the ASEAN countries have already established national strategies to address challenges related to waste management broadly through Environmental Act, and other Green Growth, Sustainable Development and Climate Change policy, regulatory framework, and strategies. Countries like Indonesia, Malaysia, Philippines, and Thailand have specific Acts/laws on waste management. From the institutional aspect, waste management policy making at the national level, is under the jurisdiction of the Ministry of Environment, while many other line-ministries also have roles in regulating specific waste streams (for instance, Ministry of Health, and Ministry of Industry for healthcare waste and industrial waste, respectively). Sometimes, a disharmony and lack of coordination among these institutions and stakeholders (for example, overlapping of the responsibilities and the authority) become a prominent cause of mismanagement of waste. At the local level, provincial government, urban local bodies (ULBs) namely, municipality are directly responsible for handling waste management services. In addition to ULBs, non-governmental sector such as private sector, NGOs, and community participation has also been progressing as public-private-partnerships in waste sector.

Identification of the gaps and the opportunities

Among numerous environmental challenges in the ASEAN region, the rapid growth of volumes of waste, and a complex waste composition with new and emerging waste streams is one of the prominent challenges. ASEAN countries have put efforts towards waste management, but, are challenged by various technology, infrastructure, financing, policy, and stakeholder participation issues. These challenges, on the other hand, could be opportunities, if ASEAN countries shift from understanding the 'waste' as 'resource.' While augmenting the waste recycling rate and WTE technology and approaches, attention must be given to the front-end solutions as well, i.e., mechanisms for waste reduction/prevention through sustainable consumptions resources management. In addition, generating co-benefits such as GHG emission reduction, enabling the achievement of SDGs etc. from the waste sector is a progressive approach that ASEAN countries should continue to explore. From the partnership angle, encouraging private sector (and small-and-medium sized enterprises) into waste value chains will help pool resources and gather shared responsibilities for waste management. From technology point of view, selection and adoption of the environmentally sound technologies (ESTs) that suit the local waste characteristics, and other social, cultural, economic and environmental concerns is very crucial. Similarly, for industrial waste, promoting industrial symbiosis, waste exchange activities are encouraged. For hazardous waste, ASEAN countries need to develop a harmonized definition and codes, and prepare an inventory as a prerequisite towards sound management of hazardous waste.

Recommendations

The recommendations are categorized into three important aspects of sound waste management; i) Policy and Regulatory, ii) Institutional, Technical and Performance, and iii) Funding/Financing/Economics aspects of sustainable waste management – while addressing the entire value chain elements of waste management (inclusive of waste generation, segregation, collection, transfer, treatment and disposal, resource recovery through 3Rs). Making waste management a priority issue at all levels of governance – regional (ASEAN), national, and local level (and the priority of the political and local community) through the development of a harmonized regional, national and local waste management policy framework as per 3Rs is critical to success. In addition, design and implementation of the right combination of regulatory, economic and social instruments with incentives for strong monitoring for compliance by all relevant stakeholders is equally important in the ASEAN context. From the institutional aspect, improving organizational efficiency, and promoting inter-departmental/agency cooperation is important. ULBs need to explore other innovative financing mechanisms like public private partnership (PPP), investment by development finance investors, application of polluters pays principle and extended producer's responsibility to strengthen the existing revenue sources from waste generators. Synergizing, encouraging and ensuring the co-responsibilities among different stakeholders in waste management together with the ULBs is the key to sustainable waste management.

These recommendations are also expected to be useful in embarking the economic integration and sustainable development as identified in the ASEAN Economic, and Socio-culture Community Blueprint 2025.

01

Introduction

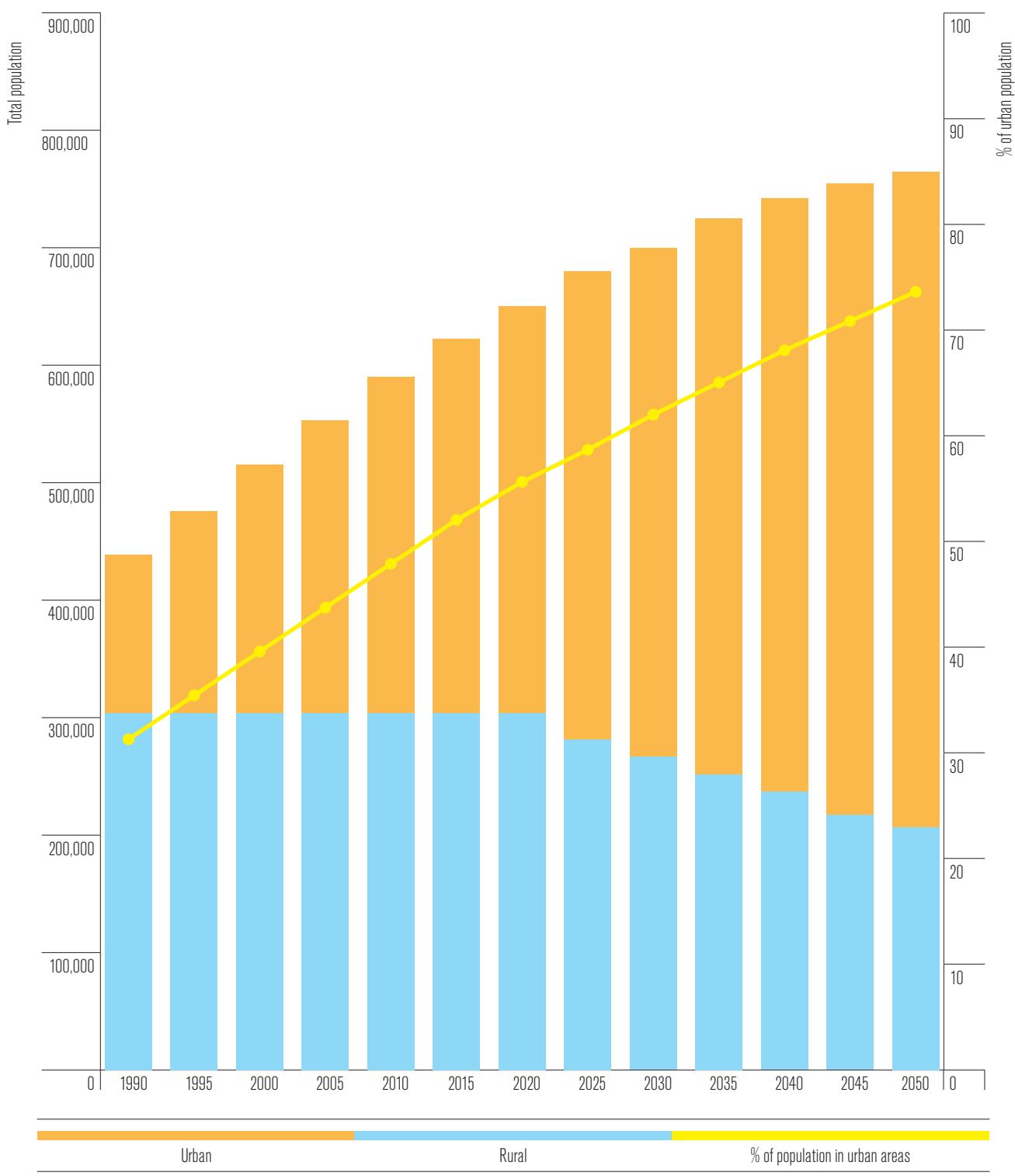
The Association of Southeast Asian Nations (ASEAN) is a regional organisation comprising ten Southeast Asian states, which promotes intergovernmental cooperation and facilitates economic integration amongst its members. It was formed in August 8, 1967 and includes Indonesia, Malaysia, the Philippines, Singapore, Thailand, Brunei Darussalam, Cambodia, Laos, Myanmar, and Viet Nam. Its principal aims include accelerating economic growth, social progress, and socio-cultural evolution among its members. ASEAN covers a land area of 4.4 million square kilometres, 3% of the total land area of Earth. ASEAN territorial waters cover an area about three times larger than its land counterpart. Member countries have a combined population of approximately 625 million people, which account 8.8% of the world's population. In 2015, the organisation's combined nominal GDP had grown to more than US\$2.8 trillion. As a single entity, it ranks as the seventh largest economy in the world, behind the USA, China, Japan, Germany, the United Kingdom and France. Geographically ASEAN shares land borders with India, China, Bangladesh, East Timor, and Papua New Guinea, and maritime borders with India, China, and Australia.

Figure 1 indicates that the region's population is projected to rise to 650 million by 2020, with more than half living in urban areas. Rising population in major cities is largely attributed to the rural-urban migration. The urban population in the region has been steadily increasing for the last two decades, from only 31.6% of the total population in 1990 to about 44% in 2005, with the biggest decrease of rural population occurring in Indonesia and the Philippines. It has been proven that, **rapid urbanisation, if not managed well, could lead to proliferation of environmental and health issues.**

ASEAN's economic performance since 2007 to 2014 is shown in **Figure 2**. It can be seen that the real growth grew to 4.6 % in 2014 and, based on OECD estimates, was expected to reach 4.9% in 2016 in the region is expected

Figure 1

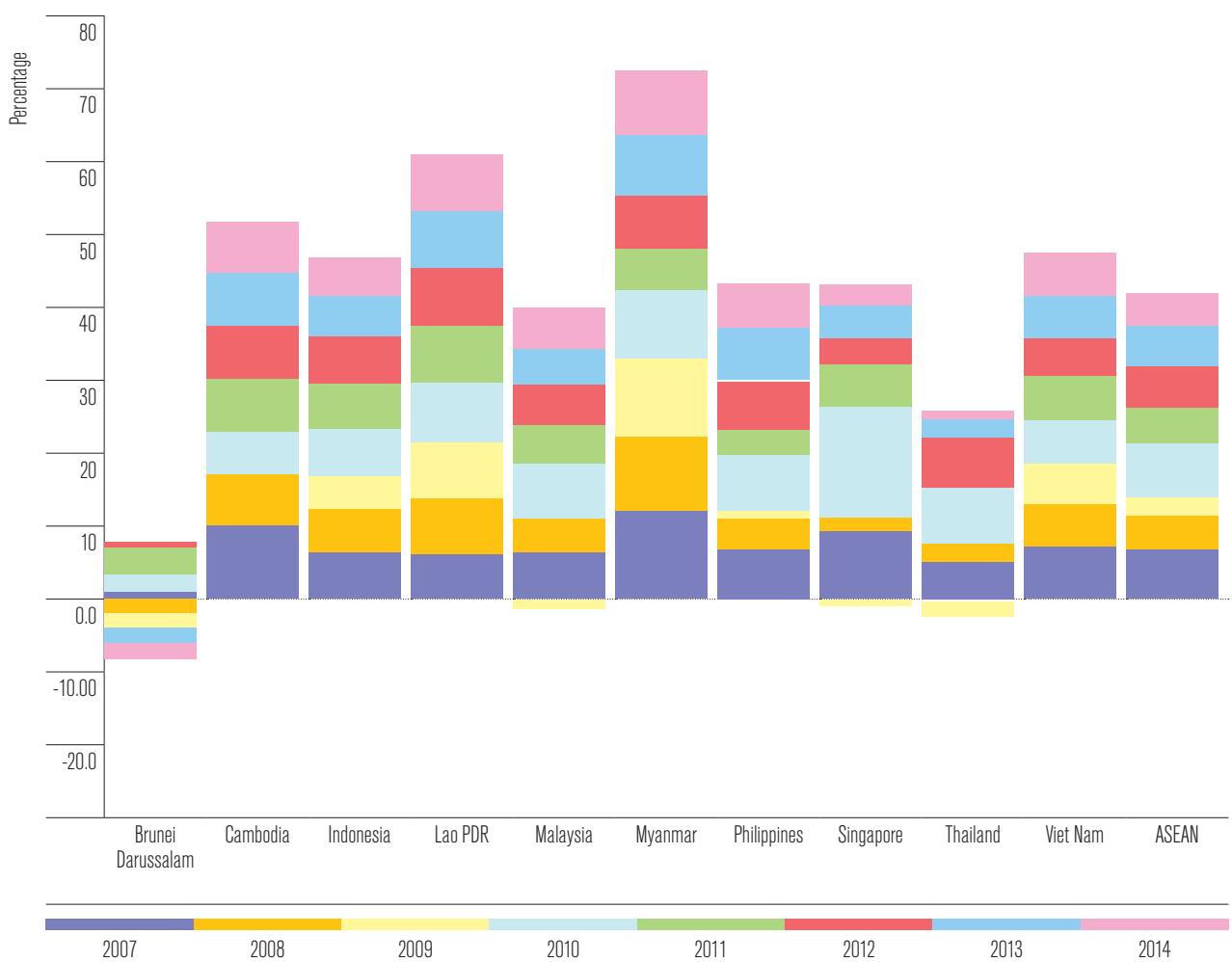
ASEAN Population Projection and Urbanisation Rate



Source: Fourth ASEAN State of the Environment Report 2009.

Figure 2

Annual GDP Growth (%)



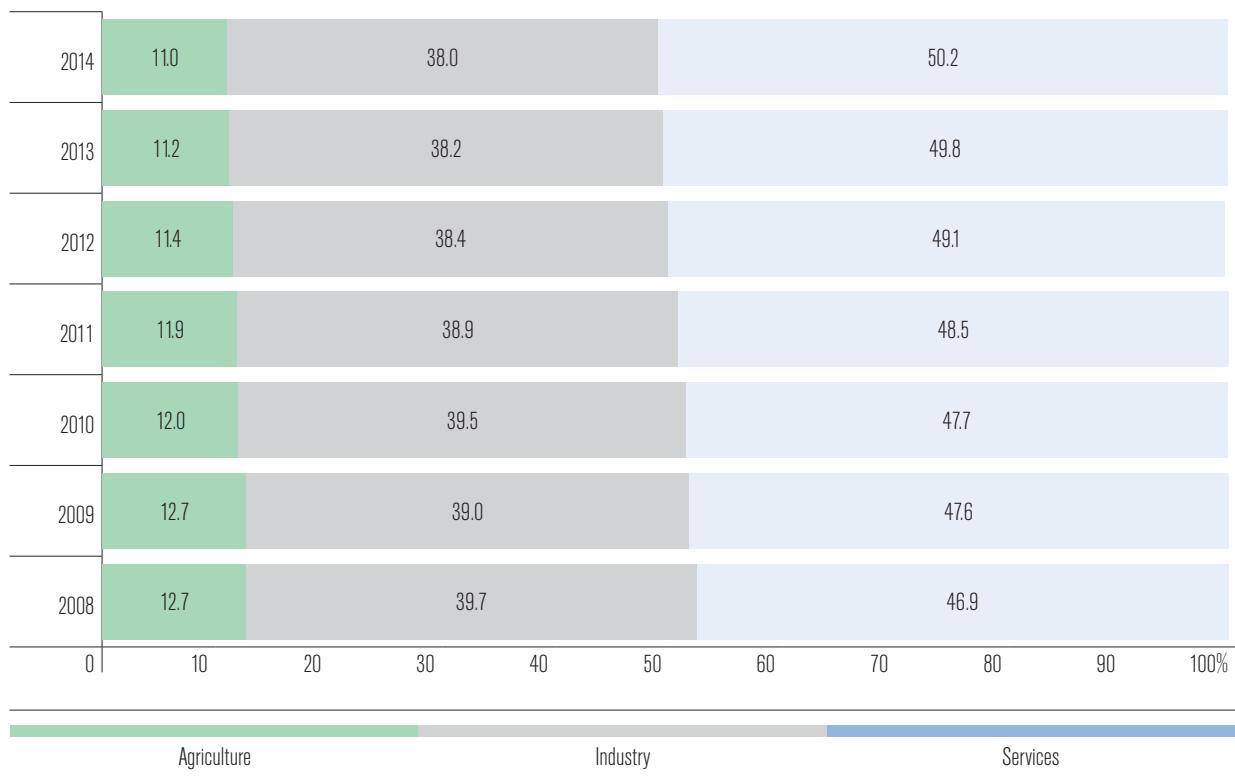
Source: *The ASEAN Secretariat, Jakarta 2015. ASEAN Integration Report.*

to reach 5.5% in 2017. Strong domestic demand, especially private consumption and investment, will drive economic growth while exports will play a less important role. Indonesia is projected to reach a growth rate of 6.4% over the period. Projected growth in Singapore is 3.1%, Malaysia 5.1%, the Philippines 5.5% and Thailand 5.1%. Growth in other parts of the region is projected to be more robust, with Cambodia reaching 6.9%, Lao PDR 7.4%, Myanmar 6.3% and Viet Nam 5.6%.

Literature cites that, the overall structure of economies in ASEAN has changed, since 2007. Figure 3 indicates that, the services sector share steadily increased to about 50.2% in 2014 while the agriculture sector share declined to 11.0%. The share representing the industry sector, including mining and quarrying, manufacturing, utilities and construction, broadly remained unchanged at 38.0%. In this context, brief geographical, socio economic

Figure 3

ASEAN Economic Sector's Average Share in Real GDP (%)



Source: *The ASEAN Secretariat, Jakarta 2015. ASEAN Integration Report.*

and environmental profile of each ASEAN country has been described in Figure 3.

Brunei Darussalam (Brunei), is located on the northwest coast of the island of Borneo in South East Asia between latitude 4°30'N and longitude 114°40'E. It has a total land area of 5,765 square kilometres with a coastline of 168 kilometres. It is bounded by the South China Sea on the north and the East Malaysian states of Sarawak and Sabah on the east and west respectively. The population of Brunei Darussalam was estimated at 4,11,900 in 2014. In 2010, Brunei Darussalam's Gross Domestic Product (GDP) at current prices was valued at BND 18,670 million and per capita income stood at BND 52,594. Oil and natural gas accounts as the largest share

of Brunei Darussalam's GDP. In 2014, the industrial sector (mining, manufacturing, construction, and electricity and water) was the largest contributor accounting for BND 11,790 million (63%) of the GDP. This was followed by the services sector (transport and communication, trade, finance, real estate, and other services in the private sector and government services), which contributed BND 7084 million (37.9%) to the GDP. The primary sector (agriculture, forestry and fishery) contributed BND 149 million (0.8%) to the GDP. Most of the manufacturing companies are small and medium enterprises. These manufacturing companies produced roof products, cement, electrical switch-board and electrical cable. There are nine industrial sites located throughout the country with a wide variety of manufacturing, services and storage

activities. Brunei Darussalam is a net importer of food. In 2009 the country embarked on initiatives intended to move it closer to self-sufficiency in food supply. The government targeted to achieve 20% self-sufficiency in rice production by 2010. Although the country was largely self-reliant in terms of poultry and egg production, much of the other primary staples of grains, rice and livestock had to be imported. Domestic rice production which stood at 1,072 tonnes in 2010, represented only 3.31% of the total demand while the rest was supplied by imports. Brunei Darussalam's net GHG emissions for 2010 totaled 6.6 million metric tonnes CO₂ equivalent.

Cambodia is one of the fastest growing countries in ASEAN. It has a population base of 15.33 million (2014) with a surface area of 181035 sq.km. About 80% of the population live in rural areas, however, the average annual urban population growth rate (2.7%) is higher than the average annual rural population growth rate 1.5%. As per 2014 estimates, the country's GDP was US\$ 16.78 billion with an annual growth of above 7% at constant 2005 prices. Although agriculture is the backbone of the economy providing 51% of total employment, the garment sector, together with construction and services sectors are the main drivers of the economy. Cambodia is rich in natural resources with forested area accounting for 55.7% of total land area. Cambodia has reported a total net GHG emissions of -0.456 million tonnes of CO₂ equivalent in year 2000. Growing economy and continued poverty reduction with ineffective land and natural resources management and environmental sustainability will lead to increased waste generation.

Indonesia is one of the largest economies in Southeast Asia. It has a population base of 254.5 million (2014) with a surface area of 1910931 sq.km. About 53% of the population live in urban areas with an average annual urban population growth rate (2.7%) which is higher than average annual rural population growth rate (-0.4%). As per 2014 estimates, the country's GDP was US\$ 888.5 billion with an annual growth of above 5% at constant 2005 prices. The industry sector is the economy's largest and accounts for 46.4% of GDP (2012), followed by services (38.6%) and agriculture (14.4%). Since 2012, the service sector has employed

more people than any other sectors, accounting for 47.9% of the total labour force, followed by agriculture (38.9%) and industry (13.2%). Indonesia has forested area accounting for 51.4% of total land area. Indonesia has reported net GHG emissions of about 1377.97 million metric tonnes in 2000 and 1791.37 million metric tonnes in 2005. The country has extensive natural resources, including crude oil, natural gas, tin, copper, and gold, and major imports include machinery and equipment, chemicals, fuels, and foodstuffs. Indonesia is one of the largest producer and consumer of palm oil providing about half the world supply. The country's major export commodities include oil and gas, electrical appliances, plywood, rubber, and textiles. The tourism sector is ranked as the 4th largest among goods and services export sectors. Indonesia has a sizeable automotive industry, ranking as the 15th largest producer in the world. Indonesia's GDP growth has been slowing since 2012. It faces a number of development challenges, including weak public service delivery management of land and natural resources and environmental sustainability due to rapid urbanization and economic development. Growing economy, though sluggish with expected increase in commodity demand, ineffective land and natural resources management and environmental sustainability may lead to increased waste generation.

Lao PDR is a landlocked country bordered by Myanmar (Burma) and China to the northwest, Viet Nam to the east, Cambodia to the south, and Thailand to the west. It has a surface area of 236800 sq.km with a population of 6689000, which is growing at an average annual rate of 1.9%. Urban and rural population accounts for 37.6% and 62.4% of total population in Lao PDR. Average annual urban growth rate is much higher (4.9%) than an annual rural growth rate (0.2%). Lao PDR's economy is one of the fastest growing economies in the East Asia and Pacific region with an estimated GDP of \$12.0 billion (2014). Its GDP growth averaged 7% over the last decade and is projected at 7% in 2016. Subsistence agriculture accounts for nearly half of the GDP and provides 80% of employment. Lao PDR's natural resources are mostly water, minerals and forests, which contribute 30% to its economic growth. More than 540 mineral deposits of gold, copper, zinc, lead and other minerals

have been identified, explored and mined in Lao PDR. Some fiscal expansion (with the deficit increasing to 3.9% of GDP) and investments add to domestic demand, triggering economic growth in future. Continued growth has resulted in lowering poverty from 33.5% to 23.2% during the last decade. About 72% of population has access to improved drinking water sources, while 72% population uses improved sanitation facilities. Lao PDR has abundant natural resources with 67.6% of the total land area as forest area. Its reported net GHG emission estimates are about 41.76 million metric tonnes of CO₂ equivalent in 2000. Increasing commodity demand, triggering greater consumption, coupled with increased mining activity and expanding service sector may lead to an increase in waste generation.

Malaysia is one of the open states that is oriented and industrialized, and is considered an upper-middle income country in ASEAN. It has a population of 29.90 million (2014) with a surface area of 330290 sq.km. About 74% of the population live in urban areas. Average annual urban population growth rate (2.7%) is much higher than average annual rural population growth rate (-1.2%). As per 2014 estimates, the country's GDP is US\$ 338.1 billion with an annual growth of above 4.7% at constant 2005 prices. In 2014, Malaysia's economy grew 6%, the second highest growth behind the Philippines. About 28.4% of the total employed are in the industrial sector, while only 12.6% are employed in the agricultural sector. Malaysia has a diversified economy and has become a leading exporter of electrical appliances, electronic parts and components, palm oil, and natural gas. China, Singapore and Japan are its major trading partners. Since the 1980s, the industrial sector, with a high level of investment, has led the country's growth. International trade and manufacturing are the key sectors of the economy, while manufacturing also has a large influence in the country's economy, even though Malaysia's economic structure has been moving away from it. The country remains one of the world's largest producers of palm oil. In an effort to diversify the economy and make it less dependent on export goods, the government has promoted the service sector e.g. tourism. As a result, tourism has become Malaysia's third largest source of foreign exchange,

although it is threatened by the air and water pollution along with deforestation affecting tourism. Malaysia is rich in natural resources with forested area accounting for 61.7% of total land area. It has reported GHG emissions of -32.864 million metric tonnes of CO₂ equivalent in 2000 and 27.28 million metric tonnes of CO₂ equivalent in 2011. Malaysia has also succeeded in nearly eradicating poverty. The share of households living below the national poverty line (USD 8.50 per day in 2012) have currently fallen from over 50% in the 1960s to less than 1%. About 100% of the population uses improved drinking water sources, while 96% of population uses improved sanitation facilities. In spite of these achievements, Malaysia still faces a number of development challenges. These include broadening energy mix through enhancement of renewable energy, energy efficiency, land transportation, waste management and protection of forest carbon pools.

Myanmar is the largest country in mainland Southeast Asia. It has a surface area of 676577 sq. km. with a population of 53.44 million (2014). It has one of the lowest population densities in the region with 33.6% and 66.4% as urban and rural population, respectively. Myanmar is endowed with fertile lands, significant untapped agricultural potential, and a rich endowment of natural resources. Its geographic location at the intersection of China and India, makes it well positioned to resume it as a regional trading hub and a key supplier of minerals, natural gas and agricultural produce. Its GDP is \$64.33 billion with a growth rate of 8.5%. Economic growth in Myanmar fell to 7% in 2015/16 due to the floods in July 2015, however its medium-term growth is projected to average at 8.2% per year. Its major trading partners are Thailand, China, India, Hong Kong SAR and Singapore. Myanmar has a rich natural resources base. It has 44.7% of total land area as forested area. Myanmar has reported net GHG emissions of -67.8 million metric tones of CO₂ equivalent in the year 2000. Recently, growth has accelerated, buoyed by improved macroeconomic management, increased gas production and exports, and stronger performance in non-gas sectors as the economy opened up. With the increased economic activity, consumption pattern is expected to increase, leading to increased waste

generation, which needs to be managed in a scientific manner.

The Philippines is one of the most dynamic economies in the East Asian region with a surface area of 300,000 sq.km. a population of 99.14 million (2014), and an annual growth rate of 1.7%. Urban population is 44.5% of total population with an annual urban population growth rate of 1.3%, while annual rural population growth rate is 2.0%. The country has sound economic fundamentals, with a GDP of \$284.8 billion and an average growth rate of above 5% in the past decade, significantly higher than in previous decades. The agricultural sector employs 30% of the labor force, and accounts for 14% of GDP. The industrial sector employs around 14% of the workforce and accounts for 30% of GDP. Meanwhile, the 47% of workers involved in the services sector are responsible for 56% of the 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. Social indicators indicate that extreme poverty decreased gradually from 10.6% in 2012 to 9% in 2014. However, high rates of structural poverty remain, especially among households depending on agriculture. About 92% of the population use improved drinking water sources, while 74% has access to improved sanitation facilities. The Philippines has rich natural resources, with 26.1% as forested area of the total land area. Its net GHG estimates are about 21.76 million metric tonnes of CO₂ equivalent in 2000. Increasing commodity demand triggering greater consumption, coupled with increased growth and expanding service sector will lead to increase in waste generation.

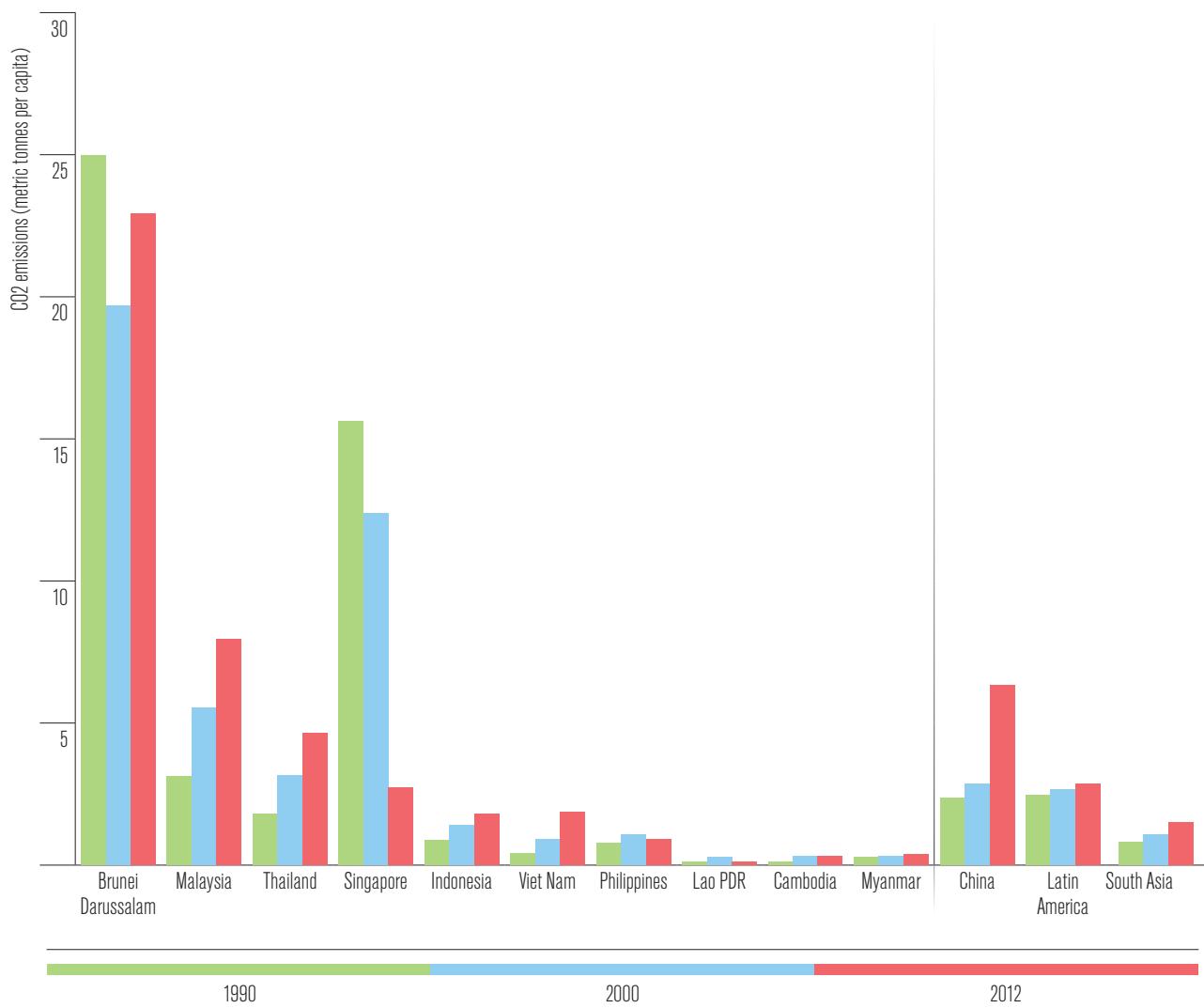
Singapore is a sovereign state located in Southeast Asia, south to the southernmost tip of continental Asia and peninsular Malaysia. It has a surface area of 716 sq.km., with a population of 5.5 million. Its total population is urban population, with an annual average growth rate of 2%. Singapore is a high-income economy with a gross national income of \$55,150 per capita, as of 2014. The country provides the world's most business-friendly regulatory environments for local entrepreneurs and is ranked among the world's most competitive economies. Its GDP is \$307.9 billion

(2014), with a growth rate of 2.9%. GDP grew with an average of 7.7% since the country's independence in 1965. In the first 25 years, growth topped 9.2%, while per capita GDP, over the same period, grew by 5.4% and 7.2%. Presently, the strong manufacturing and services sectors have become the twin pillars of the Singapore economy. Financial sector, manufacturing and oil refining are the major contributors to its GDP. Its major exports are refined petroleum, integrated circuits and computers. Further, tourism is also the major contributor to its economy. Social indicators show that the country has a 98% employment rate with 100% population covered by improved drinking water and sanitation facilities. Environmental indicators show that the total forested area is 3.3% of the total land area, while GHG emission estimates are about 46.83 million metric tonnes (2010). Considering its economic base, population projections waste generation is expected to increase.

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 67.73 million. Its urban population is 49.2% with an annual growth rate of 3%, which is much higher than the annual rural growth rate of -2%. Thailand became an upper-middle income economy in 2011, as 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 the poverty rate. GDP of Thailand is \$404.8 billion (2014) with a modest growth rate of 2.5% in 2015. Thailand's economy is export-dependent, contributing about 60% to GDP. Major exports include rice, textiles, footwear, fishery products, rubber, jewelry, cars, computer and electrical appliances. Agriculture and tourism are the other sectors, which contribute to the economy of the country. Households that have access to clean drinking water and sanitation facilities are about 95% and 93%, respectively. About 37.2% of the total land area of Thailand is forested area, while net GHG emission estimates for the year 2000 were 157.86 million tonnes of CO₂ equivalent. Expanding trade through enhanced integration with the global economy, implementing transformative public investments through private capital, enhanced domestic consumption, and improving quality of public services across the entire country is expected to revive

Figure 4

CO₂ emissions Per Capita for ASEAN Countries



Source: Report of ASEAN Regional Assessment of MDG Achievement & Post – 2015. Development Priorities.

economy growth of Thailand. Enhanced production and consumption is expected to lead to higher waste generation.

Viet Nam is the easternmost country on the Indochina peninsula in South East Asia. It has a surface area of 330972 sq. km. Urban population is 33% of

the total population, with an annual growth rate of 3%. Viet Nam's GDP is 171222 million US\$ with an annual growth rate of 5.4% at constant 2005 prices. Viet Nam has transformed its economy from one of the poorest in the world, with per capita income around US \$100, to lower-middle income status, within a quarter of a century, with per capita income of around US\$2,100 by the end of

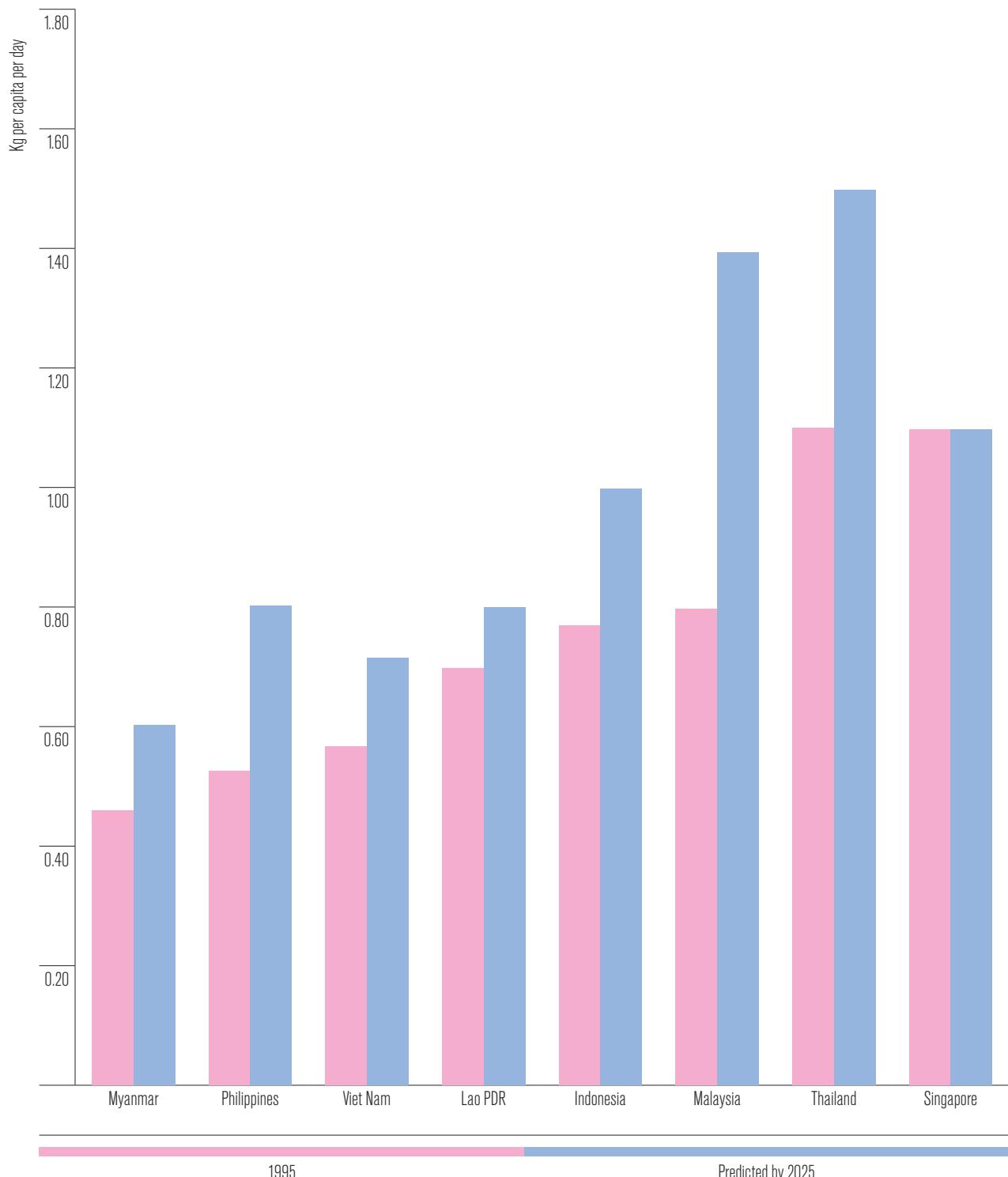
2015. Agriculture is the major contributor to the economy accounting for 47% of employment, followed by the manufacturing sector and service industry. Manufacturing, information technology and high tech industries now form a large and fastest growing part of the national economy. Agriculture products, oil and gas, IT hardware are the major items for export. Social indicators indicate that the fraction of people living in extreme poverty dropped from more than 50% in the early 1990s to 3% in the present time. Access to clean water and modern sanitation has risen to 95% and 75% households, respectively. Total forested area is about 45.4% of the total land area. It has two world natural heritage sites, six biosphere reserves and 126 conservation areas, including 28 national parks. In year 2000, the country generated 150.9 million metric tons of CO₂ equivalent. Viet Nam has boosted its international economic integration, however the benefits are constrained by the absence of linkages with domestic firms. Considering environmental sustainability infrastructure development as one of the key areas of its development strategy, a country report on the waste management sector has been prepared.

The CO₂ emissions per capita for ASEAN countries are shown in Figure 4. Global emissions of carbon dioxide (CO₂) have increased, and in ASEAN, CO₂ consumption, measured per capita, has increased in all countries except for Singapore. These emissions, when measured in relation to GDP indicate that, they have stagnated or fallen, reflecting that production and

consumption patterns have not become more CO₂ intensive but are the result of rapid economic growth. Deforestation is progressing rapidly in most countries (except for Viet Nam and the Philippines), especially in Myanmar, Indonesia and Cambodia, contributing to soil erosion, impaired water cycles, and increased greenhouse effects. **OECD estimates also indicate that ASEAN countries natural capital accounts for more than 20% of total wealth, well above the 2% average in OECD countries. Since 2000, ASEAN countries have experienced a substantial rise in material consumption and dramatic changes in material use profiles.** Construction materials and fossil fuels have been the fastest growing components of material consumption, closely linked to growing GDP. Large amounts of sand, gravel and other bulk construction materials have been used to build urban transport infrastructure and manufacturing plants. Use of biomass for energy has also increased, although at a slower speed, as it is, closely linked to population growth. **As a result of these trends, natural capital is being depleted at an increasing rate in most ASEAN countries**, especially in Brunei Darussalam, Indonesia, Thailand and Viet Nam. Furthermore, waste generated by households and businesses poses a serious environmental challenge in many ASEAN countries. **Figure 5 indicates that while low and middle-income ASEAN countries produce considerably less waste than more developed countries in the region (e.g. Singapore), the rapid urbanisation, industrialisation and strong economic growth are likely to see the amount of waste increase rapidly.**

Figure 5

Projected Urban Waste Generation in some ASEAN Countries



Source: Report of ASEAN Regional Assessment of MDG Achievement & Post – 2015. Development Priorities.

02

Waste Management and Technology Profile

Waste management systems in ASEAN countries have been described as per three waste streams i.e. Municipal Solid Waste (MSW), Hazardous waste/Industrial Waste, and E-waste/Emerging Waste streams. Current status of waste generation for different waste streams in ASEAN is summarized in Table I.

Municipal Solid Waste (MSW) Generation and Composition

Municipal solid waste has become a major concern in the present time, as the amount of waste generation has increased tremendously due to rapid urbanization and industrialization, population growth and improved life-styles. MSW primarily comes from households, but also includes wastes from offices, hotels, shopping complexes/shops, schools, institutions, and from municipal services such as street cleaning and maintenance of recreational areas. **Indonesia is generating the highest quantity of municipal waste with 64000000 tonnes per year, followed by Thailand (26770000 tonnes), Viet Nam (22020000 tonnes), Philippines (14660000 tonnes), Malaysia (12840000 tonnes) and Myanmar (841508), while Lao PDR is generating the lowest quantity of municipal solid waste (77380 tonnes).** MSW generated annually in ASEAN countries is given in Table I and **Figure 6**. Also, per capita generation of municipal waste in ASEAN countries is given in **Figure 7**. On per capita basis, Singapore and Brunei Darussalam are the highest MSW generators, followed by Malaysia, Thailand, Viet Nam, Indonesia, Lao PDR, Cambodia, Myanmar and the Philippines.



Table I Amount of Waste Generation and Composition of MSW in ASEAN Countries

No.	Countries	Waste Generation			
		Per Capita MSW Generation (kg/capita/day)	Annual MSW Generation (In ton)	Annual Hazardous Waste Generation (In MT)	Annual E-waste Generation (In Metric Kiloton ton)
1	Brunei Darussalam	1.4	210480		
2	Cambodia	0.55	1089429		
3	Indonesia	0.70	64000000		
4	Lao PDR	0.69	77380		8.00
6	Malaysia	1.17	12840000	1517434.06	
5	Myanmar	0.53	841508		
7	Philippines	0.69	14660000	1693856.72	39000
8	Singapore	3.763	7514500	411180	110
9	Thailand	1.05	26770000	3300000	368.314
10	Viet Nam	0.84	22020000		1609.775

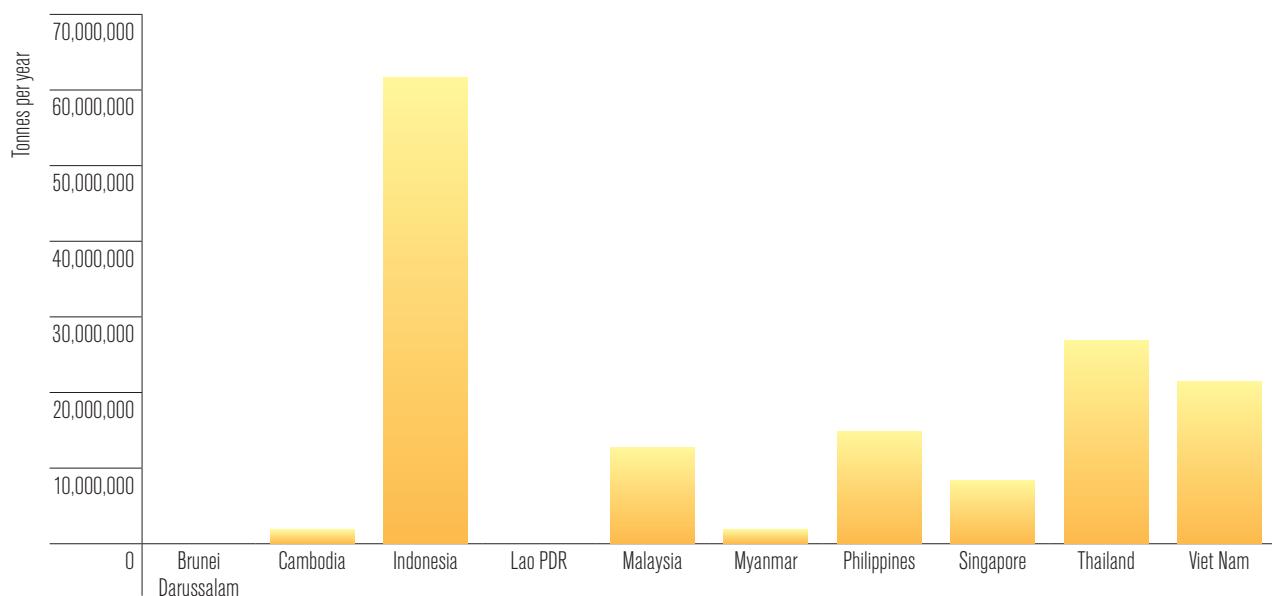
Source: Fourth ASEAN State of Environment Report 2009, available from: www.environment.asian.org (accessed 7 August 2016); AIT/UNEP, Municipal Waste Management Report: Status-quo and issues in Southeast and East Asia Countries, 2010; Regional 3R Forum in Asia and the Pacific: Country Report; Baldé, C.P., Wang, F., Kuehr, R., and Huisman, J., The Global E-waste Monitor, 2014, United Nations University; Country Presentation for 3R Meeting of the Regional 3R Forum; and Basel Convention National Reports -Year 2014, available from: <http://www.basel.int/Countries/NationalReporting> (accessed 7 August 2016); Ocean Conservancy and Trash Free Seas Alliance (2017), the Next Wave: Investment Strategies for Plastic free Seas, p. 69, available from: <http://www.oceanconservancy.org/our-work/marine-debris/the-next-wave.pdf> (accessed 20 March 2017).



MSW Composition (%)									
Food/ Organic Waste	Paper	Plastic	Metal	Glass	Textile	Rubber	Grass/Wood etc. waste	Construction Debris	Others
36	18	16	4	3					
60	9	15		3	1	1			
60	9	14	4.3	1.7	3.5	5.5			2.4
64	7	12	1	7	5	3			
45	8.2	13.2		3.3					27.3
73	2.24	17.75		0.45	1.14				5.15
52	8.70	10.55	4.22	2.34	1.61				
10.5	16.5	11.6	20.8	1.1	2.1		8.6	16.9	11.9
64	8	17.62	2	3	1.4	1	1		
55	5	10	5	3		4			

Figure 6

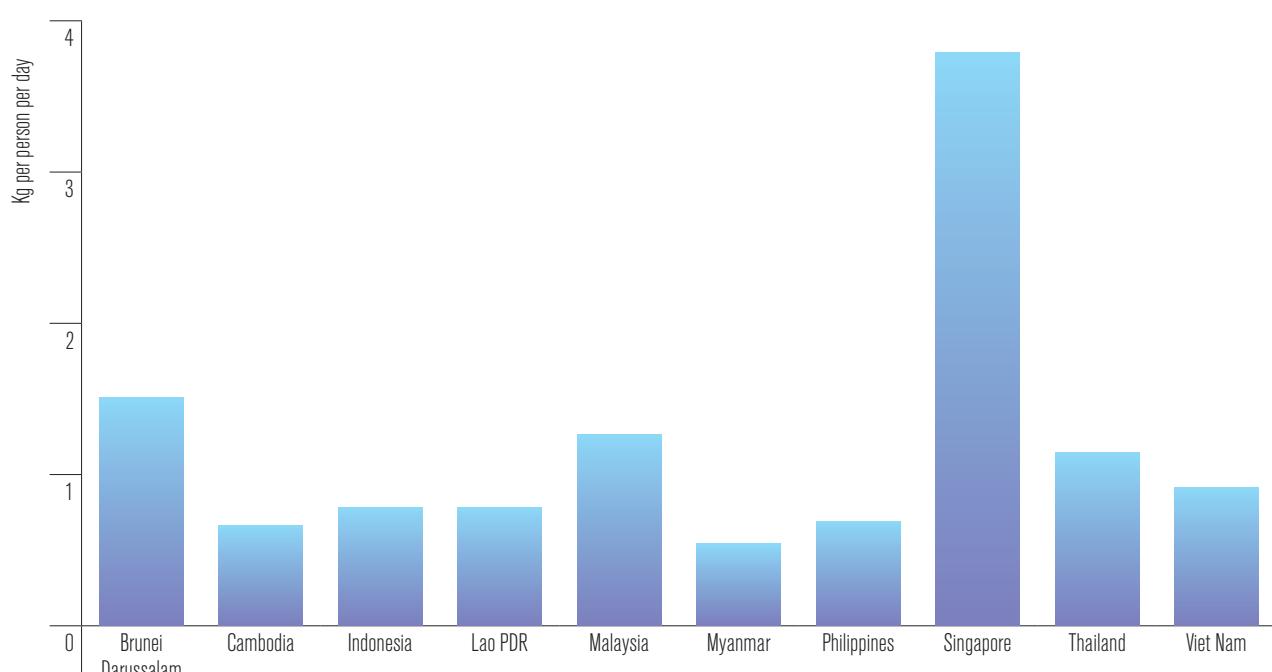
MSW Generation in ASEAN Countries



Source: Jain Amit (2016).

Figure 7

Waste generated per capita in ASEAN Countries

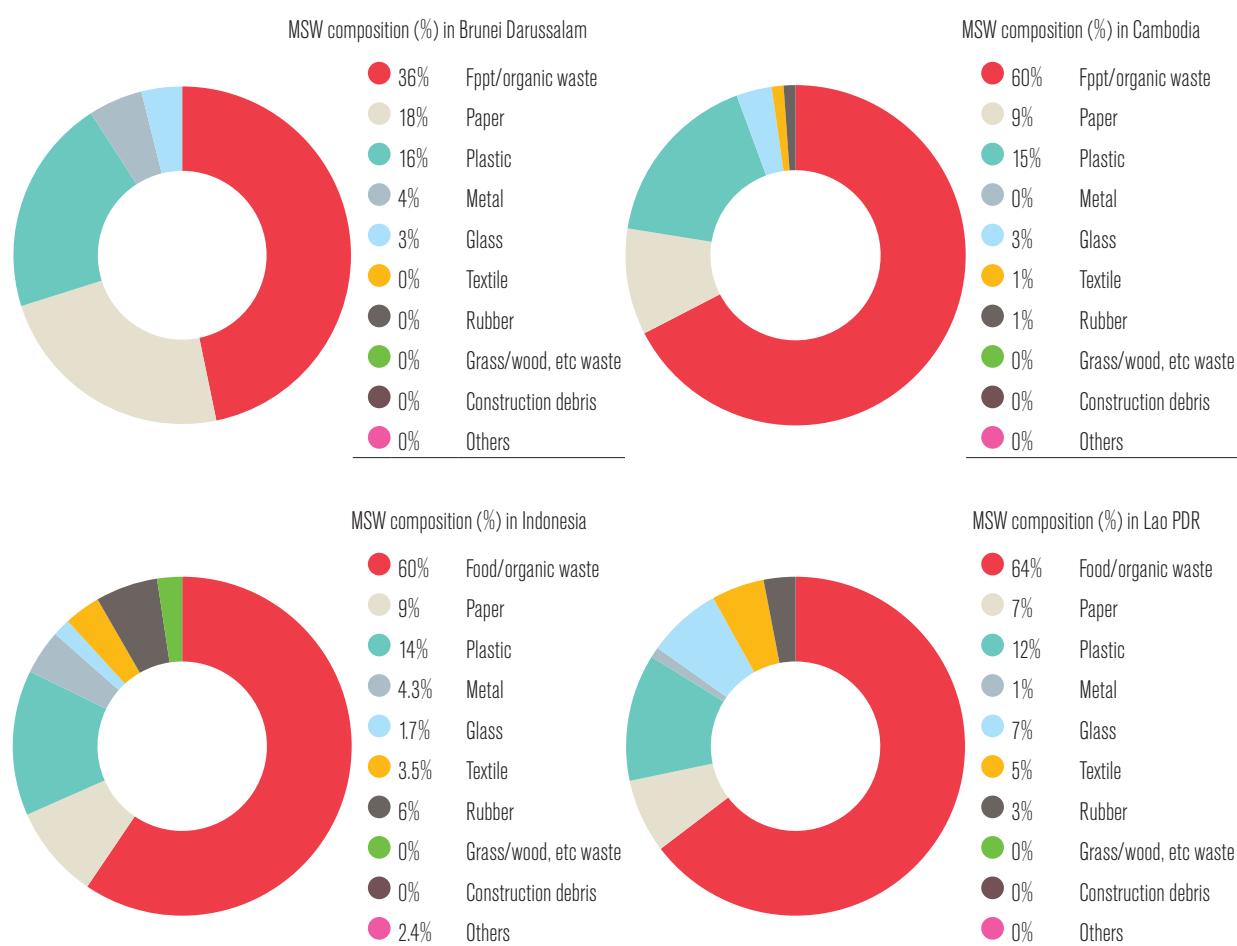


The MSW generated in the ASEAN countries is composed mainly of organic waste, plastic, paper, glass and metal. It has been found that 36% of the MSW generated in Brunei Darussalam is organic waste, followed by paper (18%) and plastic (16%); In Cambodia, 60% of the MSW is organic waste, followed by plastic (15%), paper (9%) and glass (3%); In Indonesia, 60% of the MSW is organic waste, followed by plastic (14%) and paper (9%). In Lao PDR, 64% of the MSW is organic waste, followed by plastic (12%) and paper (7%); In Malaysia 45% of the MSW is organic waste, followed by plastic (13.2%) and paper (8.2%); In

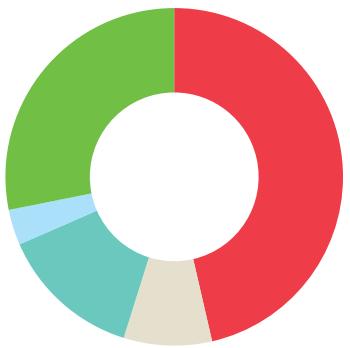
Myanmar; 73% of the MSW is organic waste, followed by plastic (17.75%) and paper (2.24%); In Philippines, 52% of the MSW is organic waste, followed by Plastic (10.55%) and Paper (8.70%). In Singapore, 10.5% of the MSW is organic waste, followed by metal (20.8%), construction Debris (16.9%) and plastic (16.5%). In Thailand, 64% of the MSW is organic waste, followed by plastic (17.62%) and paper (8%). In Viet Nam, 55% of the MSW generated in the country is organic waste, followed by Plastic (10%), Paper (5%) and Metal (5%). Furthermore, the composition of MSW in the ASEAN countries is presented in **Figure 8. Table I also**

Figure 8

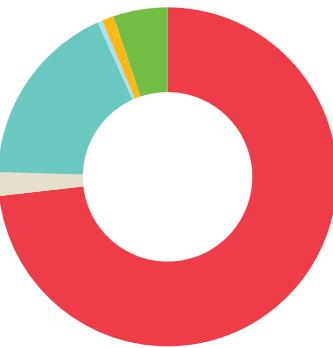
Composition of MSW in ASEAN Countries



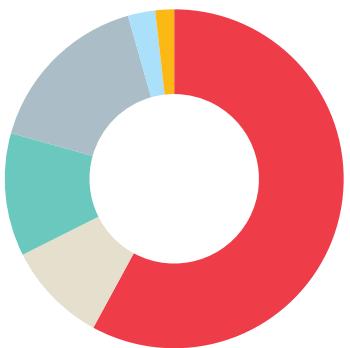
MSW composition (%) in Malaysia



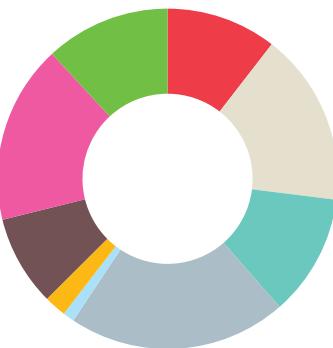
MSW composition (%) in Myanmae



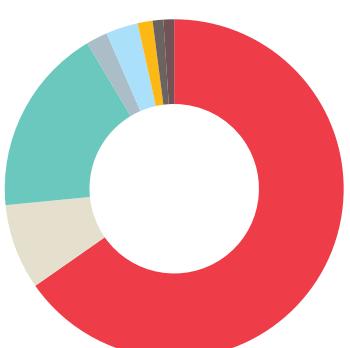
MSW composition (%) in Philippines



MSW composition (%) in Singapore



MSW composition (%) in Thailand



MSW composition (%) in Viet Nam

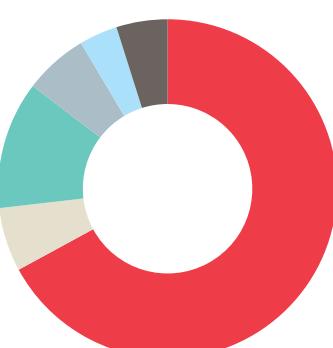
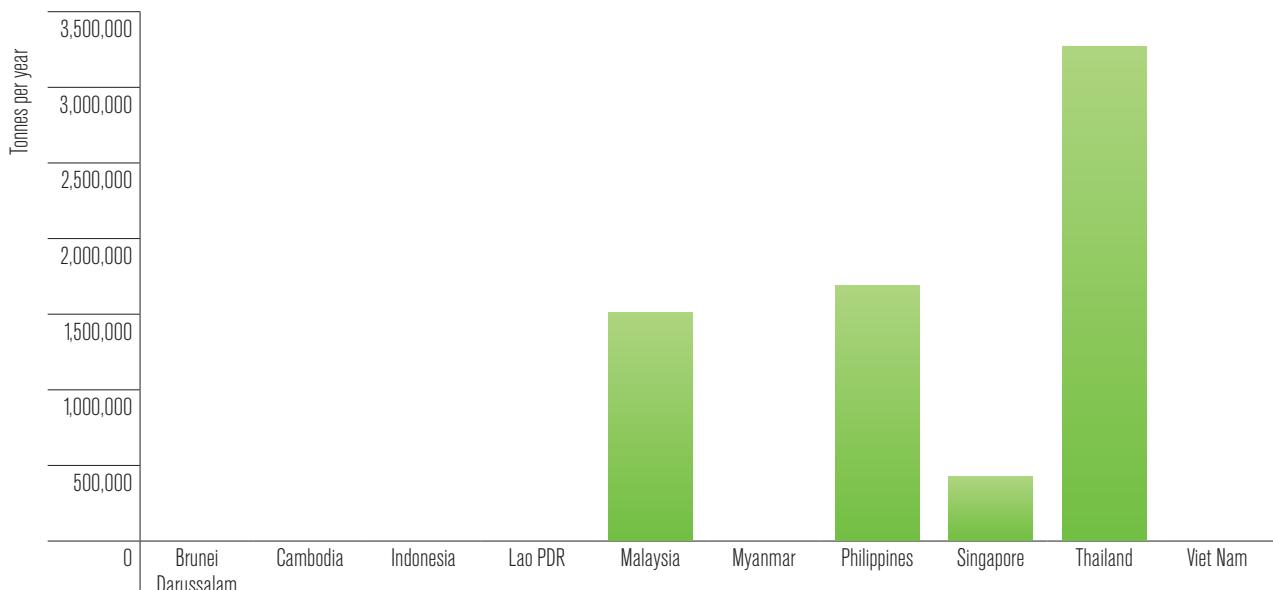


Figure 9

Total amount of hazardous waste generated in ASEAN Countries



indicates that data on waste streams like construction debris and rubber are not available, leading to an information gap. Organic waste constitutes a bulk of MSW, offering opportunity for waste reduction.

Updated hazardous waste inventory data gaps exist for Cambodia, Indonesia, Lao PDR, Myanmar, Viet Nam and Brunei Darussalam.

Industrial and Hazardous Waste

Industrial and hazardous waste data has been tabulated based on country's reporting to the secretariat of the Basel convention. Hazardous waste generated annually in ASEAN countries is given in Table 1 in **Figure 9**. Among the four ASEAN countries with updated hazardous waste inventory, Thailand is the highest generator followed by The Philippines, Malaysia and Singapore.

Emerging Waste Streams (Plastic, Healthcare and E-waste)

As per UNU's Global E-waste monitor 2014, Indonesia is generating the highest quantity of E-waste, with 745 metric kilotons per year, followed by Thailand (419 metric kilotonnes), Malaysia (232 metric kilotonnes), and Philippines (127 metric kilotonnes), while Brunei Darussalem is generating the lowest quantity of electronic waste (7). E-waste generated annually by ASEAN countries is given in **Table 2** and shown in **Figure 10**, while E-waste generated per inhabitant is given in **Figure 11**. Plastic waste stream has already been addressed in MSW, while hazardous waste also includes healthcare waste.

Table 2 Amount of E-Waste Generated in ASEAN Countries

Country	Per Inhabitant Generation (In Kg/Inh.)	Amount of E-Waste generated annually (In Metric Kilotons)
Brunei Darussalam	18.1	7.00
Cambodia	1	16.00
Indonesia	3	745.00
Lao PDR	1.2	8.00
Malaysia	7.6	232.00
Myanmar	0.4	29.00
Philippines	1.3	127.00
Singapore	19.6	110.00
Thailand	6.4	419.00
Viet Nam	1.3	116.00

Source: UNU-IAS, 2014.

Figure 10

Annual E-Waste Generated in ASEAN Countries

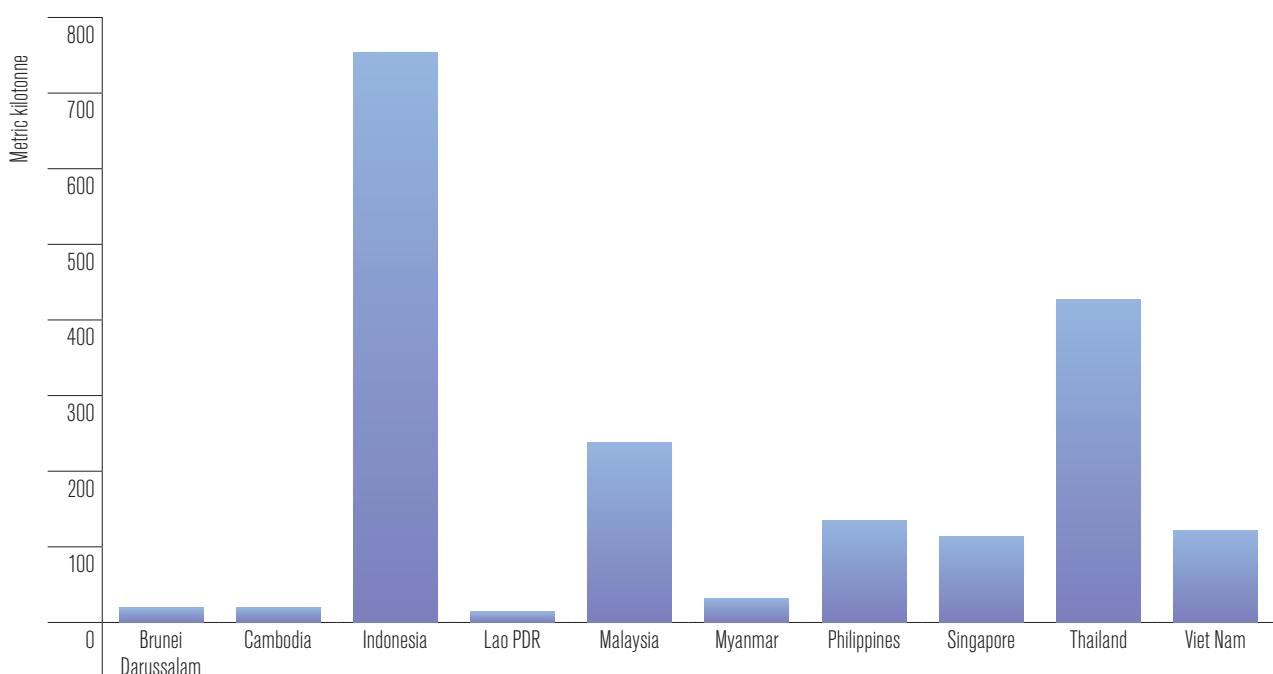
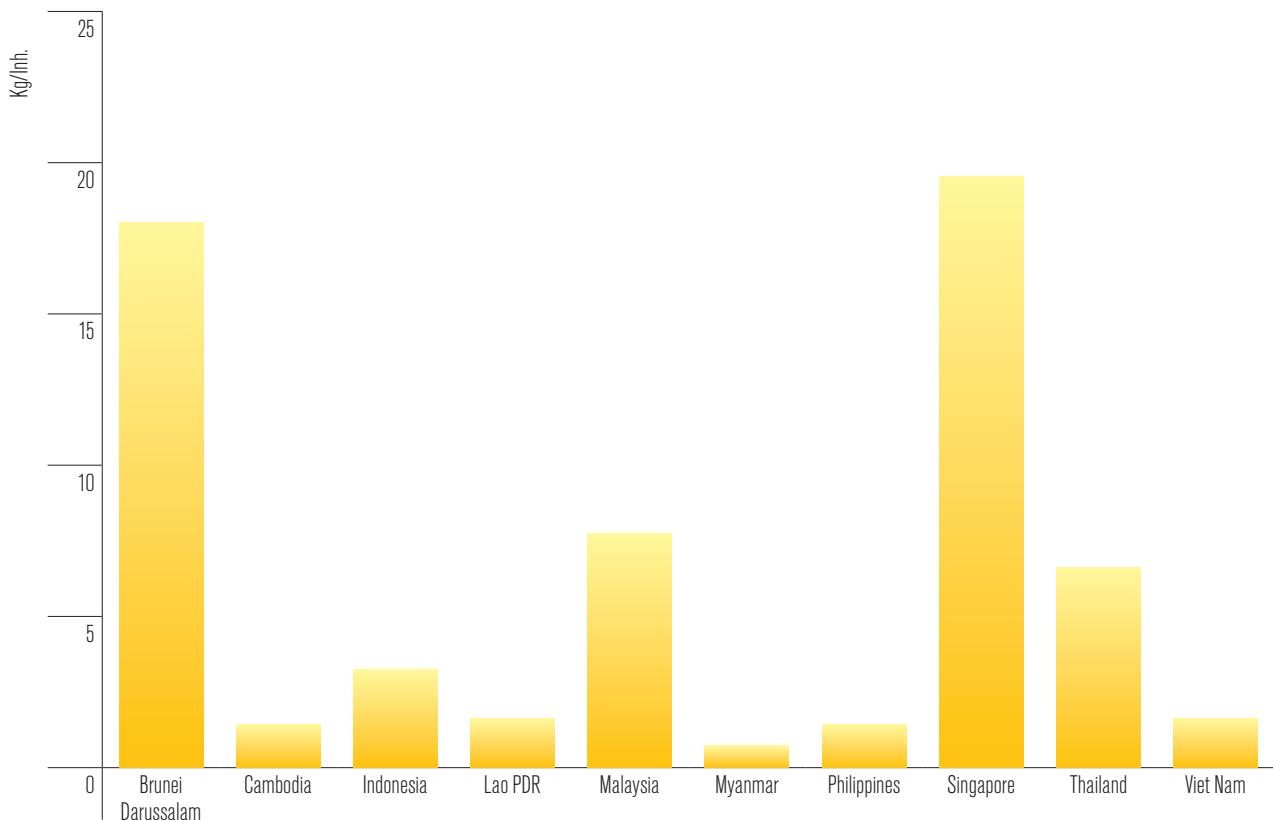


Figure 11

Per Inhabitant E-waste Generation



Technology profile for MSW in ASEAN countries is shown in Table 3.

Table 3 indicates that practices like open dumping and open burning of MSW are practiced in countries, where recycling rate is less than 50%. Sanitary landfill sites are the most common way for MSW disposal. Composting is practiced in a limited manner. This further indicates gaps in recycling infrastructure, as well as gaps in technology usage for MSW volume reduction. ASEAN countries have limited experience of composting and incineration.

Waste prevention and recycling rates are very low. Sanitary landfills and open dumps are the predominant

form of waste management, especially in the least developed countries, although there are large differences across countries. Open dumps are the most hazardous waste disposal methods as they can easily pollute air and ground water. Some countries have been taking decisive actions to limit urban waste production and dispose of it properly.

Technology profile related to industrial and hazardous waste is summarized in **Table 4**.

Table 4 indicates that majority of ASEAN countries, except for Brunei Darussalam, Cambodia, Lao PDR and Myanmar, have facilities for transport and disposal of industrial and hazardous waste. Disposal

Table 3 Technology – Municipal Solid Waste (MSW)

Country	Source Segregation	Collection Rate (Urban)	Recycling Rate	Technology		Technology Gap			
				Composting	Incineration	Sanitary Landfill	Open Dump	Open Burning	
Brunei Darussalam	<50%	90%	15%			□	□		
Cambodia	<50%	80%	<50%	●	□	□	□	●	
Indonesia	<50%	56% - 75%	<50%	●	●	□	□	●	
Lao PDR	<50%	40% - 70%	<50%	●	□	□	□	●	
Malaysia	<50%	>70%	50% -60% (Metal, Paper, Plastic); Others (<50%)		●	□	□		
Myanmar	50%		70% (Plastic, Paper, Metal)		●	□	□		
Philippines	50% - 70%	40% - 90%	20%-33% (Paper) 30%-70% (Aluminum) 20% - 58% (Other Metals) 23% - 42% (Plastic) 28% - 60% (Glass)	●	□	□	□		
Singapore	70%	>90%	50% - 60% (Paper, Horticulture) >90% (Fe, CandD, Used Slag) >80% (Scrap Tire) >80% (Wood) >50% (Others) Overall (60%)		●	□	□		
Thailand	<50%	>80%	>90% (Metal) 50% - 60% (Paper, Construction) <50% (Others)	●	●	□	□		
Viet Nam	<50%	80% - 82%	>90% (Metal) >70% (Plastic, E-waste) 50% (Paper) <50% (Others)	●		□	□		

Note: >70% (Plastic, E-waste).

technologies include incineration and secured landfill sites. All ASEAN countries except for Cambodia, and Lao PDR have recovery/recycling facilities. The level of these facilities range from small and basic material recovery facilities to high-end facilities e.g. waste oil/ solvent/chemicals and metals etc.

Technology profile related to emerging waste is summarized in **Table 5**.

Table 5 indicates that there is limited recycling infrastructure existing for plastic and E-waste in ASEAN countries. Healthcare waste is treated and disposed in majority of ASEAN countries by incineration. E-waste facilities include dismantling and material/metal recovery facilities.

Overall, the waste management profile and technology assessment in ASEAN region indicates that waste management technology is emerging from low-end to

Table 4 Technology – Industrial Waste Including Hazardous Waste

Country	Transportation	Recycling/Recovery	Disposal
Brunei Darussalam	-	+	
Cambodia	-	-	🔥
Indonesia	+	+	🔥
Lao PDR	-	-	
Malaysia	+	+	🔥
Myanmar	-	+	
Philippines	+	+	🔥
Singapore	+	+	🔥
Thailand	+	+	🔥
Viet Nam	+	+	🔥

_____ Incineration _____ Sanitary landll



Table 5 Technology - Emerging Waste Streams (Plastic, Healthcare and E-waste)

Country	Recycling			Treatment/Disposal		
	Plastic	Healthcare	E-waste	Plastic	Healthcare	E-waste
Brunei Darussalam	-	-	✓	-	-	-
Cambodia	-	-	-	-	✓	-
Indonesia	✓	-	✓	✓	✓	✓
Lao PDR	-	-	-	-	-	-
Malaysia	✓	-	✓	✓	✓	✓
Myanmar	✓	-	-	-	-	-
Philippines	✓	-	✓	✓	✓	✓
Singapore	✓	-	✓	✓	✓	✓
Thailand	✓	-	✓	✓	✓	✓
Viet Nam	✓	-	✓	✓	✓	✓
✓ Yes				- No		

high-end, though there is a need to augment recycling rate to reduce pressure on disposal options.

Policy, Regulatory and Institutional Profile

Countries across ASEAN have already established national strategies to address challenges related to waste and environmental management. These get addressed broadly in their policy and regulatory framework and strategies like green growth, sustainable development and climate change. A summary related to them has been presented in **Table 6** and **7**. Only two countries, Cambodia and Viet Nam focus specifically on green growth. Other countries have designed strategies, which pursue sustainable development more broadly and address climate change. Other ASEAN countries have adopted a more limited approach, by integrating green growth considerations into other national plans, rather than preparing separate green growth strategies.

Regulatory framework indicates that MSW, industrial and hazardous waste have been broadly covered under the regulatory framework. However, emerging waste streams like E-waste are not specifically addressed. Institutional responsibility related to each waste stream for policy, programme, plan/strategy project, regulations, standards for ASEAN countries has been described in Table 8, 9 and 10.

Table 8, Table 9 and Table 10 indicate that in all ASEAN countries, MSW (except for Brunei Darussalam) and emerging waste streams is being regulated both at national and local level. Industrial and hazardous waste is being regulated at national level in all ASEAN countries. All other countries have participation of informal sector for all the waste streams. Analysis also indicates issues related to implementation, coordination, capacity (Technical, Financial, Human Resources) and awareness of stakeholders across the waste management chain. Gap analysis has also been carried out with respect to each waste stream in ASEAN countries.

Table 6 National ASEAN environment strategies vary in their focus on green growth

Countries	National green growth strategy	National sustainable development strategy	National climate change strategy
Brunei Darussalam		National Vision, the Wawasan Brunei Darussalam 2035	
Cambodia	The National Green Growth Roadmap (2009)		Climate Change Strategic Plan (CCSP) 2014-23
Indonesia			<ul style="list-style-type: none"> • National Action Plan Addressing Climate Change (RAN MAPI) (2007) • Indonesia Climate Change Sectoral Roadmap (2009) • The National Action Plan for Greenhouse Gas Emissions Reduction (RAN GRK) (2011)
Lao PDR			Strategy on Climate Change of the Lao PDR (2010)
Malaysia	National Green Technology Policy (2009)		
Myanmar		National Sustainable Development Strategy for Myanmar (2009)	
Philippines		Philippine Agenda 21: A National Agenda for Sustainable Development for the 21st Century (1996)	<ul style="list-style-type: none"> • National Framework Strategy on Climate Change 2010-22 • National Climate Change Action Plan 2011-28
Singapore		Sustainable Singapore Blueprint (2015)	National Climate Change Strategy (2012)
Thailand	Draft Green Growth Strategies (2015-2020) National Master Plan on Cleaner Production (2008-2016) Energy Efficiency Development Plan (2011-2030) National Industrial Development Master Plan (2012-2031) Environmental Quality Management Plan (2012-2016)	Twenty Years Country Strategies (2017-2036) 11th National Social and Economic Development Plan (2012-2016)	<ul style="list-style-type: none"> • National Strategy on Climate Change 2008-12 • Thailand Climate Change Master Plan 2012-50 • National Strategy on Climate Change 2013-17
Viet Nam	National Green Growth Strategy for the period 2011-20 with a vision to 2050 • National Action Plan on Green Growth for Period 2014-20	Sustainable Development Strategy for 2011-20	National Strategy on Climate Change for 2011-20

Source: OECD Green Growth Studies (2013). Towards Green Growth Southeast Asia.

Table 7 Regulatory Framework

Countries	Basic Act/Definitions
Brunei Darussalam	As of date, Brunei Darussalam does not have a basic Act on Environment, although it is at the draft stage. It has regulations and guidelines on waste and air pollution and regulations on Hazardous Waste. As per the current regulations, various definitions of waste streams for waste and hazardous waste have been defined.
Cambodia	Cambodia has a basic Act on Environment, as well as regulations on air, water and waste management. Regulation on waste management, “Sub Decree on Solid Waste Management 1999 amended in 2015” defines solid waste, household waste and hazardous waste.
Indonesia	Indonesia has a basic Act on Environment, as well as regulations on air, water and waste management. This act defines Waste, Hazardous and toxic material and Hazardous and toxic waste.
Lao PDR	Lao PDR has a basic Act on Environment as well as regulations on water and industrial waste discharge. It has guidelines on “Environment Ambient Standards” and “Pollution Emission Standards”. “Pollution from Waste” has been identified as a pollution under the basic act. Industrial Waste Discharge regulation defines waste as sewage, wastewater, air pollution, toxic waste, and hazardous waste, including sludge in form of solid, liquid or gas.
Malaysia	Malaysia has a basic Act on Environment “Environmental Quality Act, 1974”, as well as regulations on air, water and waste management. Regulations on waste management include “Solid Waste and Public Cleansing Management Act 2007” and “Environment Quality (Schedule Wastes) Regulations 2005. These regulations define solid waste, household waste and hazardous waste. As per the current regulations, various definitions of waste streams for waste, Municipal waste, Hazardous waste, industrial effluent, sludge and sewage have been defined.
Myanmar	Myanmar has a basic Act on Environment as well as regulations on water and Environmental Conservation. Specific regulations on waste management do not exist. Hazardous waste Management is covered in Environmental Conservation Rules 2014. As per the current regulations, various definitions of waste streams for Pollutant and Waste have been defined.
Philippines	Philippines has a basic Act on Environment as well as regulations on air, water and waste management (Solid Waste and Hazardous Waste). Regulations on waste management, the “Ecological Solid Waste Management, Act 2000”, defines solid waste, municipal waste, hazardous waste, agriculture waste, bulky wastes, special wastes and yard waste. Philippine Toxic Substances, Hazardous and Nuclear Waste Act 1990 covers hazardous waste. Other regulations covering waste include Philippine Clean Water Act of 2004 and Philippine Clean Air Act of 1999.
Singapore	Singapore has a basic act on Environment, “Environmental Protection and Management Act, 2002” as well as regulations on air, water and waste management. Regulations on waste management include the “Environmental Public Health Act, 2002” and its subsidiary legislations. As per its regulatory profile, definitions of waste streams for Waste, Municipal Waste and Hazardous waste have been covered.
Thailand	Thailand has a basic Act on Environment, “Environment and Conservation of National Environmental Quality Act B.E. 2535 AD 1992” as well as regulations on air, water and waste management. Regulations on waste management includes Public Health Act 1992 and Hazardous Waste and Substances B.E. 2546 (2003), B.E. 2549 (2006), B.E. 2535 (1992) and B.E. 2548 (2005). As per its regulatory profile, definitions of waste streams for Waste, Solid waste and Hazardous Substance have been covered.
Viet Nam	Viet Nam has a basic Act on Environment “Law on Environmental Protection 1993 amended in 2005”, as well as regulations on water and hazardous waste management. Law on Environmental Protection defines waste, hazardous waste and hazardous materials. As per its regulatory profile, definitions of waste streams for Waste, Hazardous waste, Municipal Solid Waste and Waste materials have been covered.

Table 8 National ASEAN environment strategies vary in their focus on green growth

Roles of Stakeholders				
Countries	Regulator	ULBs	Private Sector (Formal)	Private Sector (Informal)
Brunei Darussalam	✓ (P1, P2, P3, P4, R)		✓	
Cambodia	✓ (P1, R)	✓ (P2, P3, P4)	✓ (P4)	✓ (Collection, Transportation and Disposal)
Indonesia	✓ (P1, R)	✓ (P2, P3, P4)	(P4)	✓ (Collection, Transportation and Disposal)
Lao PDR	✓ (P1, R)	✓ (P2, P3, P4)	(P4)	✓ (Collection, Transportation and Disposal)
Malaysia	✓ (P1, R)	✓	✓ (P4) (Collection, Transportation and Disposal)	✓ (Collection, Transportation and Disposal)
Myanmar	✓ (P1, R)	✓ (P2, P3, P4)	(P4)	✓ (Collection, Transportation and Disposal)
Philippines	✓ (P1, R)	✓ (P2, P3, P4)	Limited (P4)	✓ (Collection, Transportation and Disposal)
Singapore	✓ (P1, P2, P3, P4, R)	✓ (P4)	✓ (P4) (Collection, Transportation and Disposal)	✓ (Collection)
Thailand	✓ (P1, P2, P3, R) (Ministry of Natural Resource and Environment)	✓ (P4)	✓ (P4) (Recycling and Disposal)	✓ (Collection, Transportation and Disposal)
Viet Nam	✓ (P1, R)	✓ (P2, P3, P4)	(Collection, Transportation and Disposal) (P4)	✓ (Collection, Transportation and Disposal)

Note: P1 – Policy, P2 – Programme, P3 - Plan/Strategy, P4 – Project, R – Regulations and Standard, ✓ Yes

Source: OECD – Towards Green Growth in Southeast Asia

Table 9 Industrial and Hazardous Waste

Roles of Stakeholders				
Countries	Regulator	ULBs	Private Sector (Formal)	Private Sector (Informal)
Brunei Darussalam	✓ (P1, P2, P3, R)		✓	
Cambodia	✓ (P1, P2, P3, R)	✓ (P4)	✓ (Collection, Transportation and Disposal)	
Indonesia	✓ (P1, P2, P3, R)	✓ (P4)	✓ (Collection, Transportation and Disposal)	
Lao PDR	✓ (P1, P2, P3, R)	✓ (P4)	✓ (Collection, Transportation and Disposal)	
Malaysia	✓ (P1, P2, P3, R)	✓ (P4) (Collection, Transportation and Disposal)	✓ (Collection, Transportation and Disposal)	

Countries	Regulator	ULBs	Roles of Stakeholders	
			Private Sector (Formal)	Private Sector (Informal)
Myanmar	✓ (P1, P2, P3, R)		✓ (P4)	✓ (Collection, Transportation and Disposal)
Philippines	✓ (P1, P2, P3, R)		✓ (P4)	✓ (Collection, Transportation and Disposal)
Singapore	✓ (P1, P2, P3, R)		✓ (P4) (Collection, Transportation and Disposal)	✓ (Collection)
Thailand	✓ (P1, P2, P3, R) (Ministry of Natural Resources and Environment, Ministry of Industry)		✓ (P4)	✓ (Collection, Transportation and Disposal)
Viet Nam	✓ (P1, P2, P3, R)		✓ (P4)	✓ (Collection, Transportation and Disposal)

Note: P1 – Policy, P2 – Programme, P3 - Plan/Strategy, P4 – Project, R – Regulations and Standard, ✓ Yes

Table 10 Emerging Waste Streams

Countries	Regulator	ULBs	Roles of Stakeholders	
			Private Sector (Formal)	Private Sector (Informal)
Brunei Darussalam	✓ (P1, P2, P3)		✓	✓ (Collection, Transportation and Disposal)
Cambodia	✓ (P1, P2, P3, P4, R)	✓ (P4)		✓ (Collection, Transportation and Disposal)
Indonesia	✓ (P1, P2, P3, P4, R)	✓ (P4)		✓ (Collection, Transportation and Disposal)
Lao PDR	✓ (P1, P2, P3, P4, R)	✓ (P4)		✓ (Collection, Transportation and Disposal)
Malaysia	✓ (P1, P2, P3, P4, R)	✓ (P4)	✓ (P4) (Collection, Transportation and Disposal)	✓ (Collection, Transportation and Disposal)
Myanmar	✓ (P1, P2, P3, P4, R)	✓ (P4)		✓ (Collection, Transportation and Disposal)
Philippines	✓ (P1, P2, P3, P4, R)	✓ (P4)		✓ (Collection, Transportation and Disposal)
Singapore	✓ (P1, P2, P3, P4, R)	✓ (P4)	✓ (P4) (Collection, Transportation and Disposal)	✓ (Collection)
Thailand	✓ (P1, P2, P3, P4, R) (Ministry of Natural Resource and Environment, Ministry of Health and Ministry of Industry)	✓ (P4)	✓ (P4) (Collection, Transportation and Disposal)	✓ (Collection, Transportation and Disposal)
Viet Nam	✓ (P1, P2, P3, P4, R)	✓ (P4)	✓ (P4) (Collection, Transportation and Disposal)	✓ (Collection, Transportation and Disposal)

Note: P1 – Policy, P2 – Programme, P3 - Plan/Strategy, P4 – Project, R – Regulations and Standard, ✓ Yes

Municipal Solid Waste (MSW)

Gap analysis has been carried out based on waste management and technology profile, policy, regulatory and institutional profile for each country and for each waste stream. These gaps have been assessed at policy, programme, plan/strategy and project level, based on the country reports/presentations in response to goals identified at UNCRD's 3R forum



Goals	Countries									
	Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
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.	Relevance									
	Policies									
	Programme									
	Plan/Strategy									
	Projects									
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.	Relevance									
	Policies									
	Programme									
	Plan/Strategy									
	Projects									
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.	Relevance									
	Policies									
	Programme									
	Plan/Strategy									
	Projects									
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 .	Relevance									
	Policies									
	Programme									
	Plan/Strategy									
	Projects									
 										
Yes Partial No Design Stage Pilot Level Pilot Projects Under Preparation										

Major gaps have been identified for Cambodia, Myanmar and Brunei Darussalam, followed by the Philippines, Viet Nam and Indonesia. A summary of the individual country gap analysis is summarized below.

Brunei Darussalam

Policy/Regulatory, Programme and Plan Assessment

Lacks in addressing significant reduction of MSW, organic waste and zero waste, leading to sustainable cities. Though the country supports 3R concepts, it needs an action plan for complete implementation as per 3R hierarchy.

Technology Assessment

Lack of segregation, for example, solid waste from homes, shops and offices are often mixed together; wet and dry waste also lacks segregation. Some companies have started to establish unscientific stock piling of recyclable wastes such as scrap metals, plastic, paper, used motor-vehicle batteries for recycling. These recyclable wastes are being exported to other countries for recycling, due to lack of local facilities. Lack of waste reduction technologies like incineration and composting

Institutional Assessment

Prices of recyclable waste are normally unstable and very low especially plastic and paper. On the other hand, aluminum and other metals have competitive prices. Therefore, private sector does not find it lucrative to invest in plastic and paper recycling infrastructure. However, recently the DEPR has received an expression of interest from the private sector to establish recycling and related activities. Many companies are not able to set up compost plants in the country, due to its expensive process, cheap price of compost and considerably low returns. Country lacks in data and information and accessibility to existing data. In addition to this, there is a lack of capacity in design, implementation and monitoring of policies, programme and projects. The country is developing projects based on PPP mechanism e.g.

Waste tyre recycling facility is functioning under PPP mechanism. The long term of PPP mechanism is yet to be determined. Awareness and behavior of people related to the concept of sustainable cities/green cities by encouraging zero waste are limited. Wastes management infrastructure is costly and takes up limited land.

Cambodia

Policy/Regulatory, Programme and Plan Assessment

Cambodia does not have comprehensive policies and programmes in place for MSW. The existing policies and programmes lack in addressing significant reduction of MSW, organic component of municipal waste, including food waste, zero targets for recycling rates and other waste. However, the country has some regulations and is preparing an Integrated Solid Waste Management Strategy/Plan for future development of the Waste Management sector.

Assessment of Gaps in Technology

The solid waste generated from houses, commercial centers, hospitals, industrial handicrafts, etc. is not segregated and is disposed of and burnt at the dumpsite, while some is found to be decomposed of under weather conditions. Segregation does not happen at the source. Waste disposal site are not covered by soil. Composting is carried out at demonstration or small-scale level, while waste incineration does not exist. Majority of waste collection is carried out by informal sector though in Phnom Penh, there are three organizations responsible for collection of waste. At project level, some pilot projects have been designed and are being implemented to demonstrate waste reduction through greening production, greening lifestyle and sustainable consumption. These projects also aim to demonstrate full-scale utilization of organic component of municipal waste, thereby reduction of waste flow at disposal sites, GHG reduction, resource efficiency, energy recovery and employment creation. Only the small recycling facilities exist within the country.

Institutional Assessment

Department of Environmental Pollution control, as regulator, is responsible for pollution, policy, regulations and standards as well as monitoring and control. ULBs are responsible for programme, plan and projects. Furthermore, private sector (formal) is involved in collection and transportation in major cities at project level for recycling and disposal. Private sector (informal) is, in a major way, involved in collection, transportation and disposal. Country lacks data and information and accessibility to existing data. It lacks knowledge and skill in design, implementation and monitoring of programme, plan/strategy and projects. There has been no major initiative related to development of financial mechanism or institutional framework for developing the recycling industry in the country, although examples of formal sector involvement exist in the collection mechanism in Phnom Penh. Cost of investment is high and the project support is limited. Awareness and behavior of people related to the concept of sustainable cities/green cities by encouraging zero waste is limited.

collected by informal sector. Composting is well demonstrated and is carried out at household and community level. Waste incineration exists only in three places. No further replication has happened. At project level, pilot projects have been designed and are being implemented to demonstrate waste reduction through greening production, greening lifestyle and sustainable consumption. These projects also aim to demonstrate full-scale utilization of organic component of municipal waste thereby reduction of waste flow at disposal sites, GHG reduction, resource efficiency, energy recovery and employment creation. Concept of waste minimization and zero waste exist at programme and pilot level and need to be scaled up. For example, concept related to waste exchange/Waste Management has been tried successfully for MSW. Recycling facilities exist in major cities, while no recycling facility exists to recycle construction waste. At the municipal level, waste handling and treatment facilities are often lacking. There is a need for capacity building for choosing the most adequate technologies.

Indonesia

Policy/Regulatory, Programme and Plan Assessment

Indonesia has major policies, programmes, strategy/plan and projects in place for MSW. But these are currently not well-implemented and enforced at all governmental levels. This gets reflected in below average collection, recycling rate and resources recovery from MSW. Even though waste minimization and collection targets exist at the national level, they are not well adopted within the policy frameworks of local governments.

Technology Assessment

The solid wastes generated from houses, commercial centers, hospitals, industries, etc. are not segregated but collected and are disposed of and burnt. Segregation does not happen at the source. About 50% of the waste is collected by ULBs, while the remaining is

Institutional Assessment

National regulator/Ministry is responsible for addressing pollution, policy, regulations and standards as well as monitoring and control. ULBs are responsible for programme, plan and projects. Furthermore, private sector (formal) partly (50%) in collection, transportation and disposal but does not cater to 100% collection, transportation and disposal. Private sector (informal) is involved significantly (50%) in collection, transportation and disposal. Country lacks in data and information. Lack of knowledge and skill exist at technology, financial and institutional level. There has been no major initiative related to development of financial mechanism or institutional framework for developing recycling industry in the country, although examples of formal sector involvement exist in collection, transportation and disposal mechanism. Cost of investment is high and the project support is limited. Elaborate compost marketing efforts need to be initiated for sustainability of 3R facilities.

Lao PDR

Policy/Regulatory, Programme and Plan Assessment

Lao PDR does not have comprehensive policies and programmes in place for MSW. However, the country has environmentally sustainable city guidelines put in place, as part of the national Environmental Strategy 2020 for future development of waste management sector.

Technology Assessment

The solid wastes generated from houses, commercial centers, hospitals, industries etc., are not segregated and are disposed of and burnt at the dumpsite. Segregation does not happen at sources e.g. Food waste is recycled as animal feed, but other organic wastes are mixed with municipal wastes. Country lacks equipment and technology for MSW management i.e. number of waste collection tracks is small. Composting is carried out at demonstration or small-scale level, while waste incineration does not exist. At project level, some pilot projects in pilot cities have been designed and are being implemented to demonstrate waste reduction through greening production, greening lifestyle and sustainable consumption. These projects also aim to demonstrate full-scale utilization of the organic component of municipal waste thereby reducing GHG and the waste flow at disposal sites, creating resource efficiency and energy recovery, as well as creating employment. No recycling infrastructure exists in the country.

Institutional Assessment

While existing regulations provide a broad legal framework for waste management, there are still many gaps that need to be filled. In particular, rules to support community and private sector involvement have to be set up. The local authorities have also not yet taken any serious steps to introduce recycling. Furthermore, private sector (informal) is, in a major way, involved in collection, transportation and disposal. Country lacks data and information and accessibility to existing data. It also lacks knowledge, skill and coordination between agencies. Community involvement in waste segregation

needs to be augmented. There has been no major initiative related to the development of financial mechanisms or institutional framework for developing a recycling industry in the country, though examples of formal sector involvement exist in the collection mechanism in Vientiane. Awareness and behavior of people related to the concept of sustainable cities/green cities by encouraging zero waste are limited.

Malaysia

Policy/Regulatory, Programme and Plan Assessment

There is absence of integrated solid waste planning and management scheme. The country also lacks better understanding of waste composition to enable the development of a holistic strategy plan for the waste management.

Technology Assessment

Inadequate number of resource recovery facilities for C and D waste. Inadequate facilities and huge cost in managing solid waste (capital and operating). The country has inadequate availability of recycling and recovery facilities in local authority areas. Unsanitary dumpsites outnumber sanitary dumpsites, which require rehabilitation and closure by authority. There is no proper mechanism for food waste collection from residential and other institutions. Currently, separation of food/organic waste from source is not mandatory for household or other waste generators. The country does not have full-scale/commercial plant for treating food/organic waste. The country also has inadequate 3R facilities such as material recovery and drop off center. Further improper segregation (Co-mingling of recyclables and residual waste) affects the quality of recyclables.

Institutional Assessment

There is a lack of enforcement of regulation and coordination between agencies. Coordination among relevant local, state and federal agencies in the waste sector is a key prerequisite for effective waste management. The National Strategic Plan for

Solid Waste Management formulated in 2005 for the period up to 2020 only, targets municipal solid waste in Peninsular Malaysia. The legislation that governs solid waste management is restricted by the constitutional arrangements between Peninsular Malaysia, Sabah and Sarawak. As a result, the Solid Waste and Public Cleansing Management Act enacted in 2007, is applicable only to Peninsular Malaysia and the Federal Territories of Putrajaya and Labuan. As of August 2015, the legislation has only been adopted by six States and two Federal Territories in Peninsular Malaysia. The Eleventh Malaysia Plan calls for the establishment of a national committee on sustainable waste management to enhance coordination nationally. Lack of coordination among agencies involved in waste management has affected the effective implementation of the 3R (reuse, reduce and recycle) programme. Segregation at source is lacking and overall recycling rate is less than 50%. PET and non-PET plastic recycling rate is average. Furthermore, other waste stream recycling rate, like colored paper, cleared glass, colored glass, metal can, cooked food, uncooked food and other is very small. Therefore, the entire recycling infrastructure needs to be augmented in order to meet 22% household waste recycling target. No adequate market exists for composted food waste as fertilizer. There is inadequate awareness on 3Rs practice as well as a lack of budget for raising awareness programme. The cost of managing solid waste is highly subsidized by the federal government.

Myanmar

Policy/Regulatory, Programme and Plan Assessment

Myanmar has policies and programmes in place for MSW. However, the country is weak in developing an action plan and projects as well as in their implementation. UNEP – IGES is collaborating with ECD and is attempting to develop a national and city level waste management strategy and action plan.

Technology Assessment

The solid wastes generated from different sources are poorly segregated and are disposed of in dumpsites and burnt in the open. Segregation does not happen at the source. Pilot projects related to segregation, in some areas of Yangon and Mandalay city, mandates usage of plastic bags according to three-color codes. Composting is carried out in a limited manner. Majority of waste collection is carried out by the informal sector; although in major cities, municipal organizations are responsible for collection of waste. In some pilot collection projects, the segregation of wastes is carried out by using color bags. At project level, some pilot projects have been planned to demonstrate waste reduction through greening production, greening lifestyle and sustainable consumption. Only the small recycling facilities exist within the country. Recycling infrastructure is not developed and the recovery rate is very high.

Institutional Assessment

Ministry of Environment Conservation and Forestry is responsible for pollution, policy, regulations and standards. ULBs are responsible for programme, plan and projects monitoring and control. Furthermore, private sector (formal) is involved in collection, transportation and disposal, only in few towns. Private sector (informal) is involved in a major way in collection, transportation and disposal. Country lacks data/information and accessibility to existing data. There is lack of knowledge, experts and skilled personnel in the country. There has been no major initiative related to the development of a financial mechanism or institutional framework for developing recycling industry in the country, though policy framework exists for PPP projects. Cost of investment is high and the project support is limited. Awareness and behavior of people related to the concept of sustainable cities/green cities by encouraging zero waste is limited.

The Philippines

Policy/Regulatory, Programme and Plan Gap Assessment

The Philippines has policies and programmes in place for MSW. However, different components of MSW covered under various other regulations need to be integrated e.g. with regards to organic waste, the Ecological Solid Waste Management Act prioritizes composting; the Renewable Energy Act prioritizes its use as an energy source, while the Organic Agriculture Act also gives directions. Therefore, there is a need for convergence in different policies and regulations. In the Philippines, policies on organic waste need to be greatly improved. One of the major challenges is the proper planning and implementation by the LGUs on how to divert the organic waste from the waste stream and monitoring/validation on the actual reduction and diversion of organic wastes. Illegal dumping is evident in the country and needs to be stopped. Different levels of compliance to the RA 9003 among local government units are evident. Compliance of some LGUs is comparatively low, while others were already successful in the implementation of the Ecological Solid Waste Management Act. Not all local governments in the country have solid waste management committees. The country lacks zero MSW disposal approach.

Technology Gap Assessment

MSW collection efficiency needs to be improved in LGUs where it ranges below 50%. Furthermore, illegal dumping needs to be addressed by improving collection efficiency. There is lack of MSW segregation at primary level (household) and secondary level (transfer station). Mixed discarding of recyclable materials with other non-recyclable waste makes it difficult to collect and properly utilize recyclable materials. Recycling infrastructure lacks upgradation and coverage as well as linkage to upstream supply. Not all people have access to composting technology. The country lacks scientific closure of dumpsites and sanitary landfill infrastructure.

Institutional Gap Assessment

Country lacks in data and information and accessibility to existing data, for example, there is no actual figure at the national level on the volume of processed organic waste coming from municipal solid waste. There has been no major initiative related to development of institutional framework for developing recycling industry in the country. Cost of investment is high and the project support is limited. Private sector (informal) is, in a major way, involved in collection, transportation and disposal in cities other than the metro city. The informal waste sector consists of individuals, families, groups or small enterprises engaged in the recovery of waste materials, with revenue generation as the motivation either on a full or part time basis. The comparatively low compliance in the implementation of the regulations is due, but not limited, to; information gap, limited resources, limited market for recyclable materials in other areas and lack of determination among local leaders in implementing the law. Public-private partnerships may be able to provide an improved source of funding to organic waste management technologies. There is a lack in awareness and behavior of people related to the concept of sustainable cities/green cities by encouraging zero waste.

Singapore

Policy/Regulatory, Programme and Plan Assessment

The key challenge/constraint is behavioral change in the community to practice the 3Rs in their daily lives, in turn increasing the recycling rate.

Technology Assessment

There is constraint of land, considering growing waste generation and technological options.

Institutional Assessment

There is a lack of downstream demand such as animal feed and compost as Singapore lacks a significant agricultural sector. Waste disposal costs account for only a small part of the total utilities bill as compared to water, electricity and business costs. Companies

embark on waste reduction measures only when they see the net financial benefit. Extensive outreach effort is needed to make the companies realize the benefit of 3Rs and the potential cost savings. There is lack of skilled personnel, as well as a space constraint for companies to practice 3Rs.

Thailand

Policy/Regulatory, Programme and Plan Assessment

Although Thailand has policy, regulatory framework, programmes and plans in place, projects have not evolved to improve segregation, recycling and recovery rate.

Technology Assessment

Overall MSW collection rate, except for Metro cities, is average. Manual Segregation at source and at dumpsites leads to inefficient segregation. Furthermore, difficulties in obtaining consistent source segregated organic waste are experienced. There is a need for cost effective technology for biomass utilization. Treatment technologies like composting and waste to energy need to be replicated to reduce MSW volume. Sanitary landfill sites need to replace open dump sites, as dumpsites need to be rehabilitated and closed. A number of resource recovery facilities for construction waste need to be established in the country. Recycling and recovery rate of plastic, paper and construction waste need to be improved.

Institutional Assessment

Level of participation of households in “source” segregation of municipal waste streams is low. There is lack of financial and technical support/resources. Challenges exist in coordination of multi-stakeholder co-operations. There is lack of knowledge and skills e.g. inadequate numbers of knowledgeable staff to operate large anaerobic digestion systems. There is lack of participation of private investors due to constraints in understanding of waste management by the financial sector. Although the informal sector is currently servicing waste management streams in the country, there is a need to develop a policy framework for the informal sector to be included in the waste management system. Challenges in investment for modern recycling facilities e.g. private sector participation needs to be significant. Institutional constraints e.g. PPP projects exceeding 5,000 million THB must comply with Public Private Partnership Act, which has many procedural steps and requires time to receive approval. Technically and financially sustainable institutional model for waste management needs to be evolved.

Viet Nam

Policy/Regulatory, Programme and Plan Assessment

Viet Nam has comprehensive policies and programmes in place for MSW. The country has a regulatory framework and has an Integrated Solid Waste Management Strategy/Plan for future development of Waste Management sector. However, implementation mechanism needs to be evolved. This will also facilitate project development and technology transfer. There are no specific regulations on development of sustainable cities/green cities in Viet Nam. There is a lack of policies and mechanisms to reduce losses in the overall food supply chain (production, post harvesting and storage, processing and packaging, distribution) in the country. There is no official definition of municipal solid waste.

Technology Assessment

Manufacturing technologies are backward and obsolete (especially for heavy industry), causing issues related waste collection, transportation, treatment and disposal. Compost quality is not good, considering obsolete segregation technology /practices usage. Further dumpsites need to be scientifically rehabilitated/closed. There are a limited number of waste-to-energy projects due to high cost. Recycling technologies are obsolete, mainly at household scale in craft villages. Some domestic technologies have been certified but are still being tested, and have not been replicated across the country. Level of participation of households in "source" segregation of municipal waste streams is low or not satisfactory (less than 50%).

Institutional Assessment

New initiatives are being promoted to fill the gaps in municipal waste collection service. For example, community-based and private sector organizations are collecting waste in rural villages and in urban areas without municipal coverage. Major waste management areas that have strong involvement of private and business sector are waste collection, waste recycling and waste to energy, and composting. However, private recycling enterprises suffer from financial risks such as delayed support for sorting waste at-source, consumption, advertising products, and subsidizing product price in production of compost. There is lack of financial resources for implementing interventions. The development of waste treatment and disposal systems including landfills is a government priority but due to the lack of financial resources, the government is constructing most sanitary landfills with developmental funds. Lack of financing for operations threatens the sustainability of investments. The compost market is limited due to high operation costs, low tipping fee of the State and low selling price of compost, in addition to farmers preference of using chemical rather than organic fertilizers. There is lack of financial resource for investment in GHG reduction projects in the waste sector. There is lack of attention on the part of authorities and community on reducing household waste generation. Furthermore, there is lack of coordination between stakeholders, resulting in gaps for effective enforcement of regulations. Local institutions are limited by staff skills. Therefore, there is lack of design and implementation of projects. There is lack of capacity to absorb informal sector into the formal waste value chain. Awareness of environment protection of waste generators is still limited.

Industrial Waste including Hazardous Waste

Gap analysis has been carried out based on waste management and technology profile, policy, regulatory and institutional profile for each country for industrial and hazardous waste stream. These gaps have been assessed at policy, programme, plan/strategy and project level based on the country reports/presentations in the response to goals identified at UNCRD's 3R Forum.



Goals		Countries									
		Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
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 by applying environmental standards, clean technologies, and cleaner production.	Relevance										
	Policies	Red	Red	Blue	Red	Blue	Blue	Blue	Blue	Blue	Blue
	Programme	Red	Blue	Blue	Red	Blue	Blue	Blue	Blue	Blue	Blue
	Plan/Strategy	Red	Red	Blue	Red	Red	Blue	Blue	Blue	Blue	Blue
	Projects	Red	Blue	Blue	Red	Blue	Blue	Blue	Blue	Blue	Red
Promote the greening of the value chain by encouraging industries and associated suppliers and vendors in socially responsible and inclusive ways.	Relevance	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	Policies	Red	Red	Blue	Red	Blue	Blue	Blue	Blue	Blue	Blue
	Programme	Red	Blue	Blue	Red	Red	Blue	Blue	Blue	Blue	Red
	Plan/Strategy	Red	Red	Red	Red	Red	Red	Blue	Blue	Blue	Blue
	Projects	Red	Green	Red	Red	Red	Blue	Blue	Blue	Red	Red
Promote industrial symbiosis (i.e., recycling of waste from one industry as a resource for another), by providing relevant incentives and support.	Relevance	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	Policies	Red	Red	Blue	Red	Blue	Blue	Blue	Blue	Blue	Blue
	Programme	Red	Blue	Blue	Red	Red	Blue	Blue	Blue	Blue	Red
	Plan/Strategy	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	Projects	Red	Red	Blue	Red	Red	Red	Red	Blue	Blue	Blue
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.	Relevance	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	Policies	Red	Red	Blue	Red	Blue	Blue	Blue	Blue	Blue	Blue
	Programme	Red	Blue	Blue	Red	Red	Blue	Blue	Blue	Blue	Red
	Plan/Strategy	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	Projects	Red	Red	Blue	Red	Red	Red	Red	Blue	Blue	Blue
Develop proper classification and inventory of hazardous waste as a prerequisite towards sound management of such waste.	Relevance	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	Policies	Blue	Red	Red	Red	Red	Red	Red	Red	Red	Red
	Programme	Blue	Red	Red	Red	Red	Red	Red	Red	Red	Red
	Plan/Strategy	Blue	Red	Red	Red	Red	Red	Red	Red	Red	Red
	Projects	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red

Yes

Partial

No

Design Stage

Pilot Level

Pilot Projects

Under Preparation

Gap analysis indicates that Lao PDR has the highest number of gaps followed by Brunei Darussalam, Cambodia, Viet Nam, Malaysia, Myanmar, The Philippines, Indonesia and Thailand. Summary of gaps for each country is presented below.

Brunei Darussalam

Policy/Regulatory, Programme and Plan Assessment

The country lacks in comprehensive policy, programme and plan in industrial waste management, particularly resource efficiency and productivity, greening of the chain and industrial symbiosis.

Technology Assessment

Since industrial and hazardous waste has been identified as the major source of water pollution, Brunei Darussalam lacks technology and recycling infrastructure for industrial and hazardous waste management.

Institutional Assessment

Country lacks in data availability and accessibility of industrial and hazardous waste data. There has been no major initiative related to development of financial mechanism or institutional framework for developing recycling industry in the country, although examples of private sector involvement exist in treatment and disposal mechanism. Lack of knowledge and skill and lack of labor for managing industrial and hazardous waste.

Cambodia

Policy/Regulatory, Programme and Plan Assessment

Cambodia lacks in comprehensive policies and plans to address industrial and hazardous waste

Technology Assessment

Since industrial and hazardous waste has been identified as the major source of water pollution, Cambodia lacks technology for industrial and hazardous waste management. Only pilot level technology demonstration exists in the country.

Institutional Assessment

Private sector (formal and informal) is involved in collection, transportation and disposal. Cambodia does not have an organized mechanism for preparation of industrial, hazardous waste stream inventory data. Country lacks in data availability and accessibility. Only private sector (formal) is, in a very limited manner, involved at pilot project level. Private sector (informal) is, in a major way, involved in collection, transportation and disposal. Country lacks in data and information and accessibility to existing data. There is a lack of knowledge and skill in design, implementation and monitoring of programme, plan/strategy and projects. There has been no major initiative related to development of financial mechanism or institutional framework for developing recycling industry in the country, although examples of formal sector involvement exist in collection mechanism in Phnom Penh. Cost of investment is high and the project support is limited. Awareness and behavior of people related to the concept of sustainable cities/green cities by encouraging zero waste are limited. Lack of human and financial resources

Indonesia

Policy/Regulatory, Programme and Plan Assessment

Indonesia has legal and regulatory framework in the area of hazardous waste and it is administered mainly by the Ministry of Environment. However, there is a lack of coordination with other departments and agencies, insufficient regulatory capacity and a lack of infrastructure, which hinder the effective implementation of existing laws/regulations.

Technology Assessment

In Indonesia, although the country has strong treatment and disposal facilities, 100% of hazardous waste is not treated and disposed. This is in reference to industrial and hazardous waste related to SMEs. So there is lack of industrial and hazardous waste handling and lack in treatment facilities. There is lack of knowhow for 3R implementation in the country. Imbalance on the demand and supply of raw material and products exists in the country.

Institutional Assessment

Though Indonesia has a policy, regulation, programme and plan for an organized mechanism for preparation of industrial and hazardous waste stream inventory data, it lacks in data availability and accessibility. Ministry of Environment/National regulator is responsible for pollution related policies, programmes, plans, regulations and standards, monitoring and control. The private sector (formal and informal) is involved in collection, transportation and disposal. There is a considerable lack of funding at the regulatory level, causing insufficient monitoring, controlling and enforcement of hazardous waste treatment and disposal. There is also lack of knowledge and skill at all levels. At industrial level, cost of investment is high and the project support is limited. Therefore, there is lack of human and financial resources. For example lack of finances for replacement/modification of machinery or equipment to increase the efficiency of energy and raw material. Awareness and behavior of people related to the concept of sustainable cities/green cities by encouraging zero waste are limited.

Lao PDR

Policy/Regulatory, Programme and Plan Assessment

Lao PDR lacks in comprehensive policy and plan to address industrial and hazardous waste. Specific regulations related to industrial and hazardous waste are absent.

Technology Assessment

Since industrial and hazardous waste has been identified as the major source of water pollution, Lao PDR lacks technology for industrial and hazardous waste management. It needs a separate system for reception, storage and disposal of hazardous waste. Therefore, suboptimal disposal sites for industrial and hazardous waste are chosen, creating an environmental and/or public health hazard.

Institutional Assessment

The main agency responsible for the environment is Ministry of Natural Resources and Environment (MONRE). While this ministry, as a focal point, is involved in the preparation of environmental laws and regulations, it is not directly involved in waste management like in many other countries. Private sector (formal and informal) is involved in collection, transportation and disposal. Lao PDR does not have an organized mechanism for preparation of industrial, hazardous waste stream inventory data. Country lacks in data availability and accessibility. There is lack of knowledge, skill and coordination between agencies. Although Lao PDR is a signatory of international agreements such as the Basel and Stockholm Conventions, the country lacks adequate capacity to discover, monitor and address breaches due to lack of information and coordination. There has been no major initiative related to development of financial mechanism or institutional framework for developing recycling industry in the country although examples of formal sector involvement exist at pilot level. Awareness and behavior of people, related to the concept of sustainable cities/green cities by encouraging zero waste are limited. There is lack of human and financial resources.

Malaysia

Policy/Regulatory, Programme and Plan Assessment

Malaysia lacks an integrated waste management plan to address industrial and hazardous waste along with other waste streams.

Technology Assessment

Malaysia lacks high-end technology for 3R implementation for industrial and hazardous waste management.

Institutional Assessment

There is lack of project development in the absence of integrated strategy and plans. Institutional and financial mechanism or institutional frameworks for developing recycling industry with private sector participation e.g. PPP need to be evolved in the country. Cost of

investment is high and the project support is limited.
Lack of human and financial resources

Myanmar

Policy/Regulatory, Programme and Plan Assessment

Myanmar has policy and programme but lacks in plan/strategy to address industrial and hazardous waste in a comprehensive manner.

Technology Assessment

Since industrial and hazardous waste has been identified as the major source of pollution, Myanmar lacks advanced and appropriate technology for industrial and hazardous waste management. Only pilot level technology demonstration exists in the country.

Institutional Assessment

Ministry of Environment Conservation and Forest is responsible for pollution related policies, programmes, plans, regulations and standards. Private sector (formal and informal) is involved in collection, transportation and disposal. All the stakeholders lack capacity to develop and implement regulations. Myanmar does not have an organized mechanism for preparation of industrial, hazardous waste stream inventory data. Country lacks in data availability and accessibility. The country lacks in knowledge, skill, technology and finances. There has been limited initiative related to development of financial mechanism or institutional framework for developing recycling industry in the country; though some incentives are being introduced for industrial symbiosis. Cost of investment is high and the project support is limited. Awareness and behavior of people related to the concept of sustainable cities/green cities by encouraging zero waste are limited.

The Philippines

Policy/Regulatory, Programme and Plan Gap Assessment

Lacks integrated approach for industrial waste management considering all types of hazardous waste streams. Enforcement capacity needs strengthening. Legislation also requires updating to reflect emerging waste management issues.

Technology Gap Assessment

The Philippines lacks technology for addressing all types of industrial and hazardous waste management. Pilot level technology demonstration existing in the country, needs to be scaled up and replicated. The technical capacity in managing hazardous waste in the Philippines could be much improved.

Institutional Gap Assessment

Limited technical and financial capacity of the regulator to ensure compliance and monitoring across the entire country. There is limited technological and financial capacity of domestic industries that can receive recyclables as raw materials and their outflow to international big market such as China. There is lack of industrial symbiosis at a plan/strategy and project level. Overall there is lack of knowledge, skill, human and financial resources of different stakeholders in the waste value chain.

Singapore

Policy/Regulatory, Programme and Plan Assessment

Singapore imports most of the products, which poses a challenge to influence the supply chain.

Technology Assessment

Timing the opportunity to co-locate complementary activities is another challenge.

Institutional Assessment

Efforts are needed to help companies understand the benefits of being green. Availability of land is a challenge in Singapore, given many competing demands.

Thailand

Policy/Regulatory, Programme and Plan Assessment

Emerging policy regime, particularly green procurement and greening of the value chain needs to be implemented through development of projects. Simplification of documentation related to export and import (with language issues due to non usage of English by some countries) to control transboundary movement.

Technology Assessment

There is lack of finances for changing technology for pollution prevention and pollution control. Need to change conventional waste disposal using new technologies leading to zero discharge.

Institutional Assessment

Pilot level projects on waste exchange need to be replicated and scaled up. There is lack of experts/technical skills. Need for overall capacity building of different stakeholders involved in hazardous and industrial waste management. Need for greater coordination between stakeholders e.g. Ministry of Industry, Customs Department and Ministry of Environment.

Viet Nam

Policy/Regulatory, Programme and Plan Assessment

Viet Nam lacks in comprehensive coverage of different elements like industrial symbiosis and greening of value chain in policy and regulations to address industrial and hazardous waste. As a result, plans, programmes and projects are partial in nature and need to be evolved.

Technology Assessment

Most of heavy industries have obsolete and low-end technologies. There is a lack of usage of advanced technologies and processing equipment for hazardous waste, resulting in ineffective and unsafe treatment and disposal of waste. Many types of hazardous waste are not treated properly. Due to lack of technology discarding industrial waste together with domestic waste or even hazardous waste still occurs in Viet Nam.

Institutional Assessment

There is no updated published inventory of industrial and hazardous waste. Country has limited data and information on inventory. Lack of capacity of monitoring agencies like custom officers and environment police to quickly identify hazardous waste. Further, variation in constraint of human resources at monitoring agencies exists. Most of the household hazardous wastes are not separated at source, but are collected and transported together with non-hazardous waste to the landfill. The informal recycling sector, which includes waste-pickers and scavengers in Viet Nam, plays a significant role in waste management activities. At the open and controlled dumps, there are no operational procedures in place and thus, many waste pickers go there to sort through the trash for recyclables. Awareness of stakeholders in environmental protection is still limited. Furthermore, there is lack of knowledge and skill to collect, treat and dispose hazardous waste. There has been no major initiative related to development of financial mechanism or institutional framework for developing recycling industry in the country. Cost of investment is high and the project support is limited. Awareness related to the concept of sustainable cities/green cities by encouraging zero waste is limited. Overall, there is a lack of human and financial resources.

Emerging Waste Streams (Plastic, Healthcare and E-waste)

Gap analysis has been carried out based on waste management and technology profile, policy, regulatory and institutional profile for each country for emerging waste streams. These gaps have been assessed at policy, programme, plan/strategy and project level, based on the country reports/presentations in the response to goals identified at UNCRD's 3R forum.



Goals	Countries									
	Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
Strengthen regional, national, and local efforts to address the issue of waste, in particular plastics in the marine and coastal environment.	Relevance									
	Policies									
	Programme									
	Plan/Strategy									
	Projects									
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.	Relevance									
	Policies									
	Programme									
	Plan/Strategy									
	Projects									
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.	Relevance									
	Policies									
	Programme									
	Plan/Strategy									
	Projects									
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.	Relevance									
	Policies									
	Programme									
	Plan/Strategy									
	Projects									
 Yes Partial No Design Stage Pilot Level Pilot Projects Under Preparation Rules Regulation Draft Stage Under Review										

Goals		Countries									
		Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
Promote the 3R concept in health-care waste management.	Relevance	Red	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	Policies	Red	Red	Blue	Blue	Blue	Green	Blue	Blue	Blue	Blue
	Programme	Red	Red	Red	Red	Red	Red	Blue	Blue	Blue	Red
	Plan/Strategy	Red	Red	Red	Red	Red	Red	Blue	Blue	Blue	Red
	Projects	Red	Red	Red	Blue	Blue	Red	Blue	Blue	Red	Red
Improve resource efficiency and resource productivity by greening jobs nation-wide in all economic and development sectors	Relevance	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	Policies	Red	Red	Red	Red	Red	Red	Red	Red	Blue	Blue
	Programme	Red	Red	Red	Blue	Red	Red	Blue	Blue	Blue	Blue
	Plan/Strategy	Red	Red	Red	Blue	Red	Red	Red	Red	Blue	Red
	Projects	Red	Red	Red	Red	Red	Red	Blue	Blue	Blue	Red
Maximize co-benefits from waste management technologies for local air, water, oceans, and soil pollution and global climate change.	Relevance	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue
	Policies	Blue	Red	Red	Red	Red	Red	Red	Red	Blue	Blue
	Programme	Red	Red	Red	Red	Red	Red	Red	Red	Blue	Blue
	Plan/Strategy	Red	Red	Red	Red	Red	Red	Blue	Blue	Blue	Blue
	Projects	Red	Blue	Red	Red	Red	Red	Blue	Blue	Blue	Red
Yes Partial No Design Stage Pilot Level Pilot Projects Under Preparation Rules Regulation Draft Stage Under Review											

Except for Singapore, all the countries have major gaps related to emerging waste stream. Summary of gaps for all the countries is presented below.

Brunei Darussalam

Policy/Regulatory, Programme and Plan

Brunei Darussalam has embarked on a written comprehensive/ holistic/integrated policy/regulation, and plan/strategy addressing plastic waste. Brunei Darussalam is in the process of framing regulation, programme, plan and project specifically for E-waste management.

Technology Assessment

Brunei Darussalam lacks in technology for treatment and disposal of E-waste. Also it lacks technology for treatment of plastic waste, although a disposal facility exists in the country.

Institutional Assessment

Lack of institutional mechanism for emerging waste stream. Lack of human/capacity for emerging waste streams. Only limited awareness of stakeholders in managing emerging waste streams.

Cambodia

Policy/Regulatory, Programme and Plan

Cambodia has a policy/regulation, "sub-decree on Solid Waste Management" addressing plastic waste, but plan/strategy and projects are at design stage. Cambodia has no regulation, programme, plan and project specifically for E-waste. E-waste regulation plan/strategy and projects are at design/development stage. Cambodia has no policy/regulation on health care waste.

Technology Assessment

Cambodia lacks in technology for all the three types of emerging waste streams management.

Institutional Assessment

There is a lack in human and financial resources.

Indonesia

Policy/Regulatory, Programme and Plan

Indonesia has a policy/regulation, "under Solid Waste Management" addressing plastic waste. Country does not specifically cover plastic waste by a separate regulation. Indonesia has no specific regulation, programme, plan and project specifically for e-waste, as E-waste plan/strategy and projects are at design/development stage. It is being covered under a 10 year roadmap for EPR implementation. Indonesia has no specific policy/regulation on health care waste, as it is covered under hazardous waste management rules. As with other waste streams, coordination between mandated departments leaves room for improvement.

Technology Assessment

Indonesia lacks in technology for all the three types of emerging waste streams management. While 20% of the hospitals use their own incinerators, the majority of waste is dumped in landfills or in illegal dumping hotspots together with MSW.

Institutional Assessment

There is lack of human and financial resources. There is lack of awareness and knowledge base.

Lao PDR

Policy/Regulatory, Programme and Plan

Although the methods of disposal of waste plastics are regulated by law in the country, the enforcement of these laws could be improved. Lao PDR has no regulation, programme, plan and project specifically for E-waste. There are currently general policies, but not specific and well-enforced regulations, on healthcare waste management in Lao PDR.

Technology Assessment

Lao PDR lacks in technology for all the three types of emerging waste streams management

Institutional Assessment

Lack of knowledge, skill and strategy e.g. institutions often cannot monitor e-waste, technical understanding and available equipment for the healthcare waste

stream is also poor. Consequently, waste generators and responsible institutions sometimes select inappropriate hazardous waste disposal sites, posing a risk to the environment or public health. There is a lack of human and financial resources.

Malaysia

Policy/Regulatory, Programme and Plan

Malaysia is at the design stage of an EPR-based policy and regulatory regime. Lack of EPR based projects.

Technology Assessment

Malaysia needs to augment its recycling infrastructure in target waste streams, based on existing EPR regulations.

Institutional Assessment

Informal sector participation exists for household E-waste collection and disposal. Malaysia does not have an institutional mechanism to cater to future EPR based regulations. Lacks capacity to implement EPR based institutional mechanism. There is lack of human and financial resources for implementing interventions. There is lack of public awareness of the hazards of mismanaged healthcare waste. There is thus potential for capacity-building in creating public awareness of the issue.

Myanmar

Policy/Regulatory, Programme and Plan

Myanmar has no policy/regulation, plan (except for health care waste) for emerging waste stream. Pilot projects are only at design stage.

Technology Assessment

Myanmar lacks in technology for all the three types of emerging waste streams management.

Institutional Assessment

There is a lack of human and financial resources.

The Philippines

Policy/Regulatory, Programme and Plan

The Philippines has a policy/regulation and projects addressing plastic waste but a plan/strategy and programme are partially addressed. In the Philippines, the management of waste plastics is addressed by the Ecological Solid Waste Management Act. Waste plastics are classified as recyclable material and are readily-combustible. The country lacks in policies, programmes and projects related to E-waste management. Though it is covered under hazardous waste rules, it lacks EPR-based regulation. Healthcare waste is covered under hazardous waste rules and rules related to air pollution.

Technology Assessment

The Philippines lacks in technology for all the three types of emerging waste streams management e.g. it needs safe non-combustible technologies for treatment and disposal of healthcare waste.

Institutional Assessment

In the Philippines, institutional and financial capacity, including human and technical resources in the management of emerging waste streams requires strengthening at national, regional and local level. Lack of 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. There are no clear national guidelines on how to implement recycling or waste prevention. Standards therefore vary between municipalities and districts/wards e.g. while some local governments have banned the use of Styrofoam as packaging material, others lack an understanding of the environmental damage caused by waste plastics.

Singapore

Policy/Regulatory, Programme and Plan

Singapore does not have an EPR-based regulation for E-waste management. E-waste management framework is yet to be developed.

Technology Assessment

Land/space constraint exists for establishing E-waste recycling facility.

Institutional Assessment

Institutional mechanism for E-waste management is yet to evolve.

Thailand

Policy/Regulatory, Programme and Plan

Draft policies, regulations and plans/strategies need to be approved for implementation e.g. EPR-based regulations. Programmes and projects need to be developed. New financial instruments need to be developed to support EPR.

Technology Assessment

Plastic recycling and recovery rate needs to be enhanced through technology intervention. Healthcare waste lacks treatment and disposal technologies, which can meet emission standards. E-waste collection and recycling system needs technology intervention for establishing EPR mechanisms. There is lack of incentive and technology development on alternative materials. Updated data on E-waste inventory and recovery by informal collectors and recycling is lacking.

Institutional Assessment

An EPR-based mechanism need to be designed and implemented for E-waste. Coordination mechanism needs to be augmented between different stakeholders for emerging waste streams. There is lack of human and financial resources. Monitoring and reporting needs to be strengthened. Related authorities have limitations on skill and tools for hazardous waste analysis. Major gaps exist on public awareness of E-wastes

issues. There is a limited number of licences issued to recyclers and collection centres (including those provided by municipalities) that inhibit institutional capacity.

Viet Nam

Policy/Regulatory, Programme and Plan

There is no specific regulation on E-waste. EPR based regulatory mechanism is yet to evolve. Law on Environment Protection 2014 does not allow import of waste, but import of certain regulated types of scrap is allowed. Circular to guide implementation of the Decision No. 16/2015/QD-TTg is yet to be approved. Issues related to plastic waste stream and resource efficiency are addressed partially. Furthermore, programme plan/strategy and projects are yet to evolve.

Technology Assessment

Currently, E-waste is taken to second hand shops for re-use and reselling to junk collectors. Facilities of recycling and treatment after collecting them back are inadequate, especially for medium-to-small-scale electronic E-waste generators. Therefore, there is lack of a formal, large-scale E-waste recycling industry in the country. Most hazardous healthcare and industrial waste is mixed with general waste during collection. Therefore, a segregation mechanism needs to be improved in the country.

Institutional Assessment

There is lack of updated inventory of E-waste and healthcare waste. The country lacks 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. There is a lack of institutional capacity and mechanism to implement EPR. No mechanism of establishing network for collecting back discarded products under EPR exists. Furthermore, there is a lack of financial resources for building up waste treatment facilities for medical waste and E-waste. The current growth model is based partly on the intensive use of

natural resources with the large intensity of resource use (e.g. water, energy). Community awareness of environmental protection, especially on plastic waste, is still limited.

SWOT analysis indicates: the major strengths of the ASEAN are economic growth, resilient economy, natural resource base, basic policy and regulatory framework for growth/sustainable development and poverty reduction. Major weaknesses include gaps in policy/regulatory, programme and plan, recycling/treatment and disposal infrastructure and institutional mechanism. ASEAN countries offer significant opportunity in all aspect of waste management based on 3Rs across the value chain. In the absence of interventions, ASEAN countries face the threat of fast depletion of natural capital, green growth and sustainable development.*

*Green growth is a key strategy for achieving sustainable development as well as the Millennium Development goals. In April 2010, the Association of Southeast Asian Nations (ASEAN) summit in Hanoi adopted the ASEAN Leaders' Statement on Sustained Recovery and Development, which highlighted the leaders' determination to promote green growth,

including investments in long-term environmental sustainability and sustainable use of natural resources in order to diversify and ensure economic resilience. At least 13 separate definitions for green growth were identified in recent publications. This includes definitions by key international actors involved in green growth work:

UNESCAP: growth that emphasizes environmentally friendly resources and environmental services on which our well being relies.

World Bank: growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters.

GGGI: green growth is the new revolutionary development paradigm that sustains economic growth while at the same time ensuring climatic and environmental sustainability. It focuses on addressing the root causes of these challenges while ensuring the creation of the necessary channels for resource distribution and access to basic commodities for the impoverished.

03

Recommendation

ASEAN has embarked to achieve economic integration as a single economic community based on the four pillars identified in AEC 2015. In this regard, it has formulated the ASEAN Economic Community Blueprint 2025 and ASEAN Socio-culture Community Blueprint 2025. Major characteristics and strategic measures to achieve economic integration as well as sustainable development in these two blueprints are described below.

ASEAN Economic Community Blueprint 2025 states: "ASEAN Economic Community by 2025 shall be highly integrated and cohesive; competitive, innovative and dynamic; with enhanced connectivity and sectoral cooperation; and a more resilient, inclusive, and people-oriented, people-centered community, integrated with the global economy". **Sustainable economic development is one of the elements of this blue print.** It states: ASEAN recognises the importance of sustainable economic development as an integral part of the region's growth strategy. Protection of the environment and natural resources supports economic growth and vice versa. ASEAN would actively promote green development by developing a sustainable growth agenda that promotes the use of clean energy and related technologies, including renewable energy through green technology, as well as enhances sustainable consumption and production, and including it in national development plans. It aims to achieve sustainable development through the following strategic measures:

1. Foster policies supportive of renewable energy and set collective targets accordingly;
2. Develop a framework to support the deployment and utilization of efficient and low carbon technologies, and call for international support to ensure ASEAN access to mechanisms that foster low carbon technologies more affordably;

3. Promote the use of bio-fuels for transportation. This includes ensuring free trade in bio-fuels within the region and investment in R&D on third generation bio-fuels;
4. Enhance connectivity within ASEAN, including through multilateral electricity trade under the framework of the ASEAN Power Grid (APG) and greater liquefied natural gas (LNG) cooperation under the Trans-ASEAN Gas Pipeline (TAGP);
5. Identify infrastructure investment requirements to increase production and reduce post-production losses to meet projected future demand and ensure food security, review existing investment programmes and address investment needs in the food and agricultural sectors;
6. Develop new and appropriate technologies, best practices and management systems to ensure food safety and address health/ disease and environmental issues, particularly in the fast growing aquaculture, livestock and horticulture sub-sectors;
7. Promote good agriculture practices to minimise the negative effects on natural resources such as soil, forest and water, and reduce the greenhouse gas emission; and
8. Promote forest management, involving the community living within and surrounding the forest for the sustainability of the forest and prosperity of the people.

ASEAN Socio-Cultural Community (ASCC) Blueprint 2025 states: "ASEAN Socio-Cultural Community by 2025 shall be one that engages and benefits the peoples, and is inclusive, sustainable, resilient, and dynamic". The meaning and intent of "sustainable and resilient" have been described below.

- I. A sustainable community that promotes social development and environmental protection through effective mechanisms to meet the current and future needs of peoples;
2. A resilient community with enhanced capacity and capability to adapt and respond to social and economic vulnerabilities, disasters, climate change as well as emerging threats and challenges; and

ASCC identifies the key result areas and corresponding strategic measures as follows:

I. Conservation and Sustainable Management of Biodiversity and Natural Resources

Strategic Measures:

- I. Strengthen regional cooperation to protect, restore and promote sustainable use of terrestrial ecosystems resources, combat desertification, halt biodiversity loss, and halt and reverse land degradation;
2. Strengthen regional cooperation on sustainable forest management in the context of forest fire prevention and control, including through the implementation of the ASEAN Agreement on Transboundary Haze Pollution, to effectively address transboundary haze pollution;
3. Promote cooperation for the protection, restoration and sustainable use of coastal and marine environment, respond and deal with the risk of pollution and threats to marine ecosystem and coastal environment, in particular in respect of ecologically sensitive areas;
4. Adopt good management practices and strengthen policies to address the impact of development projects on coastal and international waters and transboundary environmental issues, including pollution, illegal movement and disposal of hazardous substances and waste, and in doing so, utilise existing regional and international institutions and agreements;

5. Enhance policy and capacity development and best practices to conserve, develop and sustainably manage marine, wetlands, peatlands, biodiversity, and land and water resources;
6. Promote capacity building in a continuous effort to have sustainable management of ecosystems and natural resources;
7. Promote cooperation on environmental management towards sustainable use of ecosystems and natural resources through environmental education, community engagement and public outreach;
8. Strengthen global and regional partnerships and support the implementation of relevant international agreements and frameworks;
9. Promote the role of the ASEAN Centre for Biodiversity as the centre of excellence in conservation and sustainable use of biodiversity; and x. Support the full implementation of the Strategic Plan for Biodiversity 2011-2020 and the Aichi Targets.

2. Environmentally Sustainable Cities

Strategic Measures

- I. Enhance participatory and integrated approaches in urban planning and management for sustainable urbanisation towards a clean and green ASEAN;
2. Strengthen the capacity of national and local institutions to implement strategies and programmes towards liveable cities;
3. Promote coordination among relevant sectors to provide access to clean land, green public space, clean air, clean and safe water, and sanitation;
4. Promote cities that are child-, youth-, the elderly- older persons, and persons with disabilities-friendly through enhanced coordination with

relevant sectors to provide sustainable and accessible infrastructure systems;

5. Strengthen positive economic, social and environmental linkages among urban, peri-urban and rural areas; and
6. Strengthen policies and strategies for the effective impact management of population growth and migration on cities.

3. Sustainable Climate

Strategic Measures:

- I. Strengthen human and institutional capacity in implementing climate change adaptation and mitigation, especially on vulnerable and marginalised communities;
2. Facilitate the development of comprehensive and coherent responses to climate change challenges, such as but not limited to multi-stakeholder and multi-sectoral approaches;
3. Leverage on private sector and community to have access to new and innovative financing mechanisms to address climate change;
4. Strengthen the capacity of sectoral institutions and local governments in conducting Greenhouse Gas (GHG) inventory, and vulnerability assessments and adaptation needs;
5. Strengthen the effort of government, private sector and community in reducing GHG emission from main activities of development;
6. Mainstream climate change risk management and GHG emission reduction on sectoral planning; and
7. Strengthen global partnerships and support the implementation of relevant international agreements and frameworks, e.g. the United Nations Framework Convention on Climate Change (UNFCCC).

4. Sustainable Consumption and Production

Strategic Measures

1. Strengthen public-private partnerships to promote the adoption of environmentally-sound technologies for maximising resource efficiency;
2. Promote environmental education (including eco-school practice), awareness, and capacity to adopt sustainable consumption and green lifestyle at all levels;
3. Enhance capacity of relevant stakeholders to implement sound waste management and energy efficiency; and
4. Promote the integration of Sustainable Consumption and Production strategy and best practices into national and regional policies or as part of CSR activities.

Furthermore, **Declaration on ASEAN Post-2015 Environmental Sustainability and Climate Change Agenda** released on the occasion of the 27th ASEAN Summit held in Kuala Lumpur, Malaysia, on 21st November 2015, states: **Taking cognizance** of ASEAN's obligations to its people in ensuring environmental sustainability for our region and to achieve sustainable development; **Affirming** commitment to strengthen international cooperation to move the sustainable development agenda forward through the achievement of the internationally agreed development goals, including the Post-2015 development agenda and the Sustainable Development Goals (SDG); **Noting** growing urbanization increases the need for sustainable environmental management; **Recognizing** the need to take an integrated and holistic framework for strategic decision-making in the face of global change to effectively address the challenges of environmental issues in this region including global warming, transboundary pollution, limited safe water supply, biodiversity loss, **chemicals and waste**, and coastal environmental degradation;

Declare their Commitment to:

1. Continue its efforts to establish a balance among economic growth, social development and environmental sustainability as well as to strengthen ASEAN's commitments for the realization of the Post 2015 Development Agenda and the attainment of the Sustainable Development Goals (SDGs);
2. Continue to implement the action lines on environmental sustainability in the ASEAN Socio-Cultural Community Blueprint in an effective and timely manner towards a clean and green ASEAN Community, while streamlining our efforts to ensure the achievement of the ASEAN Community Post-2015 Vision and ASCC Blueprint goals, key results areas, and corresponding strategic measures through the adoption and implementation of sub-sectoral action plans;
3. Achieve, by 2020, the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks and agreements, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment in the ASEAN region;
4. Incorporate environmental education (EE) and education for sustainable development (ESD) in the curricula, materials and resources; and the promotion of public awareness on the importance of sustainable development and environmentally sustainable practices;
5. Strengthen implementation of the ASEAN Environmental Education Action Plan (AEEAP) 2014-2018 to enhance public awareness on environmental management for sustainable development and accelerate the development and advancement of environmental education as a key integrating component for achieving sustainable development in the region;

6. Mobilize financial support and cooperate to build capacity for ASEAN Member States in achieving environmentally sustainability and climate resilience; and to develop a sustainable plan to streamline funding and maximize contributions towards effectively addressing the environment and climate change issues at both national and regional levels;
7. Encourage the exchange of scientific and technical expertise in partnership with regional and global experts, and enhance cooperation towards joint research and development of appropriate measures to minimize the impact of environmental degradation and climate change; and pool its experiences, expertise and technology in areas such as urban planning including green cities, climate change and water-related disaster resilience, water resources management, biodiversity conservation, chemicals and waste management, and transboundary pollution control;

Report of the ASEAN Regional Assessment of MDG Achievement and Post-2015 Development Priorities indicates the following way forward.

- ASEAN intends to take the agenda of MDGs forward and include new challenges and opportunities. Policy coordination and coherence is at the center of the agenda.
- Member countries have synergies between different policy areas e.g. skills help secure better employment which helps reduce poverty, **balanced urban growth helps balance environmental concerns**, and better water management improves health and nutrition. Therefore, ASEAN is focused on promoting and facilitating active regional collaboration around important policy issues to achieve MDGs.
- **Identifying good practices and setting regional norms.** ASEAN can establish the principle of results-driven and results based policy, focusing on identifying good and innovative approaches, and evaluating their effectiveness.

- **Promoting peer-to-peer exchanges.** Countries with different development challenges in the aggregate may nonetheless identify common areas of policy interests.
- **Improving monitoring frameworks.** ASEAN should have the mandate to develop a solid monitoring and evaluation framework.
- **Enhancing statistical capacity.** In particular, ASEAN could complement international efforts at measuring and harmonizing data, especially by focusing more on disaggregated indicators.

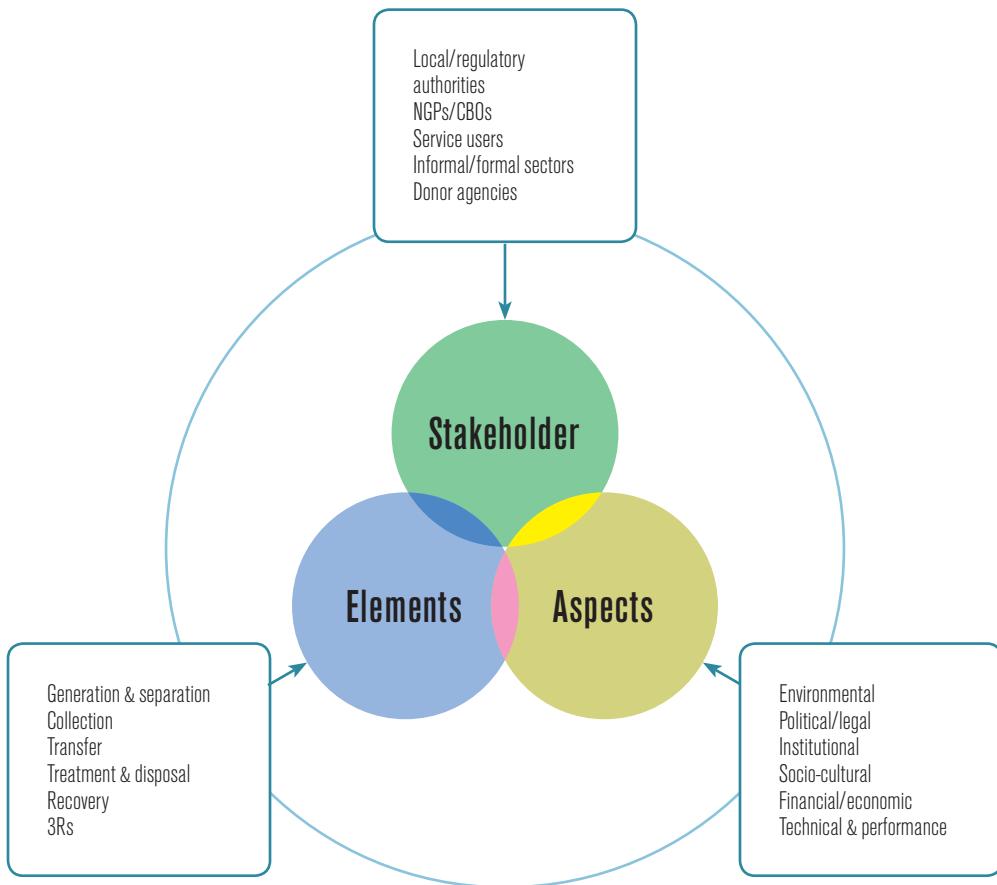
In order to achieve a robust economic integration with a least threat of depleting natural capital and overarching goal of green growth and sustainable development, ASEAN countries need to overcome weakness/ barriers at policy and regulatory, technology (recycling/treatment and disposal infrastructure) and institutional (mainly governance) level using programmatic, strategy and project based approaches in **waste management across the complete waste value chain**. The above mentioned blueprints with characteristics, elements strategic measures and way forward provide a framework for formulation of recommendation of “what” and “how” ASEAN countries can achieve better waste management in the region.

Under the broad framework mentioned above, one of the common approaches used globally is Integrated Sustainable Waste Management Framework (ISWM), applicable in a regional, national and local setting. The three major dimensions of ISWM framework is shown in Figure 12 and summarized in Table 11.

The waste management sector also follows a generally accepted waste hierarchy as shown in Figure 13. The hierarchy started as the ‘three Rs’ reduce, reuse, recycle but now a fourth R, for “Recovery”, is frequently added. The hierarchy responds to financial, environmental, social and management considerations as part of “Elements” (process) shown in Figure 12.

Figure 12

ISWM Framework



Source: A Global Review of Solid Waste Management; March 2012, No. 15 (Box No. 4)

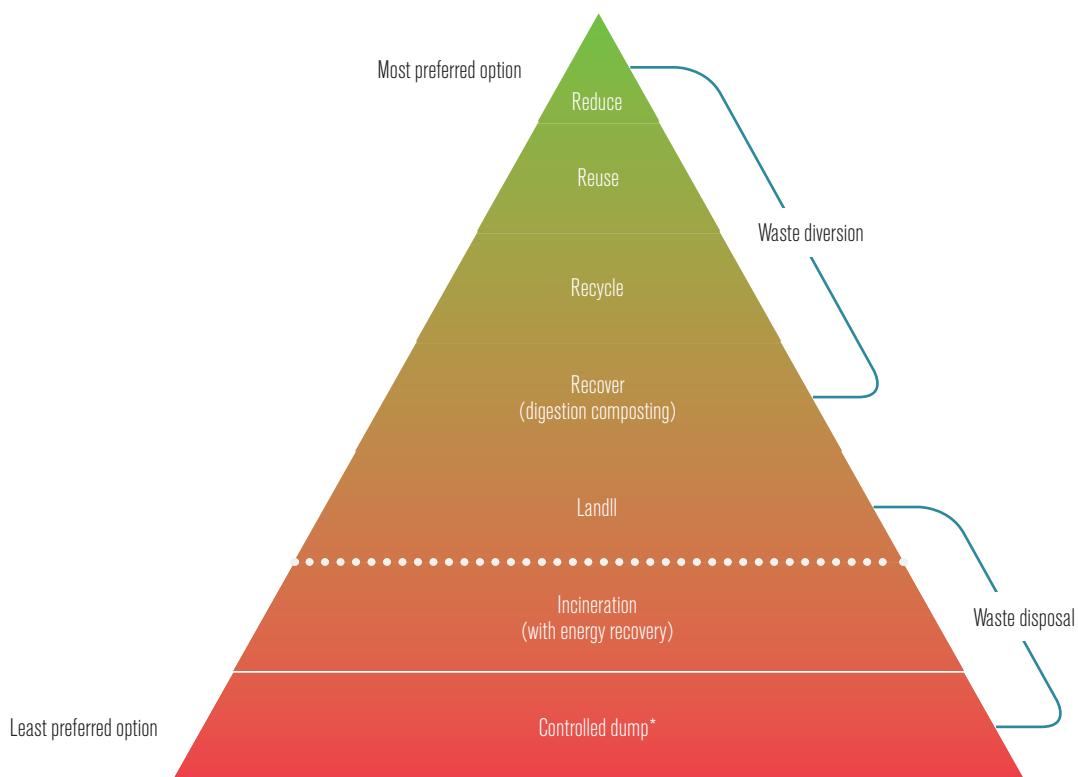
Table 11 Dimensions of ISWM Framework

Policy Dimensions/ Framework	Components (coverage)
Stakeholders:	Includes individuals or groups that have an interest or role. All stakeholders should be identified and where practical involved in creating a SWM programme (Local/Regulatory Authorities, NGOs/CBOs, Service Users, Informal/Formal Sector, Donor Agencies).
Elements (Process)	Includes the technical aspects of solid waste management. All stakeholders impact one or more of the elements. The elements need to be considered simultaneously when creating an SWM programme in order to have an efficient and effective system (Generation and Separation, Collection, Transfer, Treatment and Disposal, Recovery and 3Rs).
Aspects (Policies and Impacts):	Encompass the regulatory, environmental and financial realities in which the waste management system operates. Specific aspects can be changeable, e.g. a community increases influence or environmental regulations are tightened. Measures and priorities are created based on these various local, national and global aspects (Environmental, Political/Legal, Institutional, Socio-Cultural, Financial/Economic and Technical and Performance).

Source: A Global Review of Solid Waste Management; March 2012, No. 15 (Box No. 4)

Figure 13

Dimensions of ISWM Framework



Source: *A Global Review of Solid Waste Management; March 2012, No. 15*

A combination of these approaches in ASEAN will not only provide opportunities to leapfrog to the effective waste management system with the right set of harmonized policies (addressing gaps/inconsistencies/ redundancies between policies and programmes), facilitative governance (overlaps/ coordination in duties and responsibilities), technology penetration and assimilation, adequate funding, and stakeholders (socio-cultural/political) attention and participation leading to improved quality of life, resource productivity and a strong foundations to four pillars of economic integration. Some of the major recommendations are summarized below. These recommendations can be prioritized based on each countries requirements and acceptance of a common time bound programme in ASEAN.

Aspect 1: Policy and Regulatory

- Make waste management a priority issue at all levels of governance – regional (ASEAN), national, and local level (and the priority of the political and local community) through the development of a harmonized regional, national and local waste management policy framework as per 3Rs.
- Establish a link between effective waste management as a priority to facilitate the country's roadmap to address the broader development and environmental goals e.g. the relevant Sustainable Development Goals (SDG) and indicators.
- Sustain efforts to promote waste to energy as part of renewable energy mix, through various policy enablers for investment (such as preferential tariffs and fixation of its contribution in energy mix, necessitating the development and execution of

environmental standards and guidelines for thermal treatment technologies including monitoring and evaluation mechanism).

- Ensure nationwide time bound issuance (from draft stage to notification) and enforcement of subsequent harmonized 3R-based legal framework and institutional arrangement in order to enforce policy goals and strategies into action plans.
- Frame national level waste management plan/ strategy with achievable target setting on waste reduction, collection, and recycling, and translating those mandates into local/municipal waste management plans and programmes. Waste management in Singapore can serve as an example in the region, not only at a country level but also at a state or city level.
- Build ASEAN level cooperation in waste management by making “waste management” as priority integration sector (PIS) through regional targets, exchange of technology, skills and financing for the effective waste management in the region. Since financing is a major issue in the majority of countries, waste management infrastructure can fall under the ASEAN Infrastructure Fund.
- Design and implement the right combination of regulatory, economic and social instruments with incentives for strong monitoring for compliance by all relevant stakeholders.

Aspect 2: Institutional, Technical and Performance

- A clear, efficient and transparent institutional mechanism can address gaps in service delivery due to lack of coordination, overlap of duties and multi-stakeholder involvement. This will improve organizational efficiency, and inter-departmental/ agency cooperation. An example could be creation of a separate National Department to facilitate Integrated Solid Waste Management (ISWM), with clear roles and responsibilities to serve as a one-stop policy, investment, and technology transfer window. At the same time, channeling out the

budget and authority to regional/ state and local governments for decentralizing the implementation of the waste management systems.

- Adopting a cluster-based/urban agglomeration-based approach to address waste management, in case local municipalities and townships are scattered with isolated geographies and less population, through inter-municipal cooperation. This will assist to achieve the economies of scale in waste treatment and disposal infrastructures. For example, development of a regional MSW treatment and disposal facility or a secured landfill/ incineration facility for an industrial cluster.
- Encouraging, acknowledging and awarding the smart and green cities that bring innovative mechanisms to waste management and sanitation to the core of its city planning. An example of smart city competition in India can be used as a case study.
- Local governments to expand waste management services i.e. collection, treatment, and recovery services and infrastructures addressing all types of waste streams. In case a particular waste stream falls within the national jurisdiction, local government should synergize and converge their programmes, strategies and projects with national initiatives.
- Develop and invest in creating up-to-date waste statistics, which should be available to all stakeholders. This can be achieved by carrying out assessment and studies to maintain an up-to-date database on waste statistics (waste generation rate, composition, collection rate, recycling, energy recovery rates) at all levels of governments i.e. regional, national and municipal/local, and creating a clear house mechanism for dissemination of information.
- Design, develop and implement awareness and technical capacity building programmes on effective waste management systems at each level of governance. An example of Singapore can be used for such programmes in ASEAN context.

Aspect 3: Funding/Financing/Economics

- Augmenting public financing for waste management of urban local bodies through municipal reforms e.g. introducing double accounting mechanisms in municipalities tax reforms, securing an adequate and regular flow of the national budget for waste management. This can facilitate co-financing of waste management projects through matching contribution by ULBs. ULBs need to work measures for increasing the recovery of waste management service fees that is affordable to all.
- In addition, ULBs need to explore other innovative financing mechanisms like public private partnership (PPP), investment by development finance investors, application of polluters pays principle and extended producer's responsibility to strengthen the existing revenue sources from waste generators
- Government to create a favorable environment for investors to make investments in waste sector

Elements (Generation, Segregation, Collection, Transfer, Treatment and Disposal, Recovery, 3Rs)

- Set collection, mandatory segregation, and recycling targets and increase waste collection service coverage to 100%. Eliminate littering, burying, burning and open dumping of waste of municipal solid wastes and other waste streams.
- Technology penetration of 3Rs and recovery. ASEAN countries that have tried and tested, should learn from each other and facilitate technology transfer related to the 3Rs and recovery option.
- Triggering recycling market through (i) green procurement policies, (ii) guidelines for design for environment/design for recycling to encourage using recycled secondary raw materials in manufacturing processes, (iii) creating a waste exchange facility and an information portal of potential waste generators, recyclers. Countries like

Thailand, Singapore and Indonesia have experimented and replicated such initiatives. These need to be scaled up and replicated in other ASEAN countries.

Some of the ASEAN countries lack testing and monitoring technologies for industrial and hazardous waste and emerging waste streams. Promotion of environmentally safe recycling by implementing recycling (emissions) standards and labeling is required. Also, there is a need for development of testing and monitoring infrastructure in countries where it is absent.

Except for Singapore all ASEAN countries lack engineered landfill sites and rehabilitation programmers for dumpsites. Therefore, there is a need for creating an attractive business for the proper closures and restoration of the dump site by converting the space into material recovery facilities, solar capping, or landfill mining or their combination using hybrid approach.

Stakeholders

Synergizing, encouraging and ensuring the co-responsibilities among different stakeholders in waste management together with the urban local body; engaging other stakeholders such as cooperatives of independent waste pickers, community and NGO in the collection, transportation, treatment and disposal stages, wherever applicable.

Governments should strengthen current waste management policies and institutional framework through innovative awareness raising mechanisms and campaigns on information, education, and communication using digital technology/social media based citizen forums. This will assist in assessment of citizens' expectations and level of participation for achieving the desired service delivery. In ASEAN countries, Singapore has demonstrated usage of digital technology (web based) for awareness raising.

Governments should support the private sector, both formal and informal, as they are critical players in waste management through various fiscal leverages, including procurement policies supporting the market

for recycled products, tax rebates, concessions, subsidies etc.

- ASEAN countries institutional assessments indicate significant participation of informal sector in the waste management chain. Therefore, governments should develop policy framework in integration of informal waste sector through participatory and consultative process and support. This could be achieved by developing their capacities and skills to enhance their livelihood and social welfare security. Furthermore, mechanisms of public private partnership can be utilized in this integration enhancement through fulfilling of corporate social responsibility obligations of the formal private sector.

References

- Borongan, G. and Shigefumi, O. (2010). Municipal Waste Management Report, Status-quo and Issues in Southeast and East Asia Countries. AIT RRC.AP.Thailand. Available at: http://www.rrcap.ait.asia/Publications/MW_status_quo.pdf
- Baldé, C. P., Wang, F., Kuehr, R., Huisman, J. (2014). The global e-waste monitor – 2014. United Nations University, IAS – SCYCLE, Bonn, Germany. Available from: <https://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf>
- Basel Convention National Reports – Year 2014. Available from: <http://www.basel.int/Countries/NationalReporting/BaselConventionNationalReports/tabcid/4250/Default.aspx>
- Basel Convention. Country Fact Sheets. Available from: <http://www.basel.int/Countries/Countryfactsheets>
- Brunei Country Report at Sixth Regional 3R Forum in Asia and the Pacific. Available from: <http://www.uncrd.or.jp/index.php?page=view&type=13&nr=905&menu=308> (Accessed 7 August 2016)
- Brunei Darussalam, Department of Environment Parks and Recreation. Available from: <https://www.brunei.gov.bn> (Accessed 7 August 2016)
- Brunei Darussalam, Draft Environmental Order, 2012. Food and Agriculture Organization of the United Nations. Available from: <http://faolex.fao.org/> (Accessed 7 August 2016)
- Brunei Darussalam, Energy and Industry Department (2016). Brunei Darussalam's Initial National Communication; Under the United Nations Framework for Climate Change. Bandar Seri Begawan. Available from: <https://goo.gl/eNjmW7>
- Brunei Darussalam, Global Partnership on Waste Management. Available from: www.unep.org (Accessed 7 August 2016)
- Brunei Darussalam, Hazardous Waste (Control of Export, Import and Transit Order, 2013). Food and Agriculture Organization of the United Nations. Available from: <http://faolex.fao.org/docs/pdf/bru138947.pdf> (Accessed 7 August 2016)
- Brunei Darussalam, Ministry of Development. Available from: <http://www.mod.gov.bn> (Accessed 7 August 2016)
- Brunei Darussalam. The Municipal Boards Act, 1921. Food and Agriculture Organization of the United Nations. Available from: <http://faolex.fao.org/> (Accessed 7 August 2016)
- Cambodia Country Report (2014). The report was prepared as an input for the Fifth Regional 3R Forum in Asia and the Pacific, 25-27 February 2014, Surabaya, Indonesia. Available from: http://www.uncrd.or.jp/content/documents/15375-3R_Country-Report_Cambodia.pdf
- Cambodia, Global Partnership on Waste Management. Available from: www.unep.org (Accessed 7 August 2016)
- Cambodia, Ministry of Environment, Department of Environmental Pollution Control (DEPC).
- Doan, D.T. (2014). Updates of Regulation and Control Activities to Implement the Basel Convention in Viet Nam. Hazardous Waste Management Division, Waste Management and Environment Promotion Agency and Viet Nam Environment Administration. Available from: https://www.env.go.jp/en/recycle/asian_net/Annual_Workshops/2014_PDF/Day1_SI_08_Vietnam.pdf
- Environmental Quality (Scheduled Wastes) Regulations 2005. <http://folex.fao.org/docs/texts/mal72181.doc> (Accessed 7 August 2016)
- Environmental Research Institute of the Science, Technology, and Environment Agency (STEA) and World Bank (2005). Available from: <https://goo.gl/Yn7oHe> (Accessed 7 August 2016)

Food and Agriculture Organization of the United Nations (1996). Law on Environmental Protection and Natural Resource Management. Cambodia Available from: <http://faolex.fao.org/docs/texts/cam19300.doc>

Food and Agriculture Organization of the United Nations (FAO) (1996). Law on Water and Water Resources. Lao PDR. Available from: <http://faolex.fao.org/docs/pdf/lao7478.pdf> (Accessed 7 August 2016)

Food and Agriculture Organization of the United Nations (FAO) (2006). The Conservation of Water Resources and Rivers Law, Myanmar. Available from: <http://faolex.fao.org/docs/pdf/mya139027.pdf> (Accessed 7 August 2016)

Food and Agriculture Organization of the United Nations (FAO) (2004). Indonesia, Law on Water Resources. Available from: <http://faolex.fao.org/docs/texts/ins48775.doc> (Accessed 7 August 2016)

Food and Agriculture Organization of the United Nations (FAO). Available from: <http://faolex.fao.org> (Accessed 7 August 2016)

Food and Agriculture Organization of the United Nations (FAO). Brunei Darussalam, Pollution Control Guidelines for Industrial Development. Available from: <http://faolex.fao.org/> (Accessed 7 August 2016)

Food and Agriculture Organization of the United Nations (FAO). Clean Water Act of 2004, Philippines. Available from: <http://faolex.fao.org/docs/texts/phi70789.doc> (Accessed 7 August 2016)

Food and Agriculture Organization of the United Nations (FAO). Philippines, Clean Air Act of 1999. Available from: <http://faolex.fao.org/docs/texts/phi45271.doc> (Accessed 7 August 2016)

Food and Agriculture Organization of the United Nations (FAO). Public Health Act, 1992, Thailand. Available from: http://thailaws.com/law/t_laws/tlaw0223.pdf (Accessed 7 August 2016)

Food and Agriculture Organization of the United Nations (FAO). Sub-decree on Air Pollution, 1999. Cambodia. Available from: <http://faolex.fao.org/docs/texts/cam47647.doc>

Food and Agriculture Organization of the United Nations (FAO). Sub-decree on Water Pollution Control, 1999, Cambodia. Available from: <http://faolex.fao.org/docs/texts/cam47646.doc> (Accessed 7 August 2016)

Food and Agriculture Organization of the United Nations (FAO). The Environmental Conservation Law of Myanmar, 2012. Available from: <http://faolex.fao.org/docs/pdf/mya139025.pdf> (Accessed 7 August 2016)

Fourth ASEAN State of Environment Report 2009. Available from: www.environment.asian.org (Accessed 7 August 2016)

GSSD 2015. Cambodia's Second National Communication under the United Nations Framework Convention on Climate Change. General Secretariat, National Council for Sustainable Development/Ministry of Environment, Kingdom of Cambodia, Phnom Penh.

<http://data.worldbank.org/country/brunei-darussalam>

<http://www.worldbank.org/en/country/cambodia>

Indonesia Country Report. Sixth Regional 3R Forum in Asia and the Pacific. Available from: <http://www.uncrd.or.jp/index.php?page=view&type=13&nr=905&menu=308> (Accessed 7 August 2016)

Indonesia State of Environment Report, 2004. Available from: <http://www.aecen.org/> (Accessed 7 August 2016)

Indonesia, Environmental Protection and Management Act, 2009. Food and Agriculture Organization of the United Nations; Available from: <http://faolex.fao.org/docs/pdf/ins97643.pdf> (Accessed 7 August 2016)

Indonesia, Global Partnership on Waste Management. Available from: www.unep.org (Accessed 7 August 2016)

Indonesia, Ministry of Environmental and Forestry. Available from: www.indonesia.go.id (Accessed 7 August 2016)

Indonesia, the Management of the Waste of Hazardous and Toxic Materials, 1999. Government Regulation of the Republic of Indonesia, No. 18 of 1999. Available from: <http://extwprlegs1.fao.org/docs/pdf/ins36549E.pdf>

Kamil, Upik Sitti Aslia. Establishment and Notification on Hazardous Waste and Non HW, Notification on Hazardous waste and Non HW. Ministry of Environment and Forestry; Basel Forum, Korea, 3rd September, 2015

Kaosol, T. Sustainable Solutions for Municipal Solid Waste Management in Thailand. World Academy of Science, Engineering and Technology. Available from: <http://www.swm.eng.psu.ac.th/pub/pub-2009-p4.pdf>

Kojima, M. and E. Michida (2011). Economic Integration and Economic in Asia: An Interim Report. Institute of Developing Economies. Available from: http://www.ide.go.jp/English/Publish/Download/Report/2010/2010_431.html

Lao PDR Country Report. Sixth Regional 3R Forum in Asia and the Pacific. Available from: <http://www.uncrd.or.jp/index.php?page=view&type=13&nr=905&menu=308> (Accessed 7 August 2016)

Lao PDR, Global Partnership on Waste Management. Available from: www.unep.org (Accessed 7 August 2016)

Lao PDR, Industrial Waste Discharge Regulations, 1994. Food and Agriculture Organization of the United Nations. Available from: <http://faolex.fao.org/docs/pdf/lao17659.pdf> (Accessed 7 August 2016)

Lao PDR, the President (1999). Decree of the President of the Lao People's Democratic Republic on the Promulgation of the Environmental Protection Law (EPL). Vientiane, President's Office. Available from: <https://goo.gl/GxPMEI>

Malaysia Country Report. This country report was prepared as an input for the Sixth Regional 3R

Forum in Asia and the Pacific, Malé, Maldives, 17-19 August 2015. Available from: http://www.uncrd.or.jp/content/documents/27516-3R_Country-Report_Malaysia.pdf

Malaysia, Department of Environment. Available from: www.doe.gov.my (Accessed 7 August 2016)

Malaysia, Department of Water Supply. Available from: <http://www.water.gov.my/> (Accessed 7 August 2016)

Malaysia, Environment Quality (Clean Air) Regulations 1978. Food and Agriculture Organization of the United Nations. Available from: <http://faolex.fao.org/docs/texts/mal38060.doc> (Accessed 7 August 2016)

Malaysia, Environment Quality (Industrial Effluent) Regulations 2009. Food and Agriculture Organization of the United Nations Available from: <http://faolex.fao.org/docs/texts/mal102817.doc> (Accessed 7 August 2016)

Malaysia, Environmental Quality (Control of Pollution from Solid Waste Transfer Station and Landfill) Regulations 2009. Food and Agriculture Organization of the United Nations. Available from: <http://faolex.fao.org/docs/texts/mal99122.doc> (Accessed 7 August 2016)

Malaysia, Environmental Quality Act, 1974 (Act 127) (Amended in 2012). Food and Agriculture Organization of the United Nations. Available from: <http://faolex.fao.org/docs/pdf/mal13278.pdf> (Accessed 7 August 2016)

Malaysia, Global Partnership on Waste Management. Available from: www.unep.org (Accessed 7 August 2016)

Malaysia, Ministry of Natural Resources and Environment. Available from: <http://www.water.gov.my/> (Accessed 7 August 2016)

Mongtoeun, Y., T. Fujiwara, and S. Sethy (2014). "A Study of Commercial Solid Waste Generation and Composition in Phnom Penh City, Cambodia". Journal of natural sciences research, Vol.4, No.13. 49-54. Available from: <http://www.iiste.org/Journals/index.php/JNSR/article/view/14049>

Myanmar Country Report. Sixth Regional 3R Forum in Asia and the Pacific; Available from: <http://www.uncrd.or.jp/index.php?page=view&type=13&nr=905&menu=308> (Accessed 7 August 2016)

Myanmar, Environmental Conservation Rules, June 2014. http://www.burmalibrary.org/docs21/2014-06-Environmental_Conversation_Rules-en.pdf (Accessed 7 August 2016)

Myanmar, Global Partnership on Waste Management. Available from: www.unep.org (Accessed 7 August 2016)

Myanmar, Myanmar National Communication Report; Environment Conservation Department; Ministry of Environmental Conservation and Forestry. Available from: www.ecd.gov.mm (Accessed 7 August 2016)

Nguyen, Thao and N. J. Themelis. Solid Waste Management in Viet Nam. School of International and Public Affairs, Columbia University. Available from: <https://goo.gl/TDs8z0> (accessed 23 May 2017).

Philippines Country Report. Sixth Regional 3R Forum in Asia and the Pacific. Available from: <http://www.uncrd.or.jp/index.php?page=view&type=13&nr=905&menu=308> (Accessed 7 August 2016)

Philippines, Department of Environment and Natural Resources. Available from: www.denr.gov.ph (Accessed 7 August 2016)

Philippines, Ecological Solid Waste Management Act of 2000. Food and Agriculture Organization of the United Nations. <http://faolex.fao.org/docs/texts/phi45260.doc> (Accessed 7 August 2016)

Philippines, Global Partnership on Waste Management. Available from: www.unep.org (Accessed 7 August 2016)

Philippines, National Reporting Database on the Basel Convention (Year: 2014). Available from: www.basel.int (Accessed 7 August 2016)

Regional Workshop of the GMS on “the National Strategy of Integrated Solid Waste Management/3R” 28-29 July 2010, Hai Phong, Viet Nam

Sharp, A. and J. Sang-Arun (2012). A Guide for Sustainable Urban Organic Waste Management in Thailand: Combining Food, Energy, and Climate Co-benefits, IGES Policy Report, 2012-02. Japan: Institute for Global Environmental Strategies (IGES). Available from: <https://www.apn-gcr.org/resources/files/original/a38dd72155088c9924789b2aa10b780b.pdf>

Sidik, Ujang Solihin. Product and Packaging Directorate of Solid Waste Management Solid Waste Management Policy in Indonesia: Opportunity and Challenge. Indonesia: Ministry of Environment and Forestry.

Singapore Country Report. Sixth Regional 3R Forum in Asia and the Pacific; Country Report Available from: <http://www.uncrd.or.jp/index.php?page=view&type=13&nr=905&menu=308> (Accessed 7 August 2016)

Singapore, Environmental Protection and Management (Vehicular Emissions) Regulations, 1999 (Amended in 2008). National Environment Agency. Available from: [http://www.nea.gov.sg/docs/default-source/anti-pollution-radiation-protection/air-pollution/environmental-protection-and-management-\(vehicular-emissions\)-regulations.pdf?sfvrsn=0](http://www.nea.gov.sg/docs/default-source/anti-pollution-radiation-protection/air-pollution/environmental-protection-and-management-(vehicular-emissions)-regulations.pdf?sfvrsn=0) (Accessed 7 August 2016)

Singapore, Environmental Protection and Management Act, 2002. Food and Agriculture Organization of the United Nations. Available from: <http://faolex.fao.org/docs/pdf/sin86441.pdf> (Accessed 7 August 2016)

Singapore, Environmental Public Health Act, 1987. Food and Agriculture Organization of the United Nations. Available from: <http://faolex.fao.org/docs/pdf/sin46825.pdf> (Accessed 7 August 2016)

Singapore, Global Partnership on Waste Management. Available from: www.unep.org (Accessed 7 August 2016)

Singapore, Ministry of the Environment and Water Resources. Available from: www.mewr.gov.sg (Accessed 7 August 2016)

Singapore, National Environment Agency (2009). Integrated Solid Waste Management.

Singapore, National Environment Agency and Ministry of the Environment and Water Resources (2006). Asia 3R Conference: Integrated Solid Waste Management in Singapore. Available from: <https://goo.gl/TkwN4q>

Solid Waste and Public Cleansing Management Act 2007. Available from: faolex.fao.org/docs/texts/mal74261.doc (Accessed 7 August 2016)

Sub-Decree on Solid Waste Management, 1999, Cambodia; Food and Agriculture Organization of the United Nations. Available from: <http://faolex.fao.org/docs/texts/cam47644.doc> (Accessed 7 August 2016)

Thailand Country Report. Sixth Regional 3R Forum in Asia and the Pacific. Available from: <http://www.uncrd.or.jp/index.php?page=view&type=13&nr=905&menu=308> (Accessed 7 August 2016)

Thailand, Enhancement and Conservation of National Environmental Quality Act B.E. 2535, A.D. 1992. Food and Agriculture Organization of the United Nations. Available from: <http://faolex.fao.org/docs/texts/tha19415.doc>

Thailand, Global Partnership on Waste Management. Available from: www.unep.org (Accessed 7 August 2016)

Thailand, Ministry of Natural Resources and Environment and project Secretariat UNEP Regional Resource Centre for Asia and the Pacific (2006). Cambodia National Environmental Performance Assessment (EPA) 2006. Available from: <https://goo.gl/ZZqHH0>

Thailand, Pollution Control Department (PCD) (1997). Pollution Prevention and Mitigation Policy. Thailand, Ministry of Natural Resources and Environment. Available from: http://www.pcd.go.th/info_serv/en_reg_policy.html (Accessed 7 August 2016)

Thailand, Pollution Control Department (PCD). Law on Environmental Protection 1993 (Amended in 2005). Ministry of Natural Resources and Environment. Available from: http://www.pcd.go.th/info_serv/en_reg_envi.html (Accessed 7 August 2016).

Thailand, Pollution Control Department (PCD). Thailand State of Pollution Report, 2013. Ministry of Natural Resources and Environment.

Thailand, Pollution Control Department (PCD). The Law on Water Resources, 1998. Ministry of Natural Resources and Environment, Thailand;

Thailand, The Metropolitan Waterworks Authority. Available from: www.mwa.co.th (Accessed 7 August 2016)

The ASEAN Secretariat (2004). The ASEAN Statistical Yearbook – 2004. Jakarta, Indonesia. Available from: http://asean.org/?static_post=asean-statistical-yearbook-2004#

The ASEAN Secretariat and East Asia and Pacific Regionj World Bank Group. ASEAN Services Integration Report. Jakarta and Washington DC: The ASEAN Secretariat and The World Bank. Available from: <http://asean.org/asean-economic-community/>

The Hazardous Waste (Control of Export, Import and Transit) Act, 1998; Singapore Statues, Government of Singapore. Available from: <http://faolex.fao.org/docs/texts/sin46841.doc> (Accessed 7 August 2016)

The Institute for Local Self-Reliance Washington, DC (2000). Wasting and Recycling In Metropolitan Manila, Philippines. Greenpeace Southeast Asia. Available from: <https://goo.gl/xuQqcr>

United Nations Environment Programme (UNEP). Available from : <https://www.dropbox.com/sh/zknlx9sqxinhd6/AABGlp-ec7vqS7ugyM4XslPa?dl=0>. (Accessed 13 September 2016)

United Nations Environment Programme (UNEP). Collecting data for rapid assessment of the solid waste sector - Brunei Darussalam.

United Nations Environment Programme (UNEP). Collecting data for rapid assessment of the solid waste sector – Indonesia.

United Nations Environment Programme (UNEP). Collecting data for rapid assessment of the solid waste sector – Philippines.

United Nations Environment Programme (UNEP). Collecting data for rapid assessment of the solid waste sector – Thailand.

United Nations Environment Programme (UNEP). Collecting data for rapid assessment of the solid waste sector - Viet Nam.

United Nations Environment Programme (UNEP). Collecting data for rapid assessment of the solid waste sector – Lao PDR.

United Nations Environment Programme (UNEP). Collecting data for rapid assessment of the solid waste sector – Myanmar.

United Nations Framework Convention on Climate Change (UNFCCC). Malaysia Biennial Update Report (BUR).

- United Nations Statistic Division. World Statistic Pocket Book. Available from: www.data.un.org (Accessed 7 August 2016)
- Urban Environment Company Limited (URENCO) (2007). Final Report: The Development of E-waste Inventory in Viet Nam. MOE Japan, MONRE Viet Nam, EX Corporation. Available from: <https://goo.gl/fbHnbI>
- Viet Nam Country Report. Sixth Regional 3R Forum in Asia and the Pacific. Available from: <http://www.uncrd.or.jp/index.php?page=view&type=13&nr=905&menu=308> (Accessed 7 August 2016)
- Viet Nam, Environment Administration, Ministry of Natural Resources and Environment. Available from: www.vea.gov.vn (Accessed 7 August 2016)
- Viet Nam, Global Partnership on Waste Management. Available from: www.unep.org (Accessed 7 August 2016)
- Viet Nam, Pollution Control Department (PCD). The Law on Water Resources, 1998. Ministry of Natural Resources and Environment.
- Viet Nam, Pollution Control Department (PCD). The Management of the Waste and Hazardous Toxic Materials, 1999. Ministry of Natural Resources and Environment.
- World Bank, Viet Nam Country Profile. Available from: www.worldbank.com (Accessed 7 August 2016)
- World Bank. Indonesia Country Profile. Available from: www.worldbank.com (Accessed 7 August 2016)
- World Bank. Lao PDR Country Profile. Available from: www.worldbank.com (Accessed 7 August 2016)
- World Bank. Malaysia Country Profile. www.worldbank.com (Accessed 7 August 2016).
- World Bank. Myanmar Country Profile. Available from: www.worldbank.com (Accessed 7 August 2016)
- World Bank. Philippines Country Profile. Available from: www.worldbank.com. (Accessed 7 August 2016)
- World Bank. Singapore Country Profile. Available from: www.worldbank.com (Accessed 7 August 2016)
- World Bank. Thailand Country Profile. Available from: www.worldbank.com (Accessed 7 August 2016)



**United Nations
Environment Programme**

P.O. Box 30552 Nairobi, 00100 Kenya

Tel: (254 20) 762 1234

Fax: (254 20) 762 3927

E-mail: uneppub@unep.org

Website: www.unep.org

For more information, please contact:

Economy Division
International Environmental Technology Centre

2-110, Ryokuchi koen, Tsurumi-ku, Osaka
538-0036, Japan

Tel: +81 6 6915 4581

Fax: +81 6 6915 0304

E-mail: ietc@unep.org

Web: www.unep.org/ietc