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SIXTH REGIONAL 3R FORUM IN ASIA AND THE PACIFIC,
16-19 AUGUST 2015, MALE, MALDIVES

Evolving 3R Policies and Trends in Asia and the Pacific ~ A Comprehensive Analysis from Tokyo 3R Forum (2009) to Surabaya 3R Forum (2014)

(Background Paper for Plenary Session 1 of the Programme)

Final Draft

This background paper has been prepared by Dr. Prasad Modak, for the Sixth Regional 3R Forum in Asia and the Pacific. The views expressed herein are those of the author only and do not necessarily reflect the views of the United Nations.

Background Paper on "Evolving 3R Policies and Trends in Asia and the Pacific ~ A snapshot from Tokyo 3R Forum (2009) to Surabaya 3R Forum (2014)"

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Sixth Regional 3R Forum in Asia and the Pacific

16-19 August 2015, Male, Maldives

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Abbreviations and Acronyms

3Ps	Policies, Partnerships and Practices
3Rs	Reduce, Reuse and Recycle
3RKH	3R Knowledge Hub
AEDP	Alternative Energy Development Plan
ANZECC	Australia and New Zealand Environmental and Conservation Council
APAC	Asia and the Pacific
APFED	Asia-Pacific Forum for Environment and Development
ASEAN	Association of Southeast Asian Nations
AIT	Asian Institute of Technology
BESF	Bioenergy and Food Security Approach
C&D	Construction and Demolition
CDM	Clean Development Mechanism
CE	Circular Economy
CEPL	Circular Economy Promotion Law
CER	Certified Emissions Reduction
CSD	United Nations Commission on Sustainable Development
CSE	Centre for Science and Environment
DMC	Domestic Material Consumption
DMI	Domestic Material Intensity
EMC	Environmental Management Centre
EMPA	Swiss Federal Laboratories for Materials Science and Technology
ENVIS	Environmental Information System
EPA	Environmental Protection Agency, USA
EPR	Extended Producer Responsibility
ERT	Environmentally Responsible Technologies
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
EU	European Union
FAO	Food and Agricultural Organization
FLMS	Fundamental Law for Establishing a Sound Material-Cycle Society
GDP	Gross Domestic Product
GEO	Global Environmental Outlook
GHG	Green House Gases
GNI	Gross National Income
GPP	Green Public Procurement
GWP	Global Water Partnership
IFEU	Institute for Energy and Environmental Research
IGES	Institute for Global Environmental Strategies
IPLA	International Partnership for Expanding Waste Management Services of Local Authorities

IPR	Intellectual Property Rights
ISWA	International Solid Waste Association
ISWM	Integrated Solid Waste Management
IT	Information Technology
IWIEP	Industrial Waste Information Exchange Program
JESC	Japan Environment Sanitation Center
JICA	Japan International Cooperation Agency
J-Prism	Japanese Technical Cooperation Project for Promotion of Regional Initiative on Solid Waste Management in Pacific Island Countries
LFM	Landfill Mining
LFMR	Landfilling Mining and Reclamation
LPER	Law for Promotion of Effective Utilization of Resources
LPUR	Law for the Promotion of Effective Utilization of Resources
LREC	Law on Resource Circulation of Used Electrical and Electronic Equipment and Used Cars
LRHA	Law for the Recycling of Specified Kinds of Home Appliances
LRSR	Resources Saving and Reutilization
MBT	Mechanical and Biological Treatment
MDG	Millennium Development Goals
MEWR	Ministry of the Environment and Water Resources
MII	Measures for the Administration of Prevention and Treatment of Pollution by Electronic Information Products
MOCIE	Ministry of Commerce, Industry, and Energy, The Republic of Korea
MRF	Materials Recovery Facilities
MSW	Municipal Solid Waste
NDRC	National Development and Reform Commission, PR China
NEA	National Environmental Agency
NGO	Non-Governmental Organization
NHS	The Heart of England National Health Service
NKC	National Knowledge Commission, Government of India.
NRP	National Recycling Programme
OECD	Organization for Economic Co-operation and Development
PDR	Producer Deposit Refund
PET	Poly Ethylene Terephthalate
PPP	Public Private Partnership
PR	Producer Responsibility
R&D	Research and Development
RFID	Radio-Frequency Identification
RFMC	Recycling Fund Management Committee, Taiwan Province of China
RoHS	Restriction of Hazardous Substances
SCP	Sustainable Consumption and Production

SECO	Swiss State Secretariat for Economic Affairs
SEPA	State Environmental Protection Administration, PR China
SERI	Sustainable Europe Research Institute
SGP	Singapore Green Plan
SIDS	Small Island Developing States
SMC	Sound Material-Cycle
SME	Small and Medium Enterprises
SPREP	Secretariat of the Pacific Regional Environment Programme
SRP	Sarimbun Recycling Park
StEP	Solving The E-Waste Problem
SWM	Solid Waste Management
SWOT	Strengths, Weaknesses, Opportunities and Threats
TWG	Thematic Working Group
ULB	Urban Local Bodies
UN	United Nations
UN DESA	United Nations Department of Economic and Social Affairs
UNCED	United Nations Conference on Environment and Development
UNCRD	United Nations Centre for Regional Development
UNCSD	United Nations Conference on Sustainable Development
UNEP	United Nations Environment Programme
RRC.AP	Regional Resource Center in Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UNWTO	United Nations World Tourism Organization
UNU	United Nations University
USAID	United States Agency for International Development
W2R	Waste to Resource
WEEE	Waste of electrical and electronic equipment
WHO	World Health Organization
WTE	Waste to Energy
WWAP	World Water Assessment Programme
ZHC	Zero Hunger Challenge

Preface

This background paper is divided into five parts.

Part I looks at the global status of waste and resource management and the challenges faced today. It explores linkages of waste and resources with the economy. Further, it discusses the economic, environmental and social benefits that waste management offers when integrated with the 3Rs (viz. Reduce, Reuse, Recycle).

Part II presents a situation analysis that focuses on Asia and Pacific (APAC) region and the Small Island Developing States (SIDS) covering tourism and urban infrastructure sectors. It presents in brief evolution of policies, status on waste management infrastructure – addressing technologies, institutional models and financing.

Part III presents a snapshot on various waste streams of concern. For each of these waste streams, this Part presents statistics on the waste generation, environmental and social concerns and management practices based on 3R principles.

Part IV presents a response to the challenges faced and the role of policies, technologies and financing mechanisms that can help countries for turning waste to resources by practicing 3Rs.

Finally, Part V presents the 3R Asia Initiative through its evolution over the years and the progress it has made so far. This part provides highlights of the various Regional 3R Forums that have taken place in the past by providing highlights, recommendations, and progress made.

The paper ends with a note on the way forward.

The draft of this paper has been updated based on the Background Papers and Country Reports that were presented at the 6th Regional 3R Forum in Maldives.

1 Global Waste and Resource Management

Part I looks at the global status of waste and resource management and the challenges faced today. It explores linkages of waste and resources with the economy. Further, it discusses the economic, environmental and social benefits that waste management offers when integrated with the 3Rs (viz. Reduce, Reuse, Recycle).

1.1 Global challenges in Waste and Resource Management

The world continues to guzzle the natural resources on the earth to help the economies to grow and improve livelihoods of the people. Resource scarcity, land paucity, population rise, threatened biodiversity, natural disasters, climate change and high dependence on energy are some of the global challenges we face today.

Figure 1 shows global resource extraction when categorized according to materials over the past three decades. Optimum utilization of these materials over the chain of extraction, production, distribution, consumption, and disposal in ideality does not take place. This leads to waste generation giving rise to residues.

We have inefficient resource use at one hand and waste generation at the other. OECD estimates reveal that a fifth of the material extracted worldwide is devalued as waste, amounting to a total of 12 billion tonnes every year.[1]

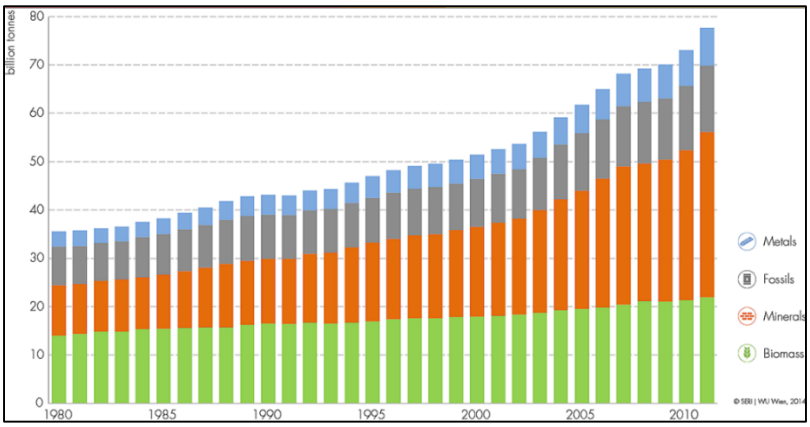

Figure 1 Global resource extraction by material category 1980-2011

Notes: The figure presents global resource extraction (includes only used materials) between 1980 and 2011. Four material categories are separately shown: metal ores, industrial and construction minerals, fossil fuels and biomass (from agriculture, forestry and fishery).

Source: SERI Global Material Flow Database

Figure 2 shows this trend in material consumption. Material consumption for the APAC region is growing rather steeply. Elements like antimony, indium, and silver are on the verge of being locked or embedded forever in the material products we have manufactured, followed by copper, titanium and tantalum. Natural gas, oil, and coal too have their reserves falling and may significantly diminish by 2060.

While the world's material use efficiency[2] improved by 2.2 to 1.1 kg per US$ of Gross Domestic Product (GDP) from 1990-2005, it worsened for the APAC region from 2.4 to 3.1 kg per US$ of GDP in the same period. Except for Japan, in APAC countries especially PR China and India, the material use efficiency is currently deteriorating.[3] A broader timeline shows that APAC region's material use has increased from 5.7 to 37 billion

[1] Business and Economic Potential of Resource Recovery and Recycling from E-waste by Dr Sunil Herat. Background Paper for Parallel Roundtable 4 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific
[2] Refer to Box 1 in Section 1.1 for definition of Material Efficiency and related terms.
[3] (a) Resource Efficiency: Economics and Outlook for Asia and the Pacific, Key Messages and Highlights http://www.unep.org/roap/Portals/96/REEO_AP_Key.pdf and (b) CSIRO and UNEP. Asia-Pacific Material Flow Database

tonnes per year between 1970 and 2010, using approximately 53% of what the entire world consumes. PR China alone takes up 64% of APAC material use and 33% of the global material use.[4]

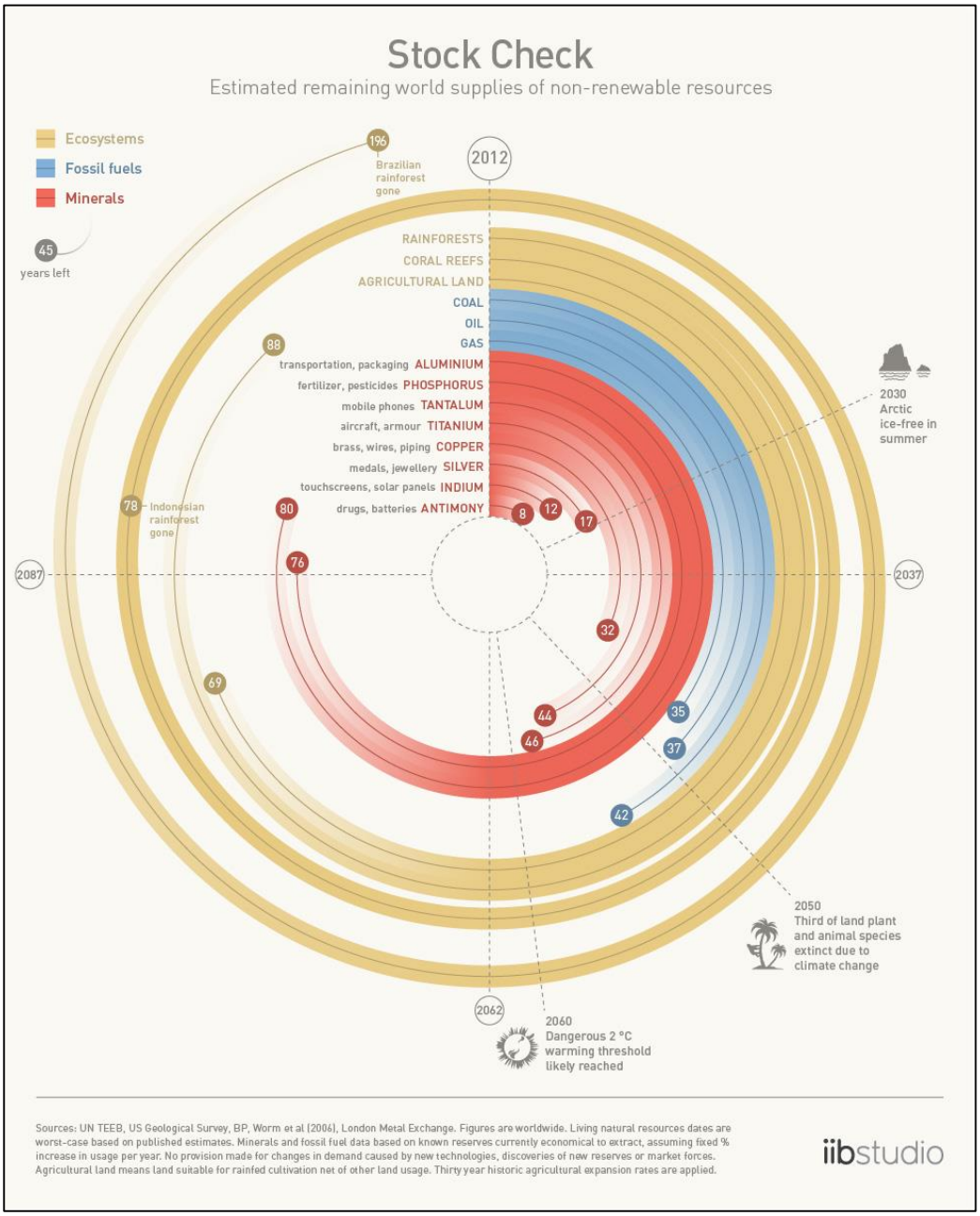

Figure 2 Global resources stock check

Source: BBC. 2012.[5]

www.csiro.au/AsiaPacific MaterialFlows

[4] UNEP (2015), Indicators for a Resource Efficient and Green Asia and the Pacific - Measuring progress of sustainable consumption and production, green economy and resource efficiency policies in the Asia-Pacific region, Schandl, H., West, J., Baynes, T., Hosking, K., Reinhardt, W., Geschke, A., Lenzen, M. United Nations Environment Programme, Bangkok. http://greeninfo.asia/Publications/Indicator-for-a-RE(High-resolution).pdf

[5] BBC (2012), http://www.bbc.com/future/story/20120618-global-resources-stock-check. Accessed on 4th August 2015

Municipal Solid Waste (MSW) has always been the focus amongst various waste streams that get generated. The worldwide MSW arisings are estimated to be around 2 billion tonnes per annum. For the other waste streams, the extrapolation ranges from 7-10 billion tonnes per annum on worldwide basis for combined "urban" waste streams such as MSW, commercial and industrial wastes (C&I) and construction and demolition (C&D) waste.[6]

MSW generation goes hand in hand with population increase. As population explodes[7] and migration from rural to urban areas takes place, and as nations prosper and lifestyles change, consumption increases (**Figure 3** and **Figure 4**). Upper middle income countries like PR China and Maldives and lower middle countries like India are going through rapid urbanization (**Figure 5**). Land paucity and our incapacity to treat the waste generated in a timely fashion has led to environmental degradation, spread of diseases and loss in biodiversity.

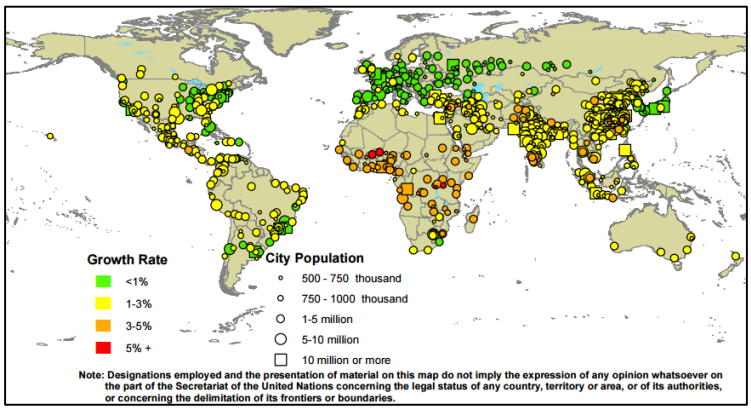

Figure 3 Growth rates of urban agglomerations by size class

Source: United Nations Population Division[8]

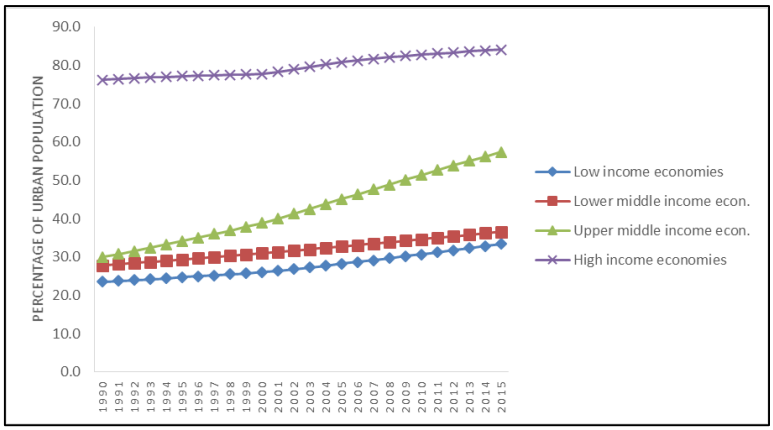

Figure 4 Urbanization trends in APAC countries (income-wise)

Source: Statistical Yearbook for Asia and the Pacific 2014, ESCAP Statistics Division[9]

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[6] UNEP (2015) Global Waste Management Outlook. http://www.unep.org/ietc/Portals/136/Publications/Waste%20Management/GWMO%20report/GWMO%20full%20report.pdf

[7] 50% the world's population lives within 100 km of the sea, and 75% of all large cities are located on the coast. UNEP's and UN-HABITAT's brochure on "Coastal Area Pollution. The Role of Cities" http://www.unep.org/urban_environment/PDFs/Coastal_Pollution_Role_of_Cities.pdf

[8] UN DESA Population Division (2014) World Urbanization Prospects, the 2014 revision http://esa.un.org/unpd/wup/Maps/CityGrowth/2014_2030GrowthRate.pdf

[9] United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) www.unescap.org/stat/data/ and http://www.unescap.org/resources/2-urbanization. Accessed on 4th August 2015

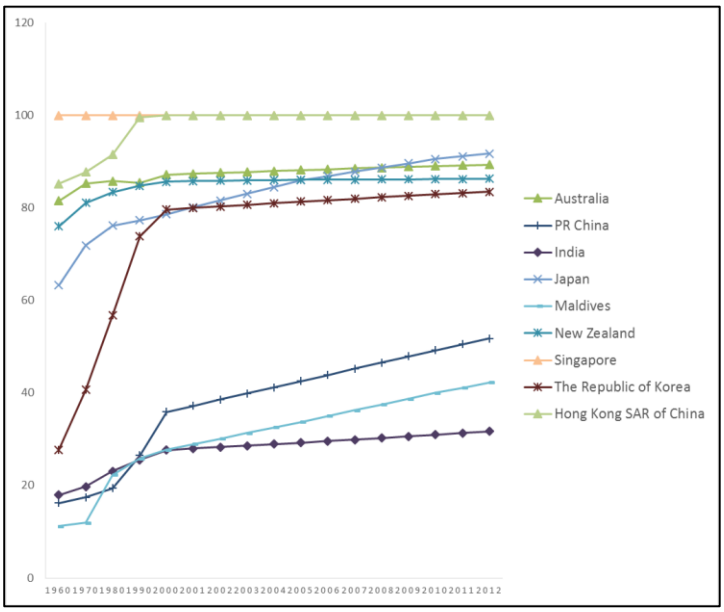

Figure 5 Trends in urban population in APAC region (country-wise)

Notes: Figure shows trends in Urban Population percentage of selected APAC countries.

Source: World Development Indicators compiled in EMC's Master Country Database

Wastes are often dumped leading to significant impacts on the human health and the ecosystems. (**Figure 6**) These impacts can be avoided if waste is perceived as a resource and 3Rs are introduced. Unfortunately, many countries still rely only on the end-of-pipe solutions to manage waste.

Figure 7 shows dumpsites in developing regions, sites that are used for the disposal of waste without fulfilling certain environmental criteria. **Figure 8** shows that proper sanitary landfills are mostly concentrated in developed regions. **Figure 9** shows that developing regions take a big share of unsound disposal in the world. The conditions developed in these disposal sites are apt for rodents and insects. These sites also emit odors and are prone to fire hazards. The informal sector uses this readily available open source of income without realizing the health and safety related risks involved. Half of the residents in Indonesia for instance get their water from water bodies located near such waste dumpsites.[10] See **Box 1.**

The World Bank estimated that the cost of inaction on sound management of wastes eats away 5% of the GDP.[11] By investing 2% of global GDP in greening certain central sectors of the economy, a shift in development can be possible towards a low-carbon, resource-efficient path, not only for the developed countries but also the developing ones.[12]

[10] 3Rs for Water Security in Asia and the Pacific by Prof. C. Visvanathan. Background Paper for Plenary Session 6 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

[11] . 3RKH Secretariat. Asian Institute of Technology (2008), 3R in Asia: A Gap Analysis in selected Asian Countries. http://www.faculty.ait.asia/visu/Prof%20Visu's%20CV/Books%20and%20research%20reports/3R%20Gap%20Analysis%20Book%20(Printed%20Version).pdf

[12] UNEP (2011), Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, www.unep.org/greeneconomy

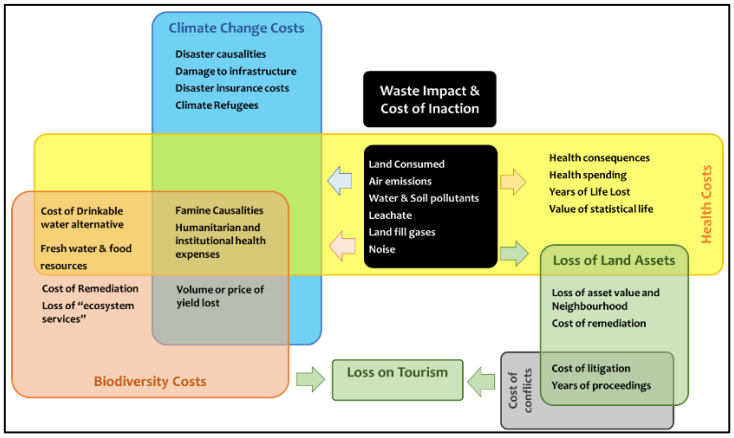

Figure 6 Impact of Unsound Management of Waste and Cost of Inaction

Source: Environmental Management Centre (EMC), Mumbai, India

We need to find ways to operate circular economy where wastes are not generated in the first instance and if generated, are put back into the pool of resources.

Figure 7 Locations of dumpsites worldwide

Source: Waste Atlas[13]

Figure 8 Locations of sanitary landfills worldwide

Source: Waste Atlas[14]

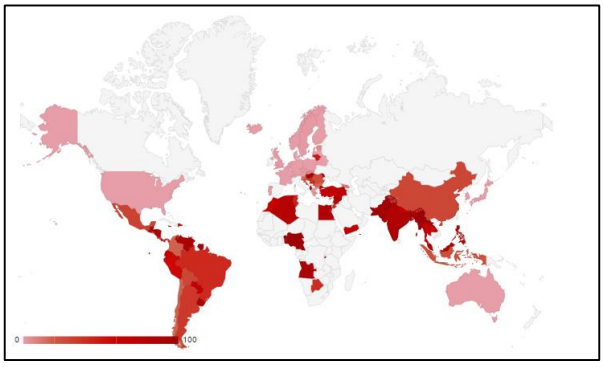

Figure 9 Unsound disposal worldwide

Notes: Figure shows the percentage of total Municipal Solid Waste (MSW) generated that is disposed or burnt in controlled and uncontrolled dumpsites.

Source: Waste Atlas[15]

[13] Waste Atlas http://www.atlas.d-waste.com/. Accessed on 4th August 2015
[14] Waste Atlas http://www.atlas.d-waste.com/. Accessed on 4th August 2015
[15] Waste Atlas http://www.atlas.d-waste.com/. Accessed on 4th August 2015

Box 1 Waste pollution in APAC

The Citarim River in Indonesia is one of the most polluted places on the planet, due to open dumping of wastes that have led to high amounts of lead, arsenic and mercury, along with floating debris of carpet of plastic, packaging, and other solid waste. The recovery of plastic bottles in the river has replaced fishery as a source of income. Similar is the situation in water bodies of India, Bangladesh, Samoa and The Philippines.[16]

1.2 Importance of 3Rs

Given these challenges on resources and waste management, is sustainable development achievable? '*Blueprint for a Green Economy'*, a 1989 book, suggests that we may have already passed a tipping point and sustainable development may be impossible, as economies continue to deplete the natural capital and spew wastes. The concept of green economy that accounts for such an environmental loss offers some hope and solace.[17] Rising interest in the concept of green or circular economy was fueled by the global financial crisis and due to greater awareness of new environmental issues.

Figure 10 shows the linear economy juxtaposed with the circular economy. Circular economy is an alternative to the traditional linear economy. In a linear economy, the open chain of extraction, production, distribution, consumption, and disposal doesn't close (**Figure 11)**. Introducing 3R in each part of this chain not only can help close the loop, but also strengthen it in terms of long-term sustainability. In this way, resource use is optimized and resources are best utilized, materials and products at the end of their lives are reincarnated through recovery and regeneration.

We avoid the cost inaction due to land consumed and lost, air emissions, water & soil pollutants, remediation, litigation, years of proceedings, climate change and their impacts on the economy and lives of the people. (Refer back to **Figure 6**) With circular economy, land is better utilized, emissions are reduced, aesthetics is taken care of, informal sector is formalized and we gain better productivity with a clean and healthy world.

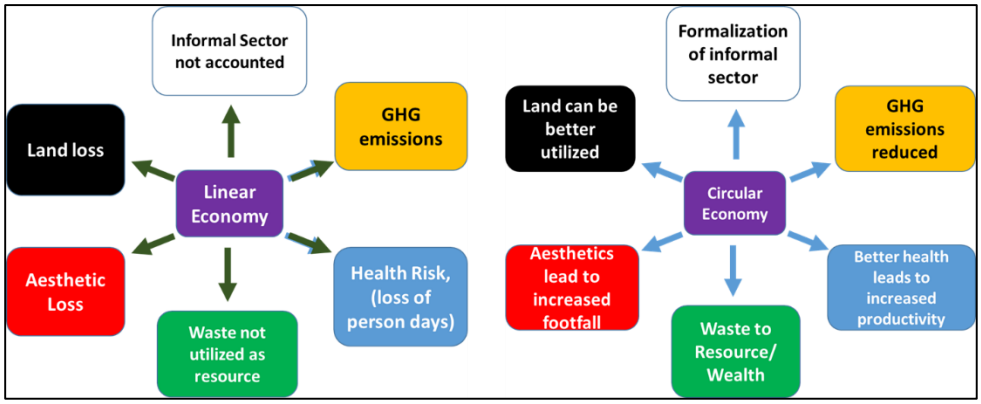

Figure 10 Linear to circular economy

[16] 3Rs for Water Security in Asia and the Pacific by Prof. C. Visvanathan. Background Paper for Plenary Session 6 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

[17] UNEP (2011) Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, www.unep.org/greeneconomy

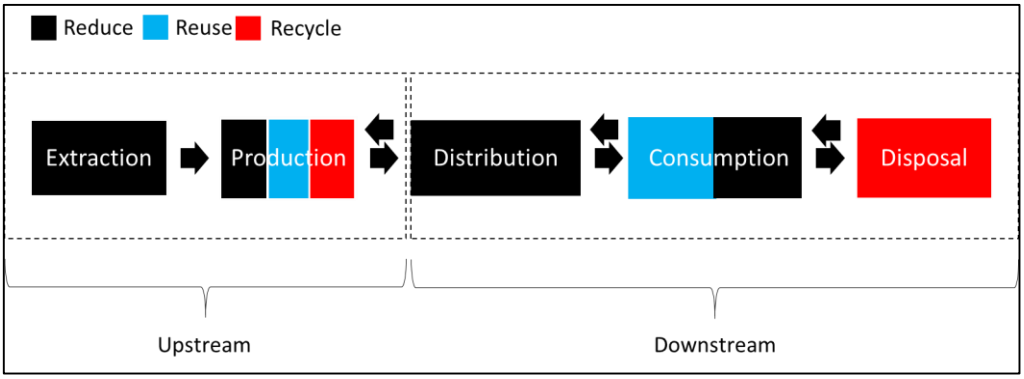

Figure 11 3R across value chain

The polarity of resource consumption and waste generation can be neutralized by implementing resource conservation, reducing emissions, avoiding the costs of neglecting the polarity, and letting 3R widen the economy (**Figure 12**).

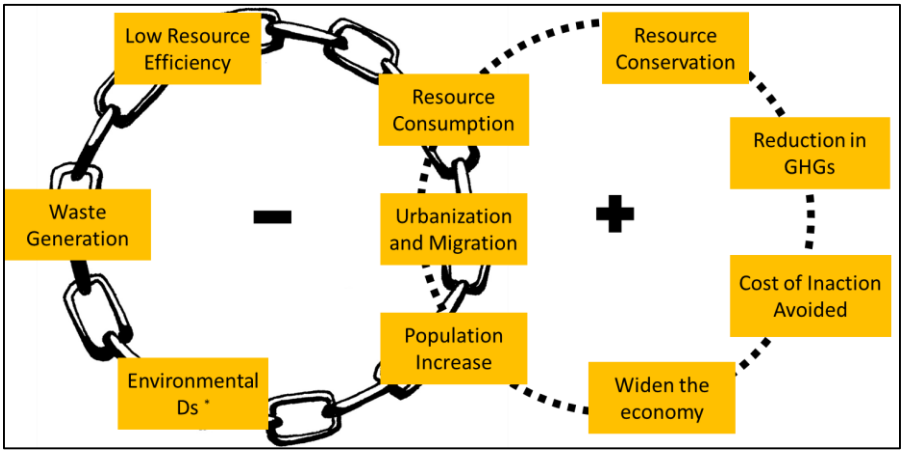

Figure 12 Nexus between Resources and Wastes

Over the years, the maxim of 'Reduce, Reuse, Recycle', or simply the '3Rs' has been extended to more than 3Rs (4Rs or even 5Rs)[18]. Establishing waste to resource linkages becomes extremely important and 3Rs play a critical role in this endeavor. 3Rs need to be supported by business models and partnerships that ensure that the efforts are sustained and lead to innovations. The concept of circular economy is synonymous to green economy.

3Rs help conserve natural resources, landfill space and also reduce energy and material consumption and the consequent greenhouse gas emissions (GHGs). 3Rs reduce public expenditure on waste management infrastructure and operations. 3Rs widen the nature of investment in the waste sector with investments flowing from disposal activities to upstream activities such as energy and material recovery. This leads to sustainable investments. 3Rs is also connected to several other broader social issues. 3Rs provide employment and livelihoods and thus address hunger and poverty. These issues bear a strong influence on the quality of life in the APAC region. **Figure 13** shows the ripple effect of 3Rs in the green economy.

[18] Other Rs besides the 3Rs: Recycle, Reduce, Rethink, Reuse, Recreate, Repair, Reform, Reintegrate, Return, Rot, RFID, Recover, Restore, Regenerate

Green economy follows a multi-pronged approach addressing resource consumption, waste reduction, resource efficiency and the conversion of waste back to the resource. Effective communication, knowledge transfer, political support and commitment towards investments and implementation are imperative if we want to push towards green economy. Local as well as global participation through interagency coordination is needed. 3Rs play an important role in such a transformation.

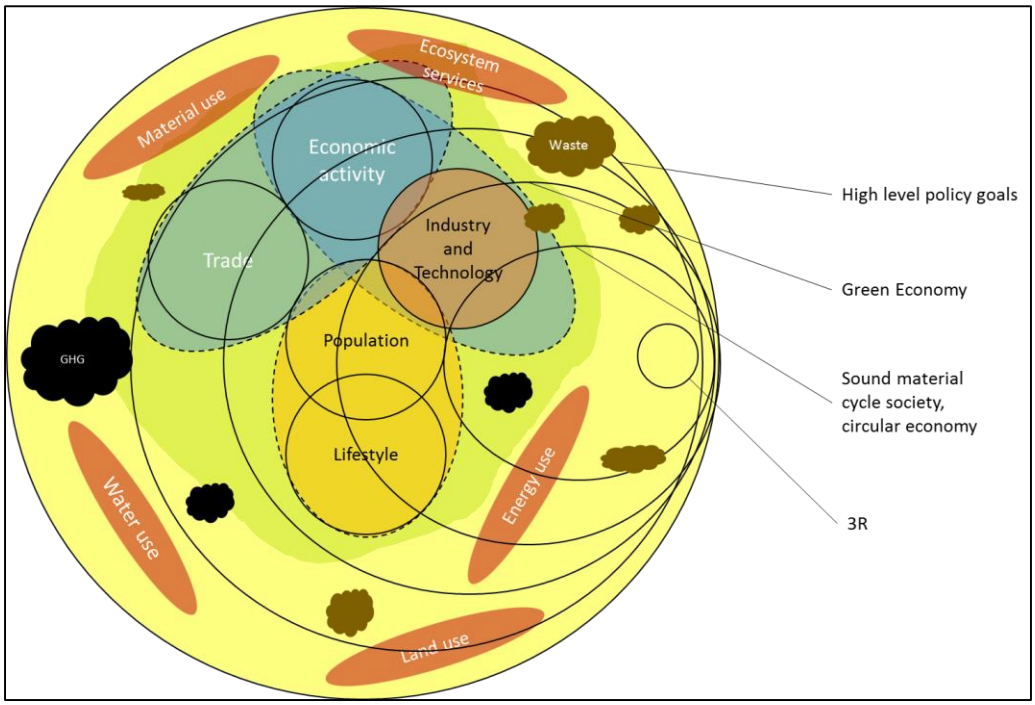

Figure 13 Importance of 3R in Green Economy

Notes: Image depicts a petri dish with nutrients as ecosystem services, material, energy, water and land. The organism is a combination of people, economy and industry. The ripple effect of concepts such as 3R affect all – nutrients, organism and also the waste and GHG emissions.

2 APAC and SIDS

Part II presents a situation analysis that focuses on APAC region and the SIDS in terms of tourism, urban infrastructure sector. It looks into evolution of policies, current waste management infrastructure – addressing technologies, institutional models and financing. Further, it looks deeper at the status of waste and resource management and the challenges faced by the APAC region with a special focus on the SIDS and tourism.

2.1 Asia Pacific (APAC) region

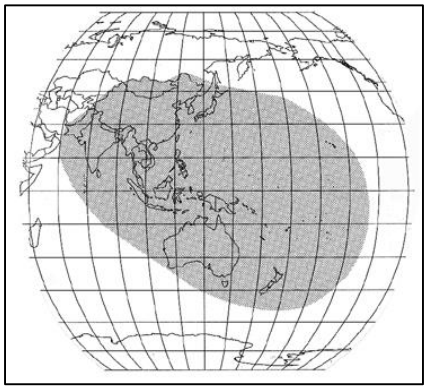

Figure 14 APAC Region

Notes: Peripheries of highlighted region: Mongolia (north), New Zealand (south), the island states of Oceania (east), and Pakistan (west).

Source: Environment Agency of the Government of Japan a Long-term Perspective on Environment and Development in the Asia-Pacific Region[19]

The APAC region is a home to half of the world's population, with a wide geographical area as depicted in **Figure 14**. APAC's economy is steered by a labor-intensive export-oriented industry that exploits human as well as natural resources.

The growth of APAC region is projected to increase to 5.8% in 2015 from an estimated 5.6% in 2014, overtaking developed economies.[20] Population in this region reached 4.3 billion people in 2014, out of which 2 billion resided in urban areas, accounting for 55% of the world's urban population. Since 1990 until 2014, a billion more have been added to this region. Seventeen of the twenty eight megacities in the world are located in this region.

Over the past decade (2005–15), APAC's economy grew by 4.9% during a time when the rest of world grew by 1.6%, impervious to the global economic crisis of 2008-09.[21] Undoubtedly, as a result of economic development, waste generation and environmental degradation is concentrated around these urban centers.

Although APAC has been following the footsteps of industrialized nations in the west, countries such as Japan, Australia, and The Republic of Korea have understood importance of 3R and have taken up concepts such as Sound Material Society, Green Growth, Circular Economy and Zero Waste.

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[19] Environment Agency of the Government of Japan a Long-term Perspective on Environment and Development in the Asia-Pacific Region https://www.env.go.jp/en/earth/ecoasia/workshop/bluebook/chapter1-1.html. Accessed on 4th August 2015

[20] UNESCAP (2014), 2014 Year-end Update Economic and Social Survey of Asia and the Pacific. http://www.unescap.org/sites/default/files/Survey-Year-end-Update-2014.pdf

[21] Resource efficiency and waste minimization achieved through the 3Rs: A core element of Asia-Pacific governments' economic growth strategies by Heinz Schandl Commonwealth Scientific and Industrial Research Organisation, Canberra. Background Paper for Plenary Session 1 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

Nexus between economic development, health and environment is raising the scale and complexity of problems. Access to sanitation in this region is only 59% and calls for better waste management and sanitation practices. The region contributes to half of the world's GHG emissions owing to its resource intensive agricultural activities and unsound waste disposal practices such as landfilling and open dumping. These practices are also the reason for the spread of diseases and loss of human capital. Moreover, its urban areas are engulfed in the highest amounts of particulate matter due to transportation and waste burning. Loss in forest cover coupled with increasing number of threatened species is a telltale sign that the development is not in the right path.[22]

Asia has been the largest resource extractor since the 1980s, owing to the fact the much of the world's population resides in this region (**Figure 15**). The onus is therefore on Asia to address these issues critically with whatever resources are available with Asia itself. Discovering innovative alternatives will therefore be no longer just an option in the times to come – it will be a compulsion to survive.

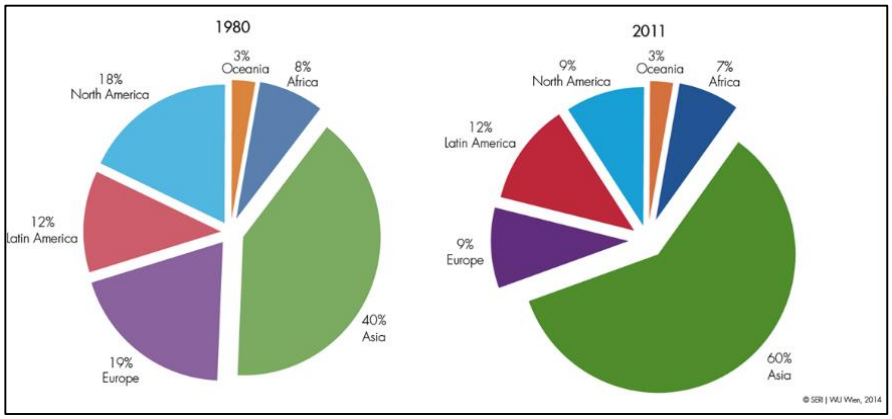


Figure 15 Shares of global resource extraction by world region 1980 vs. 2011

Notes: In this figure, global resource extraction data is disaggregated by six world regions, illustrating the shares of each region in total extraction for the years 1980 and 2011.

Source: SERI Global Material Flow Database

Asia has the largest reserves of non-renewable sources such as coal and oil and also iron. As the world runs out of non-renewable resources, extraction of the remnant natural resources will unlock tonnes of GHG emissions (**Figure 16**). The developing APAC region has been closing in with the rest of the world with respect to material consumption after four decades of sprinted development **(Figure 17)**. Sustainable Consumption and Production (SCP) supported by 3Rs therefore makes sense in the context of Asia.

Material intensity that is the ratio of Domestic Material Consumption (DMC) to GDP, has been stabilizing in the past four decades for the world in general, masking the increase in DMC for North East Asia and APAC. APAC's DMC has only started to stabilize in the last few years **(Figure 18)**. **Figure 19** digs deeper into the material intensity of PR China. While the overall material intensity has decreased, PR China's material use per capita has almost doubled. **Figure 20** shows a similar scenario for the rest of the world.

[22] Statistical Yearbook for Asia and the Pacific 2014 http://www.unescap.org/resources/statistical-yearbook-asia-and-pacific-2014

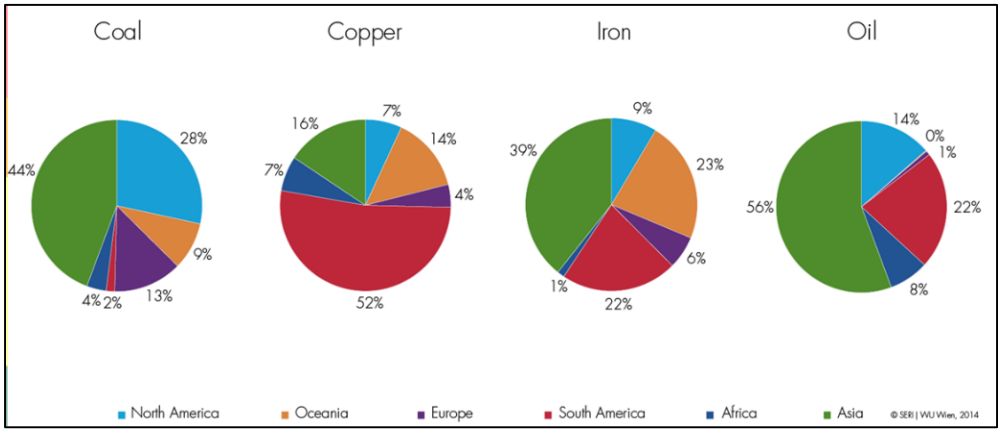


Figure 16 Reserves of non-renewable materials in 2011

Notes: In this figure, material consumption per capita and day is illustrated, using the indicator "Raw Material Consumption". Material consumption equals domestic resource extraction plus imports (and the indirect resource flows of imports) minus exports (and the indirect resource flows of exports). One full rucksack (world average consumption per capita and day) equals 27 kilograms of material consumption. The numbers only include economically used materials and thus exclude unused materials, such as overburden from mining.

Source: SERI Global Material Flow Database

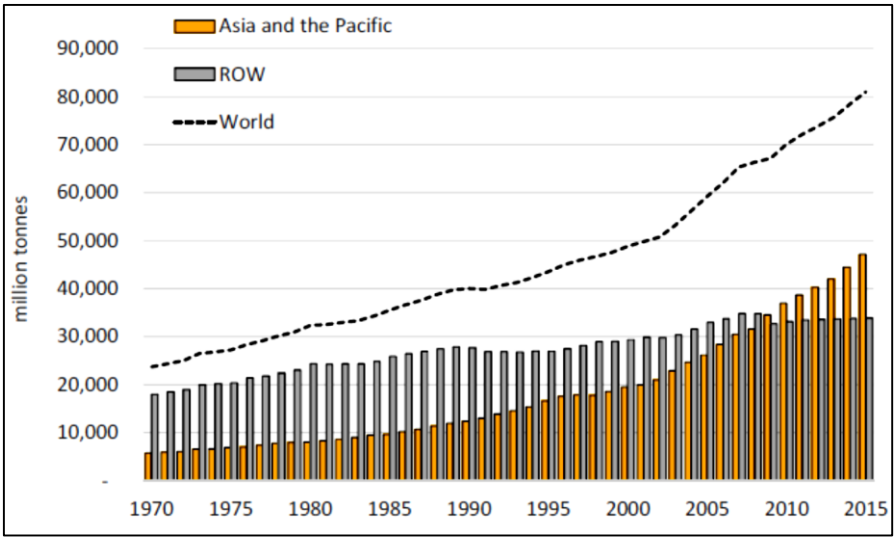


Figure 17 Domestic materials consumption (DMC) for the APAC region, Rest of the World, and World (1970-2015)

Source: UNEP (2015)[23]

[23] Resource efficiency and waste minimization achieved through the 3Rs: A core element of Asia-Pacific governments' economic growth strategies by Heinz Schandl Commonwealth Scientific and Industrial Research Organisation, Canberra. Background Paper for Plenary Session 1 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

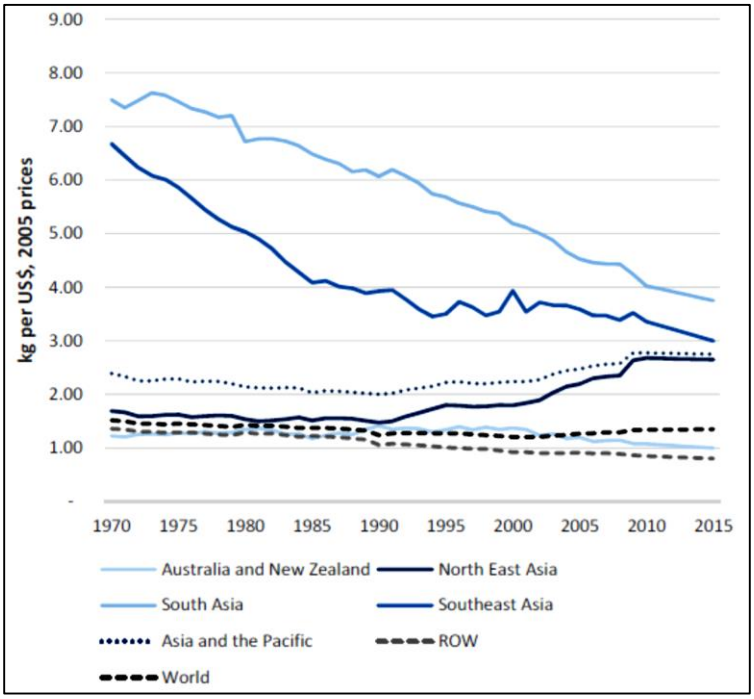


Figure 18 Material intensity in the APAC region, the rest of the world and the world, (1970-2015)

Source: UNEP (2015)[24]

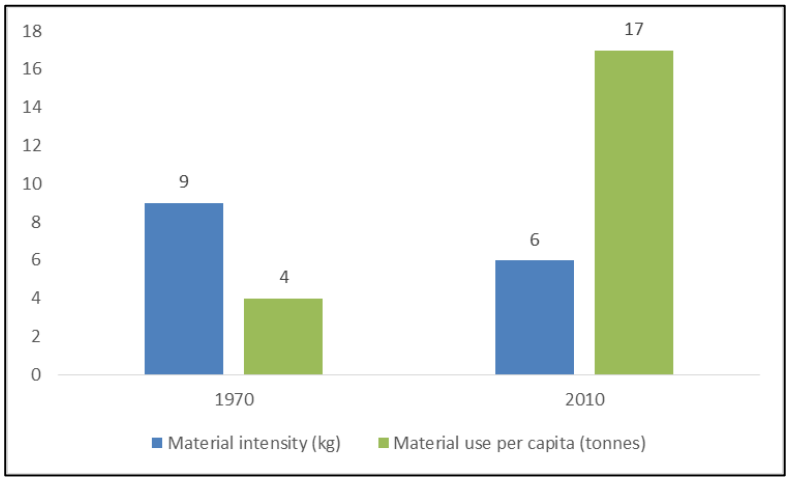


Figure 19 Material intensity and use for PR China, 1970 vs 2010

[24] Resource efficiency and waste minimization achieved through the 3Rs: A core element of Asia-Pacific governments' economic growth strategies by Heinz Schandl Commonwealth Scientific and Industrial Research Organisation, Canberra. Background Paper for Plenary Session 1 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

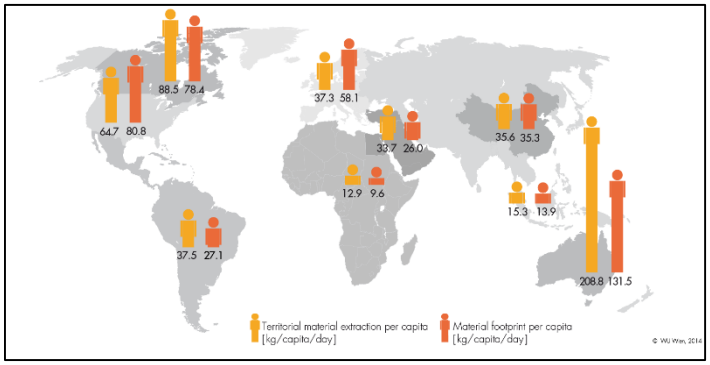
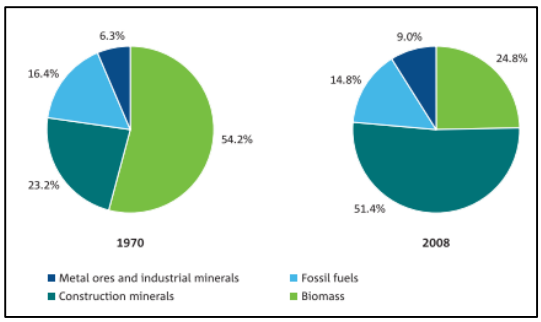


Figure 20 Material consumption per capita and day in 2007

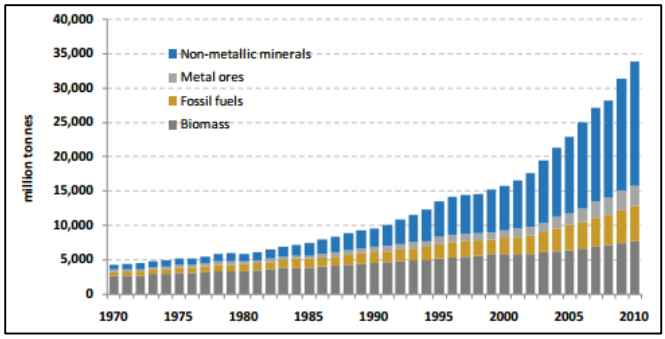
Notes: In this figure, material consumption per capita and day is illustrated, using the indicator "Raw Material Consumption". Material consumption equals domestic resource extraction plus imports (and the indirect resource flows of imports) minus exports (and the indirect resource flows of exports). One full rucksack (world average consumption per capita and day) equals 27 kilograms of material consumption. The numbers only include economically used materials and thus exclude unused materials, such as overburden from mining.

Source: SERI Global Material Flow Database

Figure 21 shows a split of material consumption by type of materials as a contrast between consumption in 1970 and 2008. Construction minerals and biomass consumption have switched places with each other, an evidence of APAC's transformation from a biomass-based to a minerals-based economy. PR China and India in particular have a large appetite of materials as seen from **Figure 22** that shows a split of material consumption by countries. Interestingly, the DMC rate for PR China has been increasing by 6.6% per annum but by 9.9% per annum for Vietnam that is fast catching up.



Graph (a)



Graph (b)

Figure 21 Domestic Material Consumption (DMC) in the APAC region by materials category (1970-2010)[25]

[25] UNEP (2013), Recent Trends in Material Flows and Resource Productivity in Asia and the Pacific 2013. http://www.unep.org/pdf/RecentTrendsAP(FinalFeb2013).pdf

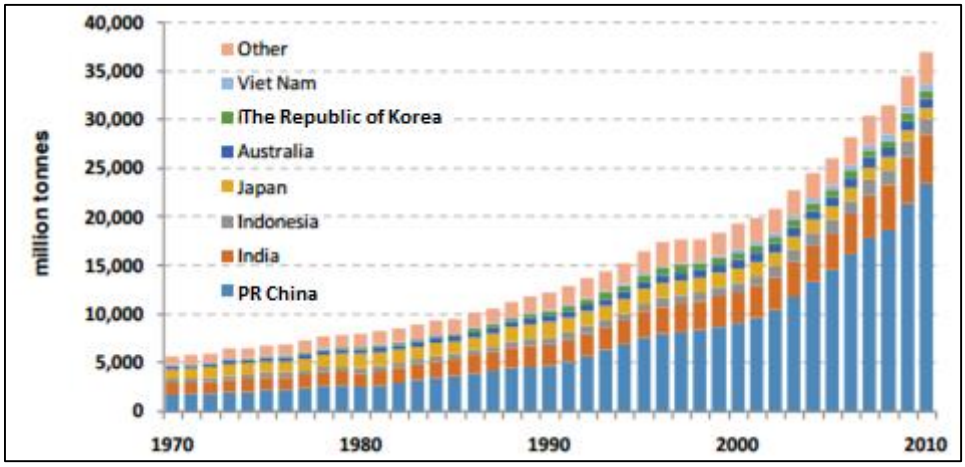


Figure 22 Domestic Material Consumption in APAC region (1970-2010) by country

Source: UNEP (2015), Indicators for a Resource Efficient and Green Asia and the Pacific - Measuring progress of sustainable consumption and production, green economy and resource efficiency policies in the Asia-Pacific region, Schandl, H., West, J., Baynes, T., Hosking, K., Reinhardt, W., Geschke, A., Lenzen, M. United Nations Environment Programme, Bangkok.[26]

2.2 Small Island Developing States (SIDS)

A special case of the APAC region are the SIDS. These are island nations and archipelagos spread all across the world, with most lying in the tropics. They face a unique and challenging situation in terms of waste and resource management. Solid waste generation rates in SIDS are estimated to range from 0.75-2.8 kg per capita per day and only about 10% of the population in the Pacific Islands has sewerage systems and the wastewater from these systems is not properly managed.[27]

In the SIDS economy it is necessary to conserve natural resources, maintain the resource base and protect biodiversity and ecosystems through the use of renewable sources of energy. Better access to information, capacity and technology can help the greening of the SIDS economy.[28] **Box 2** describes efforts of project J-Prism in this direction.

Box 2 Project J-Prism

With an intent to assist Pacific island Countries (PICs) on solid waste management, in collaboration with SPREP, the Japan International Cooperation Agency (JICA) initiated the Japanese Technical Cooperation Project for Promotion of Regional Initiative on Solid Waste Management in Pacific Island Countries (J-PRISM). J-PRISM focuses sustainable development of Pacific SIDS. It aims to do so through the development of national waste management systems, capacity building, knowledge transfer in Pacific SIDS through partnership with countries and organizations, as shown below. It has designed regional as well as national activities involving study visits, trainers dispatch, and training workshops.

[26] UNEP (2015), Indicators for a Resource Efficient and Green Asia and the Pacific - Measuring progress of sustainable consumption and production, green economy and resource efficiency policies in the Asia-Pacific region, Schandl, H., West, J., Baynes, T., Hosking, K., Reinhardt, W., Geschke, A., Lenzen, M. United Nations Environment Programme, Bangkok. http://apps.unep.org/publications/pmtdocuments/-Indicators_for_a_resource_efficient_and_green_Asia_and_the_Pacific-2015Indicator-for-a-RE.pdf

[27] UNEP (2014), Emerging issues for Small Island Developing States. Results of the UNEP Foresight Process. http://www.unep.org/pdf/Emerging_issues_for_small_island_developing_states.pdf

[28] UNEP, UN DESA and FAO (2012) SIDS-FOCUSED Green Economy: An Analysis of Challenges and Opportunities www.unep.org/greeneconomy and www.unep.org/regionalseas

- Japan International Cooperation Agency (JICA)
- Secretariat of the Pacific Regional Environment Program (SPREP)
- International Labour Organization (ILO)
- Member Countries (11 countries)
- Federated States of Micronesia
- Republic of the Fiji Islands
- Republic of Kiribati
- Republic of Marshall Islands
- Republic of Palau
- Independent State of Papua New Guinea
- Independent State of Samoa
- Solomon Islands
- Kingdom of Tonga
- Tuvalu
- Republic of Vanuatu
- (Beneficiary Countries: Cook Islands, Nauru, Niue)

Deliverable	Date
Action Plans, National Strategy, 3R Policy in member countries	2011
Waste Audit Report in FSM, PNG, RMI, Samoa, Solomon Islands, Tonga, and Vanuatu	2011-13
The Joint Mid-Term Review Report on J-PRISM	2013
Market Waste Compost Pilot Project Evaluation report (Vanuatu)	2014

Source: SPREP[29], UN Conference on SIDS[30]

Due to paucity of land, influx of tourists and rising waste generation, SIDS are highly susceptible to diseases. In addition, climate change induced sea level rise threatens these ocean embraced regions, which lack financial resources and local expertise to deal with these issues. SIDS are especially affected as freshwater resources are sensitive to sea level rise by the action of saltwater intrusion and extreme natural disasters.[31] Further, water scarcity is exasperated by inappropriate waste management practices such as landfilling and dumping of waste in open water resources that cause ground water pollution[32].

[29] http://www.sprep.org/j-prism Accessed on 4th August 2015
[30] http://www.sids2014.org/index.php?page=view&type=1006&nr=2535&menu=1507 Accessed on 4th August 2015
[31] UNFCCC (2005) climate change, Small Island Developing States. Issued by the Climate Change Secretariat (UNFCCC), Bonn, Germany. http://unfccc.int/resource/docs/publications/cc_sids.pdf
[32] Refer section 8.6.14 in Annexure F for water issues in SIDS.

2.2.1 Impact of Tourism and Marine Debris

The international tourist arrivals in APAC region have increased from 205 million to 263 million from 2010 to 2014.[33] **Figure 23** shows the rise in international tourism in the region since 1995.

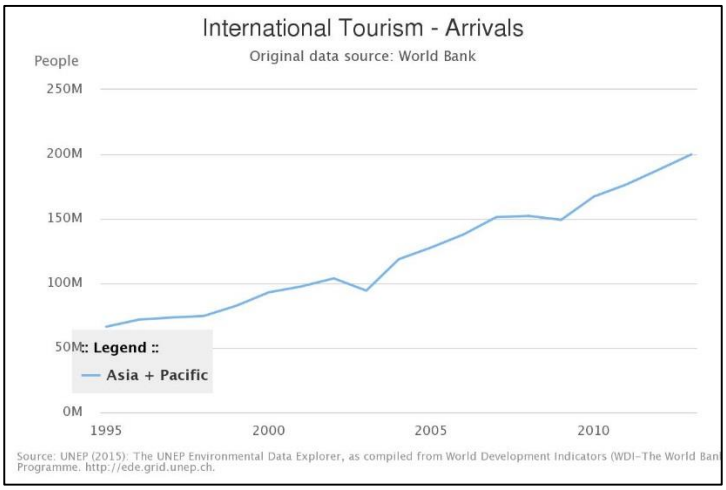


Figure 23 International tourism - Arrivals

Tourism is a resource intensive industry and is the fourth largest export category of both emerging and developing countries earning 485 billion US$ and 924 billion US$ respectively. The same is evident from the recent surge of tourism based economies like Cape Verde and Maldives. This is expected to rise as 90% of the least developing countries list tourism as a priority economic sector.[34] In 2012, 22% of the one billion tourists (i.e. 220 million) that crossed international borders came from APAC, and interestingly the same percentage of tourist population entered APAC.[35] Half of this population, travelled for leisure or recreational activities or holidays. In 2014, of the worldwide international tourist arrivals (ITA), 23% i.e. 263 million people arrived in APAC and spent 377 billion US$. Tourist receipts represent more than 30% of SIDS' total exports; whereas the world average is just over 5%.[36] Tourism is a major part of the economy of SIDS (**Figure 24**).

Waste moves places in the form of either tourism or trade. Marine debris as well as the waste on land is contributed due to tourism. Further, 80% of the marine debris comes from land-based sources and one such contributors is tourism.[37] Tourism also adds foreign waste to the local waste generated. Tourists and passengers of cruise ships generate two and four times as much waste as locals respectively.[38] Tracking such an intricate flow of waste across borders is a challenging task that countries face today. [39]

33 UNWTO Tourism Highlights, 2015 Edition
[34] Contribution of 3Rs in Sustainable Tourism Development and Protection of Marine Ecosystem ~ Win-Win Solutions through 3R as an Economic Industry by Prof. Shun Fung Chiu. Background Paper for Plenary Session 3 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific
[35] World Tourism Organization (UNTWO) 2012
[36] UNEP, UN DESA and FAO (2012) SIDS-FOCUSED Green Economy: An Analysis of Challenges and Opportunities www.unep.org/greeneconomy and www.unep.org/regionalseas
[37] EPA http://water.epa.gov/type/oceb/marinedebris/moreinfo.cfm. Accessed on 4th August 2015
[38] Contribution of 3Rs in Sustainable Tourism Development and Protection of Marine Ecosystem ~ Win-Win Solutions through 3R as an Economic Industry by Prof. Shun Fung Chiu. Background Paper for Plenary Session 3 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific
[39] Refer section 8.6.9 in Annexure F for information on linkages between 3R and sustainable tourism.

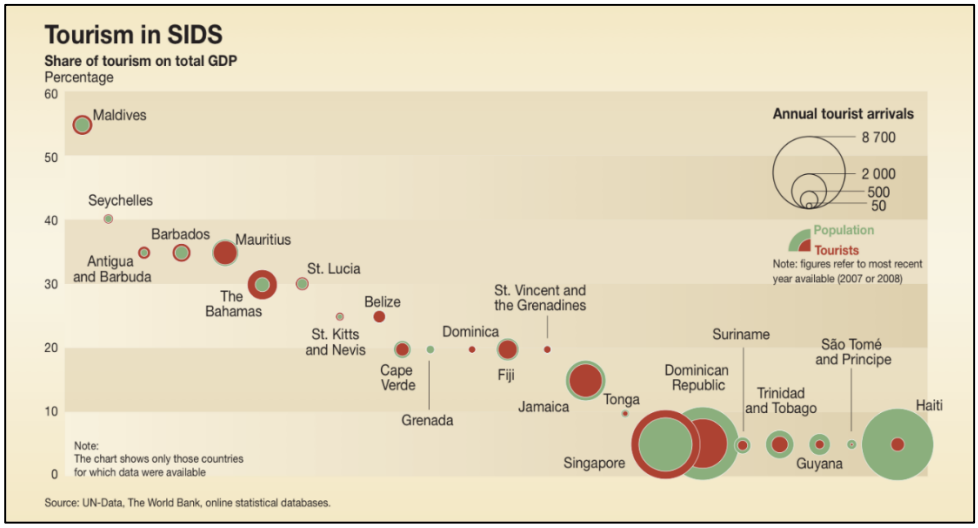


Figure 24 Share of tourism on total GDP in SIDS

Source: GRID-Arendal[40]

The SIDS in particular are isolated states, relying mainly on tourism for their livelihood. The isolated location, pristine environment and unique flora and fauna of the surrounding waters attract tourists to these island states. Increased imports, poor waste treatment systems, inefficient sanitary landfill conditions are contributing to marine debris. Plastic waste also pollutes the surrounding ground water resources thus threatening health of the inhabitants. Pollution of the water body leads to accumulation of toxic chemicals in the fishes, which are also sometimes the staple diet of the inhabitants and tourists. The giant tortoises of the World Heritage Site of Aldabara are succumbing to marine debris caused due to dumping of wastes at sea.[41]

Most of the waste collected in the SIDS is disposed through sanitary landfilling, as opposed to recycling. This leads to missed economic opportunities in terms of resource circulation, employment generation and increased dependence on imports. It also creates future challenges for SIDS due to limited availability of land, contamination of surrounding ecosystems and the contribution of decomposing garbage to the build-up of greenhouse gases.[42] Rare aquatic life attract tourists to SIDS; destruction of biodiversity will severely impact tourism, and the economic paradigm surrounding tourism, i.e. transport, hotels and food industry. Greening the waste sector refers to a shift from these less-preferred waste treatment methods towards the 3Rs. The strategy should be to move upstream in the waste management hierarchy based on the internationally recognized approach of Integrated Solid Waste Management (ISWM).[43]

Mode of transport to SIDS, internal transport within the island, accommodation and food in hotels and restaurants, toiletries, luxury amenities, sightseeing and sale of indigenous products form a web of revenue and waste generation entangled with the tourism industry. Isolated oceanic location of SIDS makes them highly vulnerable to contamination by toxic wastes, chemicals and radioactive materials. The passage of ships carrying toxic and hazardous wastes, chemicals and radioactive materials is also of priority concern.

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[40] GRID-Arendal (2013), SIDS-FOCUSED Green Economy: An Analysis of Challenges and Opportunities http://www.grida.no/graphicslib/detail/tourism-in-sids_cdf9

[41] UNEP Press Release http://www.unep.org/GC/GCSS-VIII/PressRelease_E3.asp, accessed on August 5, 2015

[42] UNEP, UN DESA and FAO (2012), SIDS-FOCUSED Green Economy: An Analysis of Challenges and Opportunities www.unep.org/greeneconomy and www.unep.org/regionalseas

43 UNEP (2011), Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. www.unep.org/greeneconomy.

Wastes if not managed properly can have a rebound effect on the SIDS economy as waste threatens the very ecosystems that attract the tourists in the first place. The SIDS economy depends on fisheries and aquaculture that are directly affected by marine debris.[44]

The intrusion of debris in water bodies has become a critical issue for SIDS. APAC region is embraced by South Asian Seas, East Asian Seas, and Northwest Pacific. Nearly, 1/3rd of APAC countries are SIDS, which are highly sensitive to waste related environmental problems. According to UNEP's Regional Seas Programme, each of these regions is surrounded by some specific major sources of marine debris (**Table 1**). The South Asia Seas are littered due to ship wrecking activities along the costs, natural disaster debris and costal industries; whereas the East Asian Seas and Northwest Pacific are littered due to intense fishing activities. Common to these regions is the dumping of waste along water bodies, owing to improper infrastructure for waste disposal.

Table 1 Sources of marine debris in APAC Region

Regional Seas	Sources of marine debris
South Asia Seas (Bangladesh, India, Maldives, Pakistan, and Sri Lanka)	• Ship-breaking yards are operational in India, Bangladesh and Pakistan • 26 December 2004 tsunami • 13 major ports on Indian Coastline • Beach areas • River side garbage dumping in Pakistan • Coastal industries • Release of sewage, solid waste and wastewater
East Asian Seas (Australia, Cambodia, PR China, Indonesia, Malaysia, The Philippines, The Republic of Korea, Thailand, Vietnam)	• Land-based sources • Sea-based sources in more remote areas • Daily solid waste • Abandoned, lost or otherwise discarded fishing gear
Northwest Pacific Seas (Japan, The Republic of Korea, Russian Federation, People's Republic of PR China)	• Polystyrene, glass and ceramic dominate • Intensive fisheries-related activities • Litter related to medical and personal hygiene

Source: Compiled from UNEP, 2009. Marine Litter: A Global Challenge.[45]

2.2.2 3Rs and Sustainable Tourism in SIDS

In response to the above challenges, many countries have incorporated sustainable practices in their tourism activities through initiatives, regional or national programmes and national policies (**Table 2**). Organizations like Pacific Asia Travel Association (PATA) and Asia Pacific Economic Co-operation (APEC) have adopted a Code for Sustainable Tourism.[46] It is now understood that economy of scale and technical capacity needed to find solutions to these challenges need proactive measures for waste minimization.[47]

Eco-tourism guarantees sustainable livelihood and provides incentives to protect wildlife while contributing to sustainable development. Sustainable tourism will involve the co-operation from hotels in using recycled products, having a recycling/take-back mechanism, segregation of waste at the source, implementing strict rules regarding waste generation and use of resources. National Environmental Agency, Singapore lists guidelines to

[44] GRID-Arendal (2013), SIDS-FOCUSED Green Economy: An Analysis of Challenges and Opportunities. Synthesis Report
[45] UNEP (2009), Marine Litter: A Global Challenge. Nairobi: UNEP. 232 pp. http://www.unep.org/pdf/unep_marine_litter-a_global_challenge.pdf
[46] These organizations are a home to 87 government, state and city tourism bodies, nearly 31 international airlines, airports and cruise lines, 61 educational institutions, and hundreds of travel industry companies in Asia Pacific and 23 member countries respectively. http://www.gdrc.org/uem/eco-tour/apec_pata-code.html
[47] Contribution of 3Rs in Sustainable Tourism Development and Protection of Marine Ecosystem ~ Win-Win Solutions through 3R as an Economic Industry by Prof. Shun Fung Chiu. Background Paper for Plenary Session 3 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

be followed by hotels and households regarding sustainable practices. Such guidelines can be tailored to SIDS specific conditions.

Table 2 Sustainable Tourism Initiatives/Programmes/Policies focusing on waste and resource management in selected countries

Country	Sustainable Tourism Initiatives/Programmes/Policies focusing on waste and resource management
Bulgaria	National Strategy for the Sustainable Development of Tourism
Croatia	"Ordinance on Quality" label for hotels, a Croatian system for awarding the "Environmentally Friendly" label to hotels and campsites
Lithuania	The National Tourism Development Programme
Mexico	The Clean Tourism Destination initiative
Bangladesh	The National Tourism Policy
Fiji	Tourism Development Plan and Ecotourism and Village-based Tourism Policy and Strategy for Fiji
India	No nationwide policy but guidelines have been issued to tour operators and tourists as part of a campaign to preserve the environment in the tourism zones.
Indonesia	General guidance for development of ecotourism at local government level.
Vietnam	Van Long wetlands project

Source: OECD Tourism Trends and Policies 2014 and Linking Green Productivity to Ecotourism: Experiences in the Asia–Pacific Region by APO, 2002[48]

Concerns over environmental footprint of tourism are not new and date back to the 1980s. Studies continue to be conducted on the various impacts of tourism on the environment. In water and land scarce regions, increasing resource consumption by tourists and their waste footprint poses a big challenge[49]. Ecotourism presents a renewed hope for these destinations by considering and mitigating the environmental impacts of tourism related activities. Re-branding of a destination for ecotourism is a driver for competition between tourist destinations, which when leveraged, benefits society, environment and businesses, as green lifestyle becomes a way of life.

Definitions of ecotourism however vary with different terminologies such as nature-based tourism, sustainable tourism, tourism for sustainable development, and environment related tourism (ERT).[50]

Figure 25 shows the components of sustainable tourism that take into consideration the environment, socioeconomic and cultural wellbeing. These eight components relate to policy, institutional and technological considerations for tourism to be sustainable, making them a guide in formulation of 3R policies, programs and plans.

[48] APO (2002) Linking Green Productivity to Ecotourism - Experiences in the Asia–Pacific Region http://www.apo-tokyo.org/publications/wp-content/uploads/sites/5/ind_gp_lgep.pdf
[49] Section 8.6.7 in Annexure F describes the impact of plastic waste on the SIDS' tourism industry and sections 8.6.5, 8.6.6 and 8.6.8 discuss the various financing schemes, technology options and employment opportunities associated with the 3Rs.
[50] APO (2002) Linking Green Productivity to Ecotourism - Experiences in the Asia–Pacific Region http://www.apo-tokyo.org/publications/wp-content/uploads/sites/5/ind_gp_lgep.pdf

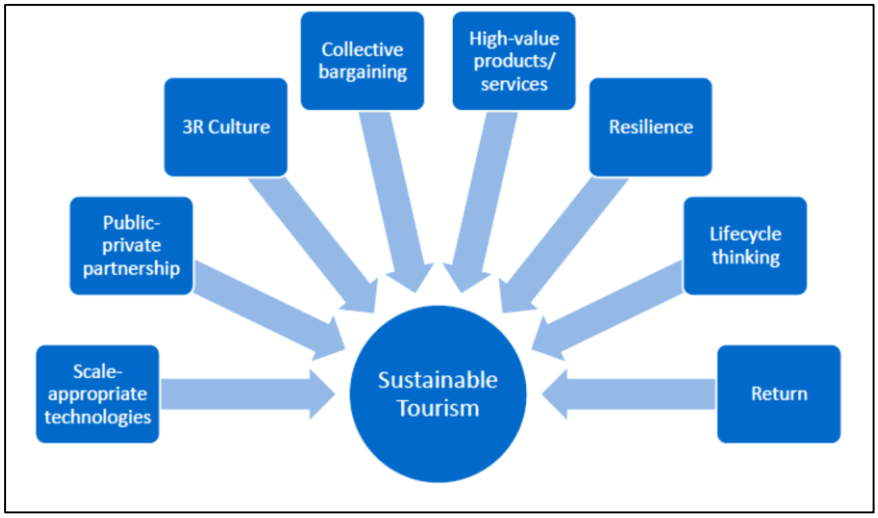


Figure 25 Framework for sustainable tourism and 3R Society in SIDS and developing countries[51]

Recognizing that sustainable tourism represents an important driver of sustainable economic growth and decent job creation, SIDS are being supported in taking the actions shown in **Box 3**.

Box 3 Sustainable tourism in SAMOA Pathway

(a) Developing and implementing policies that promote responsive, responsible, resilient and sustainable tourism, inclusive of all peoples;

(b) Diversifying sustainable tourism through products and services, including large-scale tourism projects with positive economic, social and environmental impacts and the development of ecotourism, agritourism and cultural tourism;

(c) Promoting policies that allow local communities to gain optimum benefits from tourism while allowing them to determine the extent and nature of their participation;

(d) Designing and implementing participatory measures to enhance employment opportunities, in particular of women, youth and persons with disabilities, including through partnerships and capacity development, while conserving their natural, built and cultural heritage, especially ecosystems and biodiversity;

(e) Leveraging the expertise of, inter alia, the Global Sustainable Tourism Council, the Global Observatories on Sustainable Tourism of the World Tourism Organization, the Global Partnership for Sustainable Tourism and other United Nations bodies, as well as the 10-year framework of programmes on sustainable consumption and production patterns, to provide platforms for the exchange of best practices and direct and focused support to their national efforts;

(f) Establishing, upon request, an island, food and sustainable tourism support initiative based on community participation, which takes into consideration ethical values, livelihoods and human settlements, the landscape, the sea, local culture and local products, in collaboration with the World Tourism Organization, the United Nations Development Programme, the United Nations Environment Programme, the United Nations Human Settlements Programme, the Food and Agriculture Organization of the United Nations, the United Nations Educational, Scientific and Cultural Organization, regional development banks and regional and national agricultural, cultural, environmental and tourism authorities where they exist;

[51] Contribution of 3Rs in Sustainable Tourism Development and Protection of Marine Ecosystem ~ Win-Win Solutions through 3R as an Economic Industry by Prof. Shun Fung Chiu. Background Paper for Plenary Session 3 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

(g) Establishing and maintaining, where necessary, the governance and management structures for sustainable tourism and human settlements that bring together responsibilities and expertise in the areas of tourism, environment, health, disaster risk reduction, culture, land and housing, transportation, security and immigration, planning and development, and enabling a meaningful partnership approach among the public and private sectors and local communities.

Source: SIDS ACCELERATED MODALITIES OF ACTION [S.A.M.O.A.] Pathway: Outcome of the the Third International Conference on Small Island Developing States (SIDS Conference), 1-4 September 2014, Samoa.[52]

Resources such as paper, water, electricity, IT supplies, food, local and international products, and so on are an indispensable part of the tourism industry. Management of these resources and their waste will help improve resource efficiency, reduce costs, boost revenue, and create green jobs. It provides an edge to the companies adopting these technologies and boosting their brand identities. The OECD countries have recognized this perspective; nearly 70% of its countries are encouraging environmentally friendly tourism practices to green the tourism sector (**Figure 26).** APAC could draw inspiration from this approach.

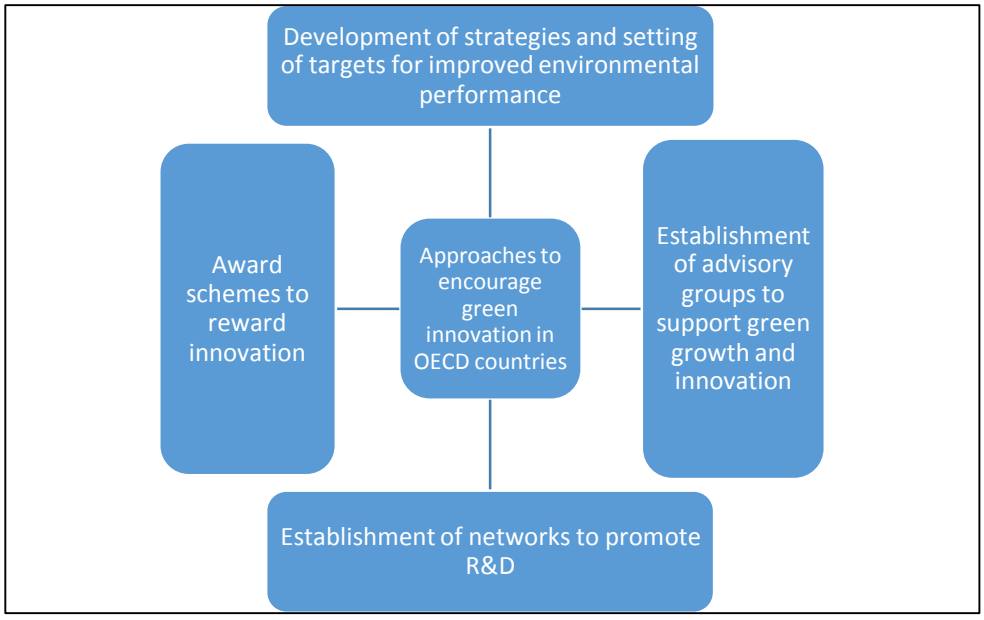


Figure 26 OECD's approach towards green innovation in tourism[53]

[52] http://www.sids2014.org/index.php?menu=1537
[53] OECD. Green Innovation in Tourism
http://dtxtq4w60xqpw.cloudfront.net/sites/all/files/docpdf/oecdgreeninnovationintourism.pdf

3 Waste Streams of Concern

Part III presents a situation analysis for various key waste streams. For each of these waste streams, this Part presents statistics on the scale of waste generation, environmental and social concerns and management practices highlighting opportunities on practicing 3Rs.

Over the past few decades, a number of new waste streams have emerged. **Figure 27** shows a quadrant representation of waste volumes and waste intensity in terms of risks. It may be observed that waste streams produced in bulk i.e. Construction and Demolition waste (C&D), agricultural waste and municipal solid waste (MSW) could be great opportunity for the application of 3Rs. Industrial and Hazardous waste is now the most voluminous and a high risk waste stream in the APAC. Marine litter also is a high risk waste stream that often is not recoverable due to changing streams of ocean currents.[54] Here international interventions and partnerships are most needed. Low volume and high risk waste streams need to be given a special focus– first more on prevention i.e. reduce - followed by safe treatment and disposal practices.

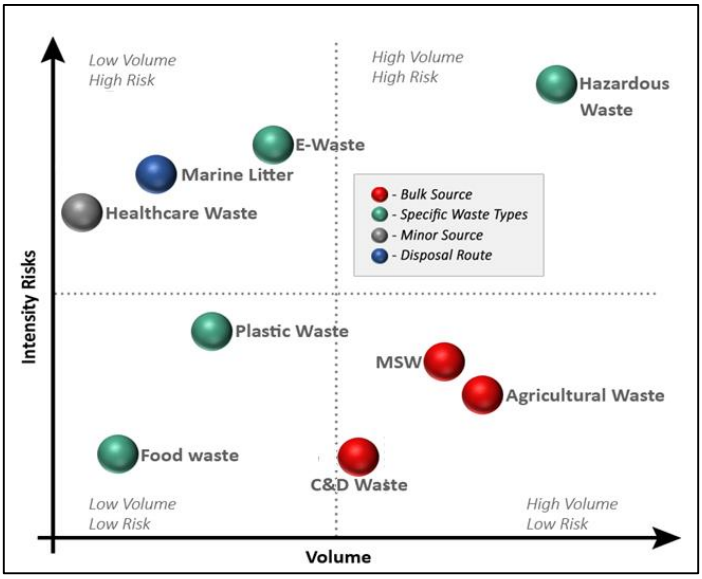


Figure 27 Intensity risks and volumes of various waste streams in APAC

Source: Environmental Management Centre (EMC), Mumbai, India

3.1 MSW

Waste generation is coupled to population increase. As population increases and more and more people migrate from rural to urban areas, their lifestyles and their consumption patterns change. With affluence, the consumption increases. **Figure 28** shows a correlation of a country's Gross National Income (GNI) with its MSW generation.

As per data in EMC's Master Country Database, 34 APAC countries generate 1.53 billion tonnes of MSW. A division of the economies in groups of low, upper middle, lower middle and high income countries offers a deeper perspective as shown in **Figure 29**. The lower middle income countries such as Bangladesh, India, Kiribati, Nigeria, Yemen etc. are growing at a faster rate, as compared to developed countries that have relatively stabilized.

Figure 30 shows the waste characteristics for 14 APAC countries. When it comes to the kind of waste generated in the APAC region, organic fraction of MSW dominates, followed by paper and metal waste. Some regions

[54] Garbage patches have been formed in the oceans due to incessant dumping of wastes and their movement is affected by the ocean currents/gyres.

such as Singapore and The Philippines generate more plastic waste than the others. Thailand and Australia generate more of glass waste, Bangladesh and Sri Lanka generate more textile waste, Thailand and Marshall Islands produce more of metal waste, Japan and Thailand produce more paper waste. Organic waste is in general high in Sri Lanka and Bangladesh, whereas inorganic waste is in general high in India and Indonesia.

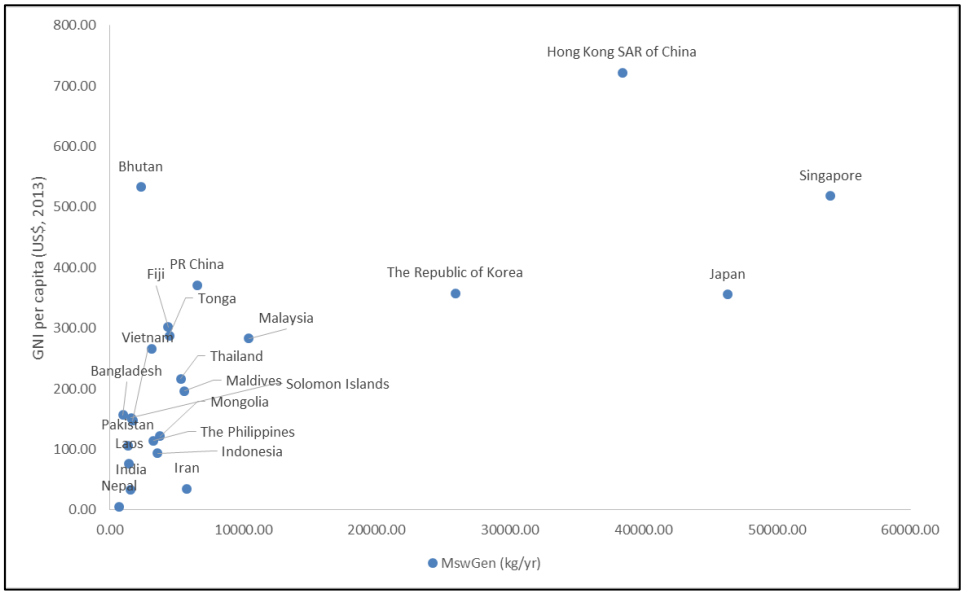


Figure 28 Relation of GNI per capita with MSW generation per capita

Notes: Graph shows MSW generation per capita and GNI per capita for 22 APAC countries. GNI data for 2013. MSW data ranges from 1994-2009, whichever latest available.

Source: EMC's Master Country Database

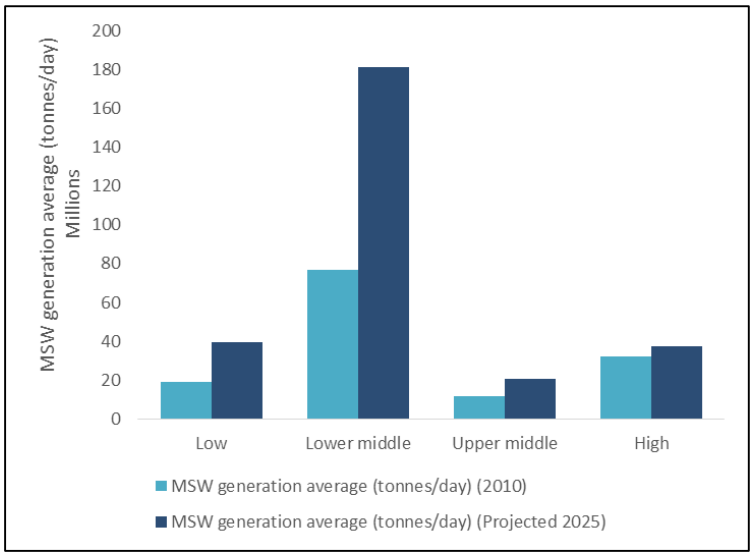


Figure 29 MSW generation and population in APAC (2010 and 2025)

Source: EMC's Master Country Database based on data from World Bank, 2012, What a Waste: A Global Review of Solid Waste Management. Updated with UN World Urbanization Prospects 2014 Revision[55]

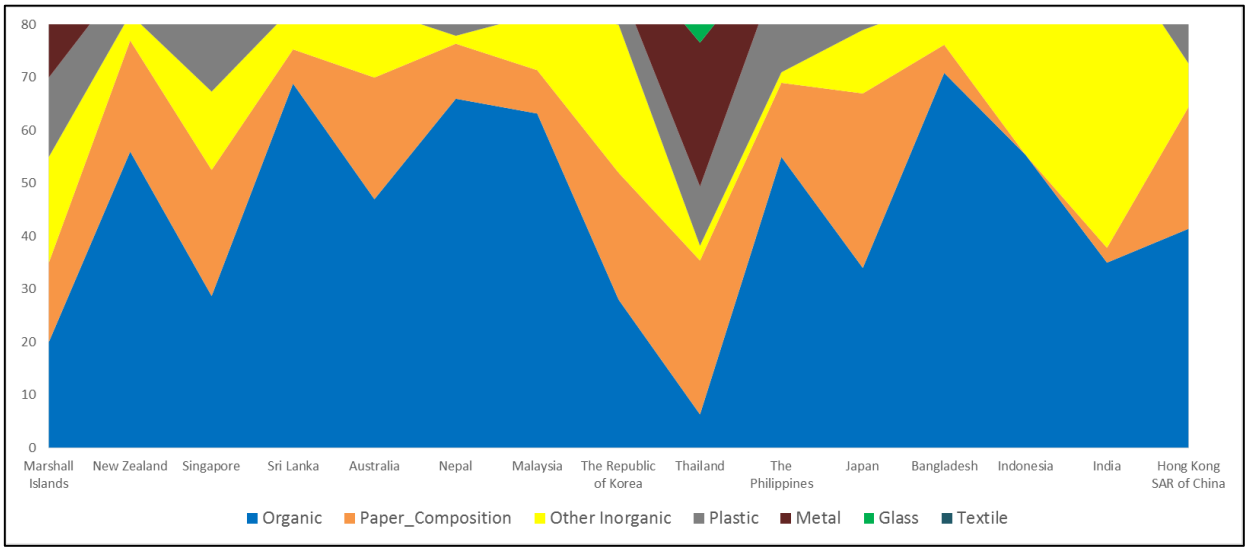


Figure 30 Waste characteristics of MSW in APAC region

Notes: Graph shows waste characteristics of 14 APAC countries. Countries arranged with population smallest to largest from left to right. Data ranges from 1995-2009. Only the latest data is used as available in this range.

Source: EMC's Master Country Database

APAC region's solid waste composition is, by and large, organic (more than 50% biodegradable) consisting of food wastes, yard wastes and mixed paper, with high moisture content, on average (about 50% or more). This renders it unsuitable for incineration. Landfilling, too, is not the best available option for such a kind of waste owing to alternate wet and arid seasons, generation of highly concentrated leachate, methane gas emissions and quick decomposition that affects landfill stability. Mechanical Biological Treatment (MBT) and composting are more appropriate technologies for such kind of waste composition.[56] In Australia for instance, 44% of its organic waste goes for recycling whereas 47% is still disposed in landfills **(Figure 31)**.

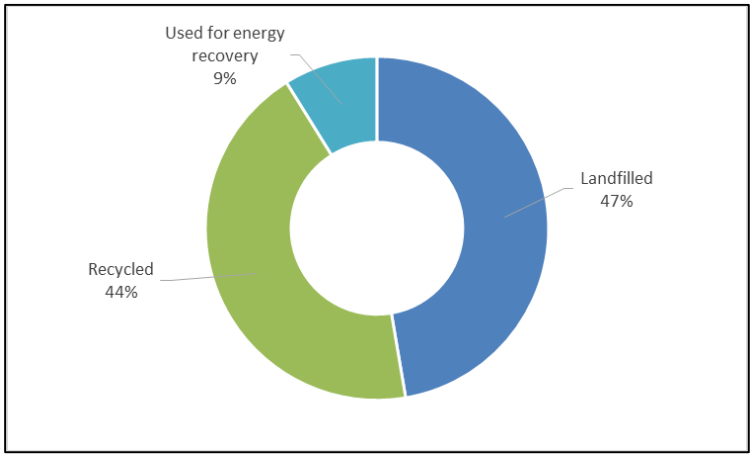


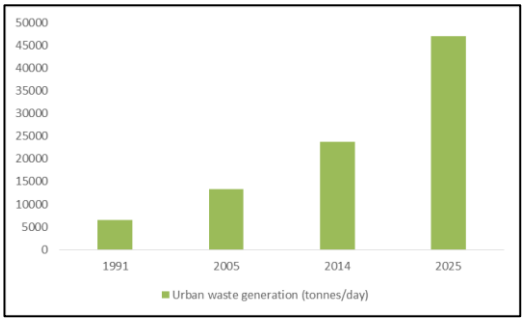
Figure 31 Organic waste disposal in Australia (2010-11)

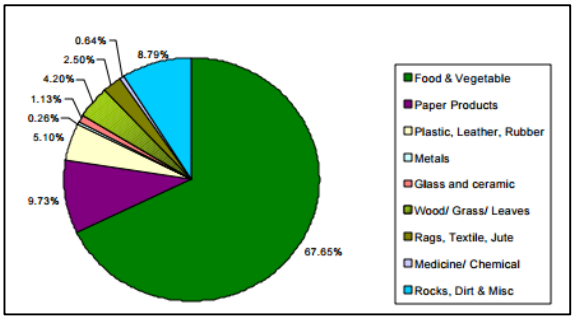
[55] http://esa.un.org/unpd/wup/. Accessed on 4th August 2015
[56] International Symposium MBT 2005. Proceedings: 23 - 25 November 2005, Hanover, Germany.

Notes: Excludes paper & cardboard and primary production wastes

Source: Country Report by Australia for the 6th regional 3R Forum in Asia and the Pacific

Figure 32 provides a snapshot of waste generation in the urban areas of Bangladesh. It has been projected to grow by almost two fold by 2025.





Average Physical Composition of Urban Solid Waste

Figure 32 Waste generation in Bangladesh

The efficiency of collection decides how well these waste streams are segregated and treated for recycling. The average collection coverage in lower-middle income countries is 64% and upper-middle income countries is 82%, and a regional average of 50-90% for Asia. (**Figure 33** and **Figure 34**) Most of the APAC countries fall into the middle income category and from **Figure 34** it can be seen that in relation to high income APAC countries, these countries have moderate collection efficiencies.

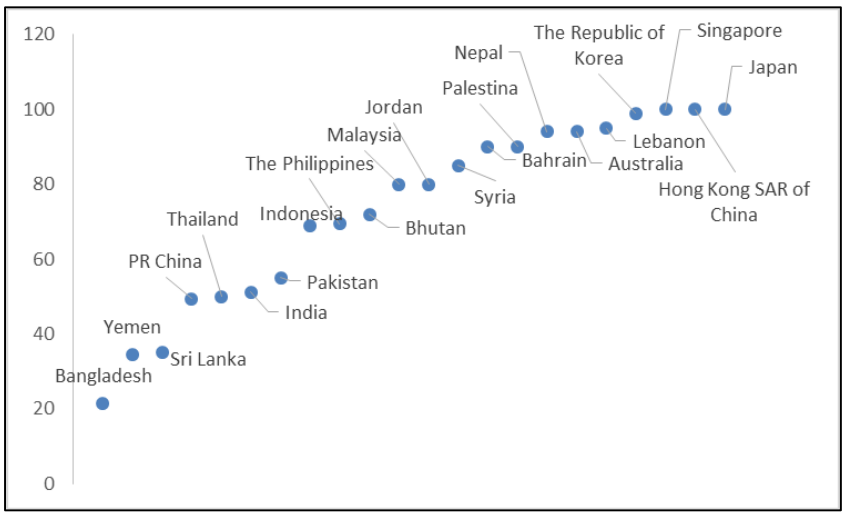


Figure 33 Collection coverage region wise (%)

Source: Waste Atlas - University of Leeds.

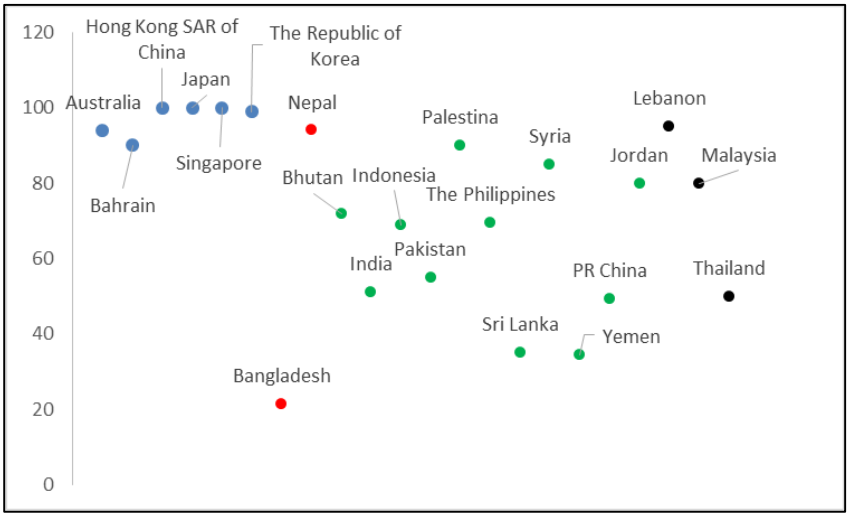


Figure 34 Collection coverage income wise (%)

Notes: Color Codes for income groups: Blue for high income group, Red for lower income group, Green for lower middle group, Black for upper middle group

Source: Waste Atlas - University of Leeds

Landfilling is most often the first option of waste management and also the last resort as it the easiest and the least expensive. With no secure landfills, rampant open dumping, and engagement of the informal sector in landfill related activities, human health is at risk and children are the most vulnerable to health hazards. A two pronged approach for APAC region would be firstly to develop programs that would bring less waste to landfills and secondly to remediate landfills and recover value from these. Landfilling mining and reclamation (LFMR) helps bring 3R principles.. In developing countries of the APAC region, paucity of financial resources and less experience on technology limits engineering of the landfills and in particular LFMR.

With landfilling costs rising everywhere in the world owing to less land, rising waste volumes and stringent environmental regulations, mining and reclamation offers a way to reuse and recycle. Recovered materials can include waste that can be converted to energy, or hazardous waste that would call for a secure treatment. Further, LFMR provides an overall reduction in GHG emissions.[57] It can help expand the existing capacity of landfills and the reclamation costs can be offset through sale of recovered materials. Contracts can be in PPP mode but need a strong support from the government to do so.

Technology, regulation and markets are important drivers for Landfill Mining projects.[58] Studies suggest that such projects are initiated by regional authorities and depend upon regulation more than technology, as different subsidy schemes, taxes, allowances, permits, either make or break landfill mining projects. However with careful feasibility calculations and economic advantage, such projects can also be picked up by private players.

3.2 Medical/Healthcare waste

[57] EPA (1997), Landfill Reclamation. http://www.epa.gov/osw/nonhaz/municipal/landfill/land-rcl.pdf
[58] Life RECLAIM "Landfill mining pilot application for recovery of invaluable metals, materials, land and energy", is a co-funded project by the EU. Its main objective is to build a pilot LFM unit in Polygyros landfill and explore the potential of the method. At the same time, the project aims at raising the awareness of the public about LFM and opening the discussion with the scientific community, the waste industry and the government. http://www.reclaim.gr/#!landfill-mining-world-map/c1v2x

With APAC region's healthcare spending expected to grow at a rate of 7.1% from 2013 to 2017, generation of healthcare waste is bound to increase.[59] WHO estimates that in many low-income countries, total health-care waste per person per year is between 0.5 to 3 kg.[60]

Healthcare waste is a mishmash of different kinds of wastes such as infectious waste, pathological waste, sharps, chemicals, pharmaceuticals, genotoxic waste, radioactive waste etc. Radioactive waste, chemicals, sharps and hazardous waste usually form 20% of this waste (**Figure 35**) whereas the rest is general waste. Healthcare waste poses risk to human health in the form of spread of drug-resistant organisms, radiation, injuries from equipment/tools used such as sharps, and pollution and poisoning due to pharmaceutical products and waste water. Disposal after proper treatment is extremely important.

For a long time, landfill and incineration has been the primary option to deal with healthcare waste. However, disposal need not be the last resort for such wastes. The 3Rs can be implemented in healthcare systems. Some countries have already taken a lead in this direction. **Table 3** shows 3R initiatives in Nepal and India.[61]

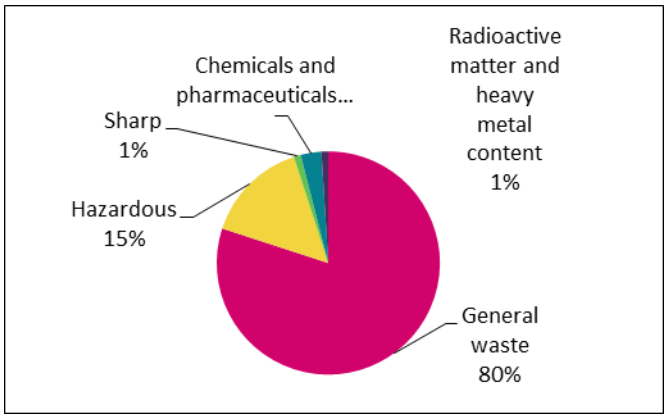


Figure 35 Typical characteristics of healthcare waste

Source: WHO Factsheet[62]

Table 3 3R in healthcare waste management

3R in Countries	What have they done?
Recycling in Nepal	Health Care Foundation recycles blood-contaminated plastics after autoclaving. The foundation also recycles paper, plastic and glass, and estimates that 40% of waste-handling costs are covered by recycling.
Reuse in Delhi, India	Authorized agencies collect mercury waste from health care establishments to be used in the manufacturing process of thermometers / blood pressure measuring apparatus etc.
Reuse in Canada	Approximately, 41% of Canadian hospitals reuse certain types of non-disposable medical devices, such as endoscopes.

59 Deloitte (2014), Global health care outlook: Shared challenges, shared opportunities. https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/dttl-lshc-2014-global-health-care-sector-report.pdf

60 https://sustainabledevelopment.un.org/content/documents/asia-pacific-RIM_waste_final-draft_27Oct09.pdf

61 WHO. Safe management of wastes from health-care activities http://www.who.int/injection_safety/toolbox/docs/en/waste_management.pdf

62 WHO. Waste from health-care activities http://www.who.int/mediacentre/factsheets/fs253/en/

Recycling in England	The Heart of England National Health Service (NHS) Foundation Trust facility invested in balers and compactors to facilitate waste recycling, particularly paper and cardboard.
Composting in UK	The Newham General Hospital in the UK began onsite composting of food waste in 2007.
Environmental Management System (EMS) in UK	As an example, a hospital in the UK introduced an EMS and worked with local authorities and waste contractors to change waste-management methods and introduce recycling schemes. They found that using an environmental procurement policy reduced health-care waste quantities by 4.1% (78 tonnes), energy consumption by 3.6% and water usage by 9.6%.

Sources: WHO[63], Mercury Waste Management in the Health Care Establishments in Delhi[64]

3.3 Agricultural/Biomass waste

EMC estimates that 2.716 billion tonnes of crop residues (i.e. AgroWaste) are produced in the APAC region, assuming that all residues generated go to waste. Although this is ideally not the case, as residues generated do get reused and recycled. These residues are used for (1) energy in the form of ethanol, biogas or electricity and (2) left in the field to increase fertility (3) other purposes such as animal feed, etc. A large part of these residues however remain unutilized or undermanaged as they either rot or are burnt.

Other sources suggest an annual generation of 998 million tonnes and 1.7 billion tonnes of agricultural and biomass waste. 1.7 billon tonnes of this waste could replace 245 million tonnes of gasoline.[65]

In developing countries such as India (especially the Northern region), PR China, Pakistan and Bangladesh, 80-90% of the energy required by households in villages comes from agricultural residues due to wood scarcity, with no attention paid to the pollution it causes. If simply left to rot, nutrients in these residues could go into nearby water bodies causing eutrophication. Moreover, the release of ammonia, hydrogen sulphide and methane could lead to odor and GHG emissions. Utilization of agricultural waste is in fact identified as a counter measure again climate change.[66]

Myanmar generates 19.12 MCT/ annual agricultural biomass waste and Bangladesh generated 65 million metric tonne per year. Singapore's data provides better perspective at the utilization of this waste. In 2014, about 70% of wood and horticultural waste are used to convert into energy at the biomass plants. 13% of food waste are recycled. All remaining organic waste is sent to waste to energy incineration plants for energy recovery.[67]

Figure 36 shows that Asia constitutes 77% of the total AgroWaste generated in Africa, South America and Asia, with most of it coming from Japan, The Republic of Korea and Singapore. Reports however suggest that PR China is the largest generator followed by India, generating 587 million tonnes from rice, corn and wheat alone.[68]

[63] WHO. Safe management of wastes from health-care activities http://www.who.int/injection_safety/toolbox/docs/en/waste_management.pdf
[64] Delhi Pollution Control Committee http://dpcc.delhigovt.nic.in/mercury.html. Accessed on 4th August, 2015
[65] Enabling Frameworks for Promotion of 3R Science and Technologies and Technology Transfer by UNEP-IETC. Background Paper for Plenary Session 2 of the Programme. Final Draft for the 6th regional 3R Forum in Asia and the Pacific
[66] Enabling Frameworks for Promotion of 3R Science and Technologies and Technology Transfer by UNEP-IETC. Background Paper for Plenary Session 2 of the Programme. Final Draft for the 6th regional 3R Forum in Asia and the Pacific
[67] Country Report by Myanmar, Bangladesh and Singapore for the 6th regional 3R Forum in Asia and the Pacific
[68] Enabling Frameworks for Promotion of 3R Science and Technologies and Technology Transfer by UNEP-IETC. Background Paper for Plenary Session 2 of the Programme. Final Draft for the 6th regional 3R Forum in Asia and the Pacific

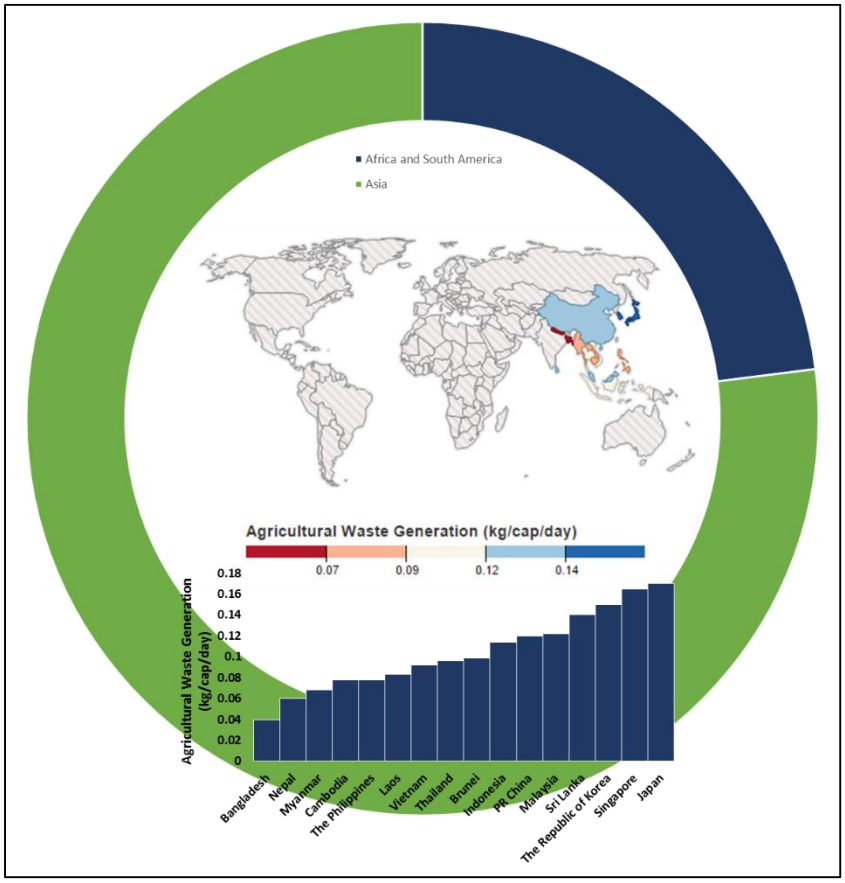


Figure 36 Agricultural Waste Generation in APAC

Notes: An estimated 15% of total waste generation consists of AgroWaste. Graph includes crop waste, animal waste, food processing waste, hazardous, and toxic waste. Countries highlighted in orange are developed countries.

Source: Developed using 'Challenges and Opportunities in Agro-waste Management: An Asian Perspective. Inaugural Meeting of First Regional 3R Forum in Asia', 11-12 Nov 2009, Tokyo, Japan http://www.uncrd.or.jp/content/documents/Session2_Agamuthu.pdf

A contrast can be seen between India and Thailand in the way they deal with agriculture in general. While India depends mostly on subsistence agriculture, Thailand is carrying out sustainable agricultural production.[69] An interesting case in point is that of the Republic of Korea, where infrastructure for the management of agriculture waste is stressed upon. The Republic of Korea has established infrastructure to collect and recycle waste agricultural plastic films and agrochemical containers in collaboration with the municipalities. The Korea Environment Corporation has been overseeing this since 1980.[70]

[69] Resource efficiency and waste minimization achieved through the 3Rs: A core element of Asia-Pacific governments' economic growth strategies by Heinz Schandl Commonwealth Scientific and Industrial Research Organisation, Canberra. Background Paper for Plenary Session 1 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

[70] Country Report by the Republic of Korea for the 6th regional 3R Forum in Asia and the Pacific

Table 4 Biomass Policies/Programmes in APAC

Country	Biomass Policy/Programme
Thailand	Very Small Power Producers (VSPPs) scheme, 2001
Malaysia	Five-Fuel Policy under the Eighth Malaysia Plan, National Renewable Energy Policy and Action Plan (NREPAP), National Biomass Strategy (NBS)
Cambodia	National Sustainable Development Plan (NSDP 2009-2013), Rural Electrification Master Plan, the Renewable Energy Action Plan (REAP) and, the Cambodia Climate Change Strategic Plan (CCCSP).
India	Biomass Power and Cogeneration Programme, Ethanol Blending Program (EBP)
PR China	Circular Economy Promotion Law, the Renewable Energy Law

Source: Compiled from Circular Economic Utilization of Agriculture and Biomass Waste – A Potential Opportunity for Asia and the Pacific by Prof. P. Agamuthu. Background Paper for Parallel Roundtable 3 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

The agricultural sector has contributed to 0.7%-30% of the total GDP for APAC countries. The corresponding biomass economy driven by the wastes generated is worth a total of 17 trillion US$, making up a majority of the renewable energy production in APAC. It supplies 30% of the energy supplies in developing countries, 10% of the global energy supply and 7% of the energy supplies in APAC alone.

Briquetting is a preferred option for converting agricultural waste to energy for reasons such as (a) technology is universally accepted (b) there are a number of export-oriented briquette producers and buyers (c) considered as an appropriate technology for indigenous production and in rural areas of developing countries. 153 million tonnes of briquettes worth 23 billion US$ could come from APAC region.[71]

A constant supply is important for the economy to be sustainable.[72] **Box 4** shows FAO's approach towards helping developing countries effectively design their policies and strategies to deal with agricultural waste and to make the most out of it, especially the challenges faced in the supply of agricultural waste.

Box 4 FAO's Bioenergy and Food Security Approach

A shift from fossil fuels to biomass and biofuels is necessary for sustainable development. However, options like biofuels incite the 'food versus fuel' debate. To analyze the complex relationship between food security, sustainability and bioenergy development, the Food and Agricultural Organization (FAO) developed the Bioenergy and Food Security Approach (BESF). This is done to ensure that bioenergy development promotes food security and energy security, and agricultural and rural development. It can be achieved by adhering to a set of 24 voluntary indicators developed by The Global Bio-Energy Partnership. Using the BEFS Approach, developing countries can effectively design their bioenergy policies and strategies.

BEFS has been successfully applied in countries such as Thailand and Mali. Thai economy has strengthened itself by using its strong agricultural sector to initiate a shift to industrialization. Thailand's Alternative Energy Development Plan (AEDP) aims to leverage its strong agricultural sector to expand biofuels production six-fold to five billion liters by 2022.

Findings of BEFS outline strategies necessary to improve agricultural productivity and meet ambitious biofuel targets. In Thailand, BEFS Analysis assesses the feasibility of bioenergy sector and recognizes that biofuels

[71] Enabling Frameworks for Promotion of 3R Science and Technologies and Technology Transfer by UNEP-IETC. Background Paper for Plenary Session 2 of the Programme. Final Draft for the 6th regional 3R Forum in Asia and the Pacific

[72] Enabling Frameworks for Promotion of 3R Science and Technologies and Technology Transfer by UNEP-IETC. Background Paper for Plenary Session 2 of the Programme. Final Draft for the 6th regional 3R Forum in Asia and the Pacific

and bioenergy[73] is an extension of the agricultural sector. Thailand exports its harvest rice, sugarcane, rubber sheets, palm oil, cassava etc., thus generating revenue and also residues in the country. These residues are used as energy sources for the industry, rice mills burn paddy husks for electricity production, sugar mills and ethanol plants co-fire their refineries using bagasse. Private industries have developed biogas technology using animal manure and landfill residues. In the biofuel sector, BEFS analysis has helped in the design of detailed roadmaps and arrive at solutions such as increasing yield for cassava and sugarcane, and mandatory blending targets for biodiesel.

3.4 E-Waste

Global e-waste has been increasing in the past decade and estimates say that it will continue to rise with rising population. This is reflected across the APAC region, especially in Eastern and Southern Asia, followed by Western and South Eastern Asia, Australia and New Zealand. The e-waste market accounts for 4.8 billion US$, dominated by gold, copper and plastics. (**Figure 37**)

APAC is an abode to 16.6 million tonnes of e-waste, thus accounting for 40% of the total e-waste produced in the world. **Figure 38** shows APAC's highest e-waste generating countries in absolute million tonnes. Australia, New Zealand, Marshall Islands, Hong Kong SAR of China, Singapore and Brunei top this list if relative quantities are considered in kg per inhabitant. In absolute terms, highest e-waste generating countries are PR China (6 million metric tonnes (MT)), Japan (2.2 million MT), and India (1.7 million MT).

Parts of the e-waste generated are valuable, such as scarce metals or metals in high demand, whereas some are hazardous and need to be safely disposed of. For example, in 2014, the amount of gold in e-waste worldwide (300 tonnes) accounted for 11% of the gold mined.[74] Toxic e-waste includes lead glass, batteries, printed circuit boards, brominated flame retardants, cables etc. The toxicity comes from chemicals like lead, cadmium and mercury, which can lead to impaired mental development, cancer, liver and kidney damage.

Globally, 6.7 million tonnes of e-waste is collected, which is merely 16% of the global e-waste generated (**Figure 39).** Out of this, 28% is collected in Asia, with PR China and Japan collecting 1.29 million MT and 0.5 million MT respectively. 84% of the collected waste is recycled around the world, much of which is illegally trafficked across borders. The informal sector of countries such as PR China and India bears the brunt of this activity. [75] Over 1 million poor people are involved in the recycling operations in India. Environmentally sound management (ESM) of this waste is absent or very limited worldwide.[76]

Table 5 E-waste regulation in APAC countries

Country	E-waste regulation
India	E-waste rule mandates producers to be responsible for the collection and financing the systems according to the EPR principle
Bangladesh	No specific laws for e-waste
Pakistan	No inventory or exact data on e-waste generation
Thailand	National Strategic Plan on Integrated Management of E-waste, Draft Act on Economic Policy Instruments for Environmental Management proposes a –Buy-back' for consumers

73 Bioenergy is the conversion of biomass resources such as agricultural and forest residues, organic municipal waste and energy crops into useful energy carriers including heat, electricity and transport fuels. http://ec.europa.eu/research/energy/eu/index_en.cfm?pg=research-bioenergy. Accessed on 4th August 2015

74 Business and Economic Potential of Resource Recovery and Recycling from E-waste by Dr Sunil Herat. Background Paper for Parallel Roundtable 4 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

75 Refer to sections 8.6.9 and 8.6.10 in Annexure F for information on e-waste and measures taken to tackle the e-waste problem

76 Business and Economic Potential of Resource Recovery and Recycling from E-waste by Dr Sunil Herat. Background Paper for Parallel Roundtable 4 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

	through government subsidized Buy-back centers to create a market for used products containing hazardous substances.
Vietnam	Recently proposed detailed specifications on e-waste take scheme
Malaysia	E-waste regulated since 2005. Imports of e-waste not allowed
The Republic of Korea	EPR system exists since 2003 for 27 items. No restriction on imports because remanufactured goods are not considered wastes.
PR China	Technical Poilcy on Pollution Prevention and Control of WEEE, 2006. Ordinance Management of Prevention and Control of Pollution from Electronic and Information Products, 2007. Administrative Measures on Pollution Prevention of WEEE. Tecnical Specifications of Pollution Control for Processing WEEE, 2008. Regulation on Management of the Recycling and Disposal of Waste Electrical and Electronic Equipment, 2011.
Japan	Specific Household Appliance Act (1998), Promotion of Recycling of Small Waste Electrical and Electronics Equipment Act (2013), Recycling Promotion Law (2001)

Source: (a) Business and Economic Potential of Resource Recovery and Recycling from E-waste by Dr Sunil Herat. Background Paper for Parallel Roundtable 4 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific (b) Country Report by The Republic of Korea for the 6th regional 3R Forum in Asia and the Pacific (c) SteP (2013) E-waste in PR China: A country report

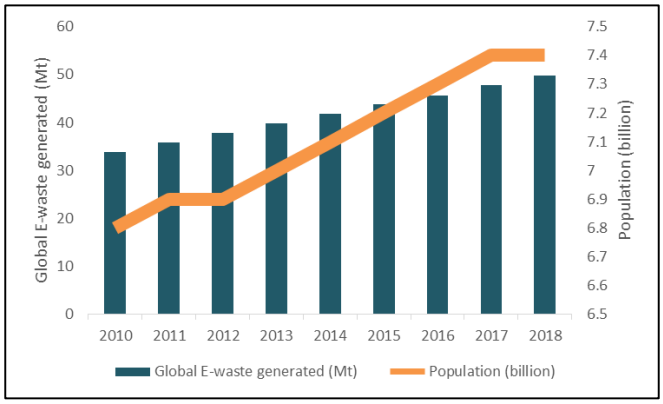


Figure 37 Relation of population with e-waste generation

Notes: Eastern Asian countries: PR China, Hong Kong SAR of China, Macau, Japan, Mongolia, North Korea, The Republic of Korea, and Taiwan Province of China. Southern Asian countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka. Western countries comprise of 21 countries. South eastern countries comprise of 11 countries and 3 territories

Source: Global E-waste Monitor, 2014[77]

[77] Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany. http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf

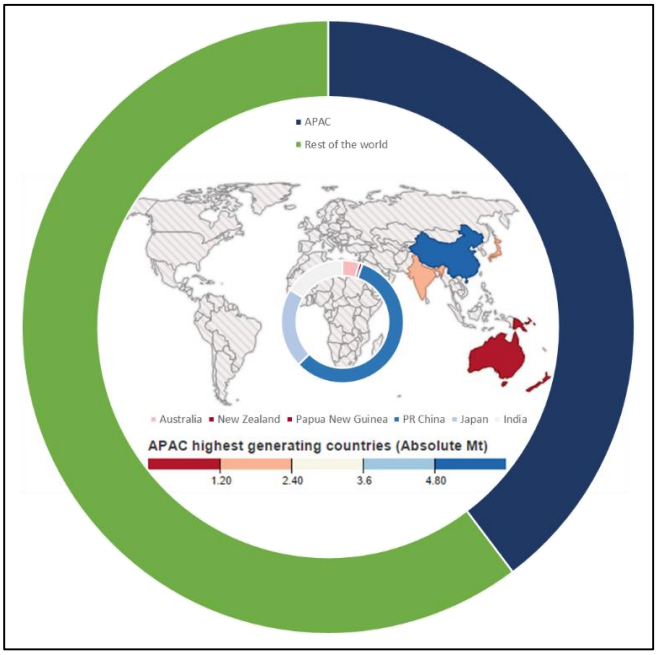


Figure 38 E-waste generation in the world and in APAC

Source: Global E-waste Monitor, 2014[78]

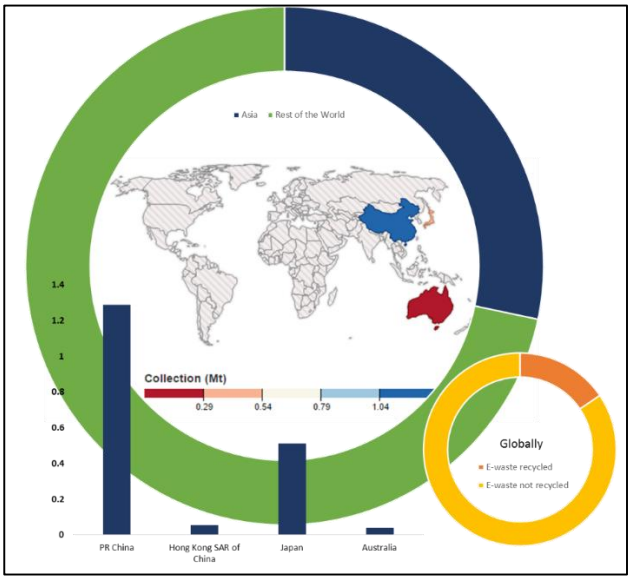


Figure 39 E-waste collection and recycling worldwide and in APAC regions

Source: Global E-waste Monitor, 2014[79]

[78] Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany. http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf

[79] Baldé, C.P., Wang, F., Kuehr, R., Huisman, J. (2015), The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany. http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf

For many years, countries all over the world have been exporting their e-waste to Asia where informal sector is engaged in recycling the waste in hazardous conditions. There are many unclaimed/orphan electronic products, no one is claiming responsibility for, and these are a burden on the region's local and governmental authorities and residents. Large quantities of e-waste is being piled up in the APAC region, and no place to dispose in a secured infrastructure.

Extended Producer Responsibility (EPR) eases this situation by placing responsibility of e-waste management on the producer. The principle of EPR is often viewed as a powerful economic instrument, as much as a moral or an environmental imperative. Japan, PR China, Republic of Korea, Taiwan Province of China and Thailand have undertaken proactive efforts to introduce EPR in its policies, as shown in **Table 6** and **Table 7**.

Table 6 Administrative policy instruments in Thailand related to EPR

Plan or Act	Major Content	Status /date
The National Master Plan on the Cleaner Production and Cleaner Technology	◦ Aims to promote cleaner production in many sectors, including the industrial sector, to minimize pollutions and wastes ◦ Employs legal instruments, supporting tools, economic instruments ◦ Regarding industrial sector, the aims are to reduce pollution and hazardous substances from production processes and products	Approved in 2002
National Integrated Waste Management Plan	◦ Cradle to cradle concept ◦ Addresses minimizing waste generation, increasing waste segregation, and enhancing waste utilization	Approved in 2003
Strategic Plan on E-Wastes	◦ Aims for environmentally sound management of e-waste by improving collection and segregation systems and suitable management of e-waste ◦ Introduces Polluter Pays Principle (PPP) ◦ Covers responsibilities of producers, importers and consumers	Approved in 2007
(Draft) Strategic Plan on Packaging and Packaging Waste Management	◦ Aims to reduce waste from packaging ◦ Employs integrated waste management and life cycle approaches ◦ Covers design, production, consumption, treatment and disposal of packages	Drafting
(Draft) Promotion of Hazardous Waste Management from Used Product Act	◦ Aims to reduce environmental and health impacts from hazardous waste originated from used products, to promote the utilization of the product, and to properly disposal of used products ◦ Employs EPR concept by applying charges for producers/importers of regulated products, setting up a buy-back system, and establishing a fund to manage all financial capital related to hazardous waste and used products	Merged under the (draft) Economic Tool for Environmental and Water Pollution Tax Management Act (editing and waiting for submitting to the committee of Ministry of Finance; as of December 2008)

Source: Compiled by Authors

Table 7 EPR highlights and progress in APAC countries

Year	Country EPR highlights and progress
1970 (1973-74)	Japan argued about implementation of EPR, as cost to municipality was high
1984	Environment Protection Administration (EPA), Taiwan Province of China organized mixed metal scrappers together in two districts in an attempt to effectively monitor their recycling practices. However, this measure was not successful.
1990s	Municipalities and the Ministry of Welfare (MoW), Japan started demanding that used home appliances should be designated as "tekisei-shori-konnanbutsu" (AEHA 1998).
1992	Law for Promotion of Effective Utilization of Resources (LPER), Japan - start of EPR in Japan EPR policy in Republic of Korea began with the enactment of the Law for Promotion of Resources Saving and Reutilization (LRSR) through Producer Deposit Refund (PDR) system. There were 17 items in seven categories under the Waste Management Law.
1993	17 items reduced to 13 items in five categories, under the Waste Management Law, Republic of Korea
1994	OECD Manual for EPR as a policy instrument launched
1996	PET bottles for detergent and refrigerators were newly added, finally resulting in 12 items in six categories, Republic of Korea
1997	The Law for Container and Packaging Recycling (LCPR), Japan
1998	Recycling Fund Management Committee (RFMC) system was introduced in 1998, Taiwan Province of China
2000	Fundamental Law for Establishing a Sound Material-Cycle Society (FLMS), Japan
2001	Recycling of used computers does not fall under the Law for the Recycling of Specified Kinds of Home Appliances (LRHA) and is therefore not regulated as a compulsory legal requirement under the law. However, since April 2001, computers discarded by businesses must be collected and recycled pursuant to the Law for the Promotion of Effective Utilization of Resources (LPUR).
2002	SEPA and other ministries jointly issued the List of Commodities which were Banned for Import (Categories 4 and 5). According to this list, certain types of waste, including batteries, air conditioners, computers, refrigerators, and TVs, were banned for import, PR China
January 2003,	The Producer Responsibility (PR) system was launched under an amendment to Resources Saving and Reutilization (LRSR), Republic of Korea
October 2003	Computer manufacturers have been voluntarily taking part in collection and recycling since October 2003, Japan
2003	SEPA issued the Notice on Strengthening the Environmental Management of E-waste with the goals of reducing the overall volume of e-waste, increasing the reutilization rate, and reducing negative environmental impacts, PR China
2005	NDRC and six other Ministries enacted Guidelines for CE Pilot Projects to promote the concept to enterprises, PR China
2006	Printers, copy machines, and facsimiles were added after a pilot period, Republic of Korea
March 2007, **Enacted in March 2007**	Measures for the Administration of Prevention and Treatment of Pollution by Electronic Information Products (MII), often referred to as the Chinese version of RoHS (Restriction of Hazardous Substances) legislation.

2007	Specific article on take-back and deposit refund in Solid Waste and Public Cleansing Management Act 2007. Draft Regulation on Recycling and Disposal of End-of-life Electrical and Electronic Equipment, Malaysia
2007	WEEE Strategic Plan in 2007 and Draft Act on Economic Instruments for Environmental Management (under development), Thailand
2008	Law on Resource Circulation of Used Electrical and Electronic Equipment and Used Cars (LREC) was enacted, Republic of Korea. The law introduced new provisions regarding the efficient use of used consumer appliances and used cars, which were previously regulated separately under the revised LRSR and Car Management Law respectively
2008	Specific article on EPR is under preparation under Solid Waste Management Act 2008, Indonesia
January 2009	Circular Economy Promotion Law (CEPL), PR China is looked at, as an economic approach and is not administered by the environmental departments of the government.
February 25th, 2009	Ordinance on the Collection and Treatment of Waste Electrical and Electronic Products was promulgated by the State Council, PR China. It will be implemented starting from January 1st, 2011. Under this Ordinance, NDRC and other ministries were authorized to formulate a special list of waste products and the roles of different actors in the collection and reuse/recycle system were defined.
2010	Draft regulations on the reclamation and treatment processes for disposal products (under planning; draft released in 2010), Viet Nam
2011	Rules on the Administration of the Recovery and Disposal of Discarded Electronic and Electrical Products (promulgated in 2009, effective in 2011), PR China

Sources: IGES[80]

Solving the e-waste problem (StEP Initiative) is a collaborative global initiative uniquely leading global thinking, knowledge, awareness and innovation in the management and development of environmentally, economically and ethically-sound e-waste resource recovery, reuse and prevention. StEP's programmes focus on helping governments with legislations. Through their global e-waste map, they have provided country-wise information about e-waste generated/consumed and legislation regarding the same.[81] **Box 5** describes more details. This initiative should be promoted and collaborated within Asia.

Box 5 StEP initiative

StEP membership is open to companies, governmental organizations, academic institutions, NGOs and international organizations that commit to actively and constructively participating in StEP's work by signing StEP's Memorandum of Understanding. StEP members are expected to make monetary and in-kind contributions to support the Initiative and its projects. Since its inception in 2007, it has conducted several events, established partnerships and published several papers.

Year	StEP events and cooperations	StEP Publications
2007	Launch of StEP at UN	-
2008	1st World Reuse Forum, organized by StEP	-

[80] (a) IGES Proposal for Rio+20 Issue Brief: Applying EPR in developing countries. enviroscope.iges.or.jp/modules/envirolib/upload/3553/attach/rio_issue_brief_vol3_EPR_mar2012.pdf (b) Extended Producer Responsibility (EPR) Policy In East Asia - In Consideration Of International Resource Circulation http://pub.iges.or.jp/modules/envirolib/view.php?docid=2607

[81] StEP website http://ias.unu.edu/en/research/solving-the-e-waste-problem-step-initiative.html#outline. Accessed on August 4th, 2015.

2009	MoU with Secretariat of Basel Convention, 1st E-waste Summer School (EWAS), 1st E-waste Management Forum, Cairo	White Papers: E-waste Take-Back System Design, Common Understanding of Reuse, Revision of WEEE Directive, Publication with UNEP: Recycling – From E-waste to Resources
2010	2nd E-waste Summer (EWAS)	-
2011	MoU with GeSI, 3rd E-waste Summer School (EWAS), StEP Open Meeting Addis Ababa (Ethiopia)	StEP Green Papers: E-waste Indicators, Impacts of Substance Restrictions
2012	StEP comments Ghana draft e-waste bill, 1st E-waste Academy Managers Edition (EWAM), St StEP ep Open Meeting Beijing	StEP Green Papers: Recommendations for Standards, Impacts of Substance Restrictions
2013	MoU with the Green Grid StEP Side-Event at Basel COP E-waste World Map, 4th E-waste Academy Scientists Edition (EWAS)	StEP Green Papers: Transboundary Movements, E-waste in China, E-waste in Ethiopia
2014	StEP suspends Task Forces and identifies project priorities for the next year, 2nd E-waste Academy Managers Edition (EWAM), 5th E-waste Academy Scientists Edition (EWAS)	StEP White Papers: Recommendations for Standards Development for Collection, Storage, Transport and Treatment of E-waste, One Global Definition of E-waste StEP Green Papers: Differentiating EEE Products and Wastes

Sources: (a) StEP Initiative Annual report 13-14 and StEP website (b) Business and Economic Potential of Resource Recovery and Recycling from E-waste by Dr Sunil Herat. Background Paper for Parallel Roundtable 4 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific (c) StEP Annual Report 2013-14

3.5 Industrial and hazardous waste

Industrial and hazardous wastes include housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, and special wastes. There is no internationally accepted definition of this waste but there is a general consensus that 10 to 15% of wastes produced by the industry are hazardous and it is increasing at a rate of by 2 to 5% per annum. Low concentrations of hazardous substance in products/materials is not officially categorized as hazardous waste because of increase in the number of chemicals produced and their use in a broader range of products. Many countries are now paying attention to such concentrations of waste in places where it is more often overlooked, such as in households (called household hazardous waste), and offices. Healthcare waste too is sometimes classified as sub-category of hazardous wastes in many countries.[82]

The manufacturing industry in PR China generates substantial quantities of industrial and hazardous waste as shown in **Figure 40** and **Figure 41**. On the other hand, the country encourages and supports cleaner production and minimization of the generation of solid wastes, by putting efforts into not only cleaner production, but also policy and regulation making, technical training, advanced experience spreading, etc. The Ministry has also facilitated establishment of hazardous waste market and enhanced domestic hazardous waste disposal capacity.[83]

Such an approach is also needs to be replicated throughout APAC region, focusing more on the infrastructure required for the application of 3R for hazardous waste. It will be necessary to separate hazardous waste from non-hazardous waste, be it from a hospital, a household or an office, in order to stop the disposal of such waste in an unsafe and uncontrolled manner.[84] Small-sized enterprises can collectively apply 3R to hazardous waste

[82] https://sustainabledevelopment.un.org/content/documents/asia-pacific-RIM_waste_final-draft_27Oct09.pdf
[83] Basel Convention Country Report for PR China
[84] UNEP (2015) Global Waste Management Outlook

through common hazardous waste facilities, medium-sized enterprises will require funding and large companies can invest in cleaner technologies.

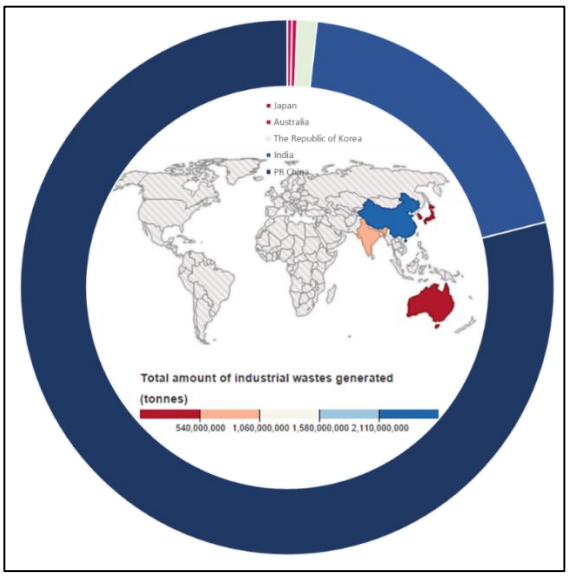


Figure 40 Industrial wastes generated in the APAC region

Notes: Data for countries varies from 2008 to 2013.

Source: EMC's Master Country Database based on compilation of OECD data, Frost & Sullivan data, and Government data for 5 countries.

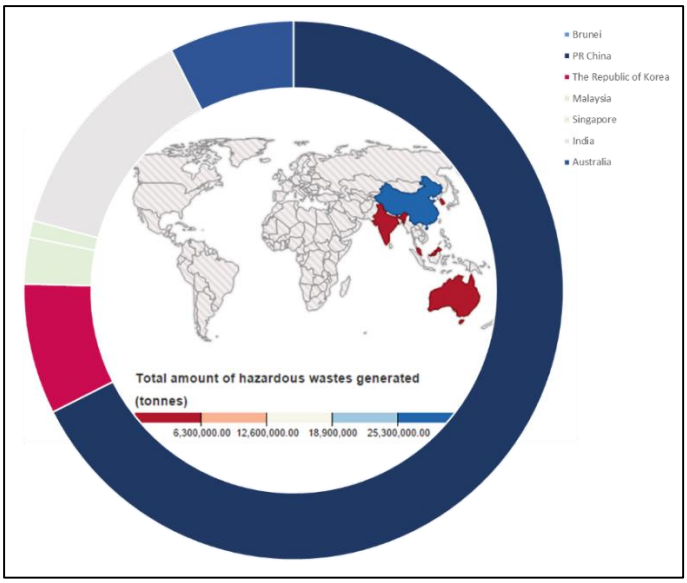


Figure 41 Hazardous wastes generated in the APAC region

Source: EMC's Master Country Database. Brunei and The Republic of Korea data on the Generation and Transboundary Movements of Hazardous Wastes and Other wastes in 2006 (as reported). PR China 2013 data from PR China Statistical Yearbook 2014. 2008 UN statistics data Malaysia and Singapore. Data for India and Australia obtained from respective Governments.

3R for industrial and hazardous waste can avoid environmental risks, conserve natural resource by reducing the consumption of raw materials, in a way that is economically beneficial. 3R also helps avoid the amount of this waste going to the landfill and associated environmental, social and economic costs. It reduces pollution at source

where extraction of the raw materials is required. When a company adopts 3R in its handling of hazardous waste, it displays corporate stewardship and enhances its image as a green company.

At a micro level, through green chemistry, hazardous waste can be reduced or avoided all together, by eliminating generation of this waste at each step of the process. Less hazardous but equally efficacious materials can be used to replace hazardous substances, in turn reducing the amount of hazardous waste generated. **Box 6** shows two applications of green chemistry for reduction of hazardous waste, and initiatives taken by various APAC countries.

Box 6 3R for hazardous waste

- The traditional multistep method to make a drug for treating high cholesterol used large amounts of hazardous reagents and produced a large amount of toxic waste in the process. Professor Yi Tang, of the University of California, created a synthesis using an engineered enzyme and a low-cost feedstock. Codexis, a biocatalysis company, optimized both the enzyme and the chemical process. The result greatly reduces hazard and waste, is cost-effective, and meets the needs of customers.
- In 2005, Nobel Prize was given to a group of scientists for producing a catalyst that would aid metathesis, a very common reaction in the chemical industry, reducing potentially hazardous waste through smarter production.
- A Waste Reduction Framework Plan was launched in in Hong Kong SAR of China in November 1998 to minimize the amount of waste produced that requires disposal and to promote recycling of different types of wastes.
- A territory-wide waste recovery programme was introduced in January 2005 in Hong Kong SAR of China to facilitate separation of different types of wastes at sources. A 20-hectare EcoPark is being developed for this.
- In Indonesia, an Environmental compliance program, called PROPER, was launched by the Ministry of Environment to increase efforts to comply with applicable regulations such as hazardous waste management.
- Japan's Basic Law for Establishing a Sound Material-Cycle Society aims to promote sound cyclical use and disposal of these wastes. Under the Voluntary Action Plan on the Environment adopted by the Keidanren (Japan Federation of Economic Organization), measures are taken on promoting recycling and limiting the discharge of wastes. At April 1, 2006, the number of 3R facilities authorized by governors is 19,164.
- In the Republic of Korea, the Extended Producer Responsibility (EPR) system and the Waste Charge System have been in effect. Private companies operated 219 incinerators and 20 landfills for specified wastes, which are considered as hazardous waste pursuant to the Waste Management Act.
- In Malaysia, Malaysian Agenda for Waste Reduction (MAWAR); and promotion of cleaner production tackle hazardous waste. Measures taken by industries/waste generators include cleaner production, waste minimization and ISO 14001 certification.
- In Singapore, National Recycling Programme (NRP) for households was launched in April 2001 to increase recycling rate for household hazardous wastes. Private companies can apply to Agency for Science, Technology and Research (A*STAR) for research funding on reduction of hazardous waste generation or recycling of hazardous wastes. A number of privately operated toxic waste treatment companies are licensed by the Pollution Control Department for treatment, recovery, reprocessing, recycling and disposal of hazardous industrial wastes
- In Thailand, co-incineration of wastes in cement kilns is an option other than landfilling, since 2001. There are seven cement manufacturers expanded their capability in co-incinerators of hazardous wastes. A pilot project on waste exchange programs are being conducted in Thailand to encourage recycling in industries. As of 2004, over 400 industries had registered on the waste exchange database established by Ministry of Industry. The following methods have been used as support tools to reduce and/or eliminate generation of wastes: ISO 14000s, ISO 18000, Life cycle Assessment and Greening of Supply Chain etc.; research on clean technologies and waste minimization e.g. research on cleaner production in the dyeing and synthetic rubber industries; and technical guidelines on the environmental sound management of

hazardous wastes generated from communities e.g. laboratory waste, commercial waste, infectious waste, vessel and port waste. Deposit-refund system, e.g. bring-back program, this system will be used as a tool for subsidizing the consumer to return the remains of products containing hazardous substances such as dry cell batteries for final disposal or recovery

- In Viet Nam, there are about 20-30 facilities that have hazardous waste recovery activities with permit.

Sources: (a) American Chemical Society. http://www.acs.org/content/acs/en/greenchemistry/what-is-green-chemistry/examples.html. Accessed on 14th September, 2015. (b) Press Release. http://www.nobelprize.org/nobel_prizes/chemistry/laureates/2005/press.html. Accessed on 14th September, 2015. (c) Basel Convention Country Reports http://www.env.go.jp/en/recycle/asian_net/Country_Information/National_Reporting.html. For Hong Kong SAR of China, http://www.epd.gov.hk/epd/english/top.html, http://www.env.go.jp/en/recycle/asian_net/Country_Information/Statistical_Data/HongKong_of_Statistical_Data.html, http://www.epd.gov.hk/epd/english/resources_pub/envir_info/envir_info.html

3.6 Construction and demolition waste (C&D)

With rapid urbanization and increase in population, migration from rural to urban areas, new construction projects and demolition of old construction projects have contributed to a rise in the C&D waste. Indiscriminate disposal of C&D waste can lead to sulfate leaching and release of other chemicals, especially when this waste comes in contact with the environment[85], cause floods due to obstruction of storm water and choke the landfills.

Table 8 shows the C&D waste generation rates as compiled for various countries. Recycling potential of C&D waste is high. Hong Kong SAR of China, PR China, Japan, and Singapore, have achieved high recycling rates of C&D waste[86]

Table 8 C&D waste generation rates

Location	Waste Generation Rate	Waste Characterized	Income Group
Thailand	21.38 kg/m2 (residential); 18.99 kg/m2 (commercial)	Typical C&D waste	Upper middle
Hong Kong SAR of China	0.175 m3/m2 (Public residential); 0.250 m3/m2 (Private residential); 0.200 m3/m2 (Commercial)	Typical C&D waste	High
Taiwan Province of China	21% of waste; 2.4 MMT/year	Concrete waste	High
Norway	29-31 kg/m2 (construction); 574-1100 kg/m2 (demolition)	Typical C&D waste	High
Greece	50 m3/1000m2 (construction); 0.8 m3/m2 (demolition); C&D waste density is 1.6 ton/m3	Typical C&D waste	High
Florida, U.S.	12-21 kg/m2 (construction); 20-82 kg/m2 (renovation); 595-910 kg/m2 (demolition)	Typical C&D waste	High

[85] Y. Jang, T. Townsend. Advances in Environmental Research 5 (2001) 203-217
[86] ADB (2015), People's Republic of China: Construction and Demolition Waste Management and Recycling http://www.adb.org/sites/default/files/project-document/161008/48105-001-tar.pdf

U.S.	4.38 lb/sq ft (new residential); 3.89 lb/sq ft (new commercial)	Typical C&D waste	High
India	40-60 kg waste /m2 (average for a pucca house)	Building related C&D waste generation	Lower Middle

Source: (1) Adapted from Construction Waste Quantification and Benchmarking: A Study in Klang Valley, Malaysia. J. Chem. Chem. Eng. 5 (2011) 909-916. (2) TIFAC (Technology Information, Forecasting and Assessment Council), 2001. Utilization of waste from construction industry. Department of Science and Technology, Government of India. Code No. TMS150.

PR China builds more than one-third of all the buildings in the world, producing and consuming 55% of the cement globally, and consumes 45% of the national energy for these activities. It is estimated that about 350 million tons of C&D is generated in the country per year. [87] C&D waste recycling rates in PR China however do not exceed 5%–10% due to concerns over quality (resulting from the absence of clear technical regulations on segregation at source), low costs of natural aggregates, low disposal fees (often fully subsidized) at municipal solid waste and C&D waste landfills, and illegal disposal. [88]

Japan has focused on dematerialization and resource efficiency for more than a decade now. Its 'Sound Material Cycle Society' initiative was launched in 2000, followed by the Construction Waste Recycling Law. It resulted in high rates of recycling, as high as 99% of concrete was recycled in 2006.[89]

It is estimated that India generates 531 million tonnes of C&D waste annually[90]. Two C&D recycling plants are currently operational in India at Delhi and Ahmedabad, under partnership between municipal agency and private waste management company. The materials recovered from these facilities are used to manufacture building materials like pavement blocks and not for load bearing structural purposes. The existing green building certification programs are voluntary in nature and promote the use of recycled materials in new buildings with limited provisions that range from 10% to 15%. The situation is similar to that of PR China, as the responsibility of the waste generators is not clearly defined.

The report 'Waste and Recycling in Australia 2011' shows that 8,529,374 tonnes of C&D waste disposed nationally in 2008-09, with a national resource recovery rate of 55%. Every state and territory in Australia has a different strategy to manage this waste.[91] In New Zealand, C&D waste may represent up to half of all the waste generated, with 20% of it going to the landfill, and the remaining going to clean-fill. [92] The government works with the industry for reducing C&D waste, and saving money in disposal costs.

[87] ADB (2015), People's Republic of China: Construction and Demolition Waste Management and Recycling http://www.adb.org/sites/default/files/project-document/161008/48105-001-tar.pdf
[88] ADB (2015), People's Republic of China: Construction and Demolition Waste Management and Recycling http://www.adb.org/sites/default/files/project-document/161008/48105-001-tar.pdf
[89] Construction and Demolition Waste Status Report Hyder Consulting Pty Ltd- ABN 76 104 485 289 http://www.environment.gov.au/protection/national-waste-policy/publications/waste-and-recycling-australia-2011
90 Somvanshi, A., 2014. Solid Wealth, Down to Earth Magazine, Centre for Science and Engineering, New Delhi. http://www.downtoearth.org.in/content/solid-wealth. Last accessed on 14 March 2015.
[91] Construction and Demolition Waste Status Report Hyder Consulting Pty Ltd- ABN 76 104 485 289 http://www.environment.gov.au/protection/national-waste-policy/publications/waste-and-recycling-australia-2011
[92]Cleanfills accept inert material, such as clay, soil, concrete or brick, that, when buried, will have no harmful effects on people or the environment. http://www.mfe.govt.nz/more/environmental-reporting/waste/solid-waste-disposal-indicator/solid-waste-composition

4 The Response

Part IV presents a response to the challenges in global waste and resource management described in earlier sections. It discusses the role of policies, technologies and financing mechanisms that can help countries ride on the opportunity of turning waste to resources by practicing 3Rs.

4.1 Policies

Decision makers need to follow a *systems approach* and a *life cycle perspective* to respond to the growing challenges in waste and resource management. Many countries have begun to understand the need for inclusion of 3R principles in their national policies. Some countries in Asia such as PR China, India, Indonesia and Thailand have incorporated the 3Rs in their respective national policies. Bangladesh, Cambodia, Indonesia, Malaysia, The Philippines, Thailand and Viet Nam have specific national 3R strategic plans.[93]

3R policies have been focusing on MSW over the years and the technologies in this arena have also reached more maturity. Compared to MSW, both policy instruments and technology options are relatively less developed for waste streams such as plastic, food and E-waste. **Figure 42** provides a mapping for the same.

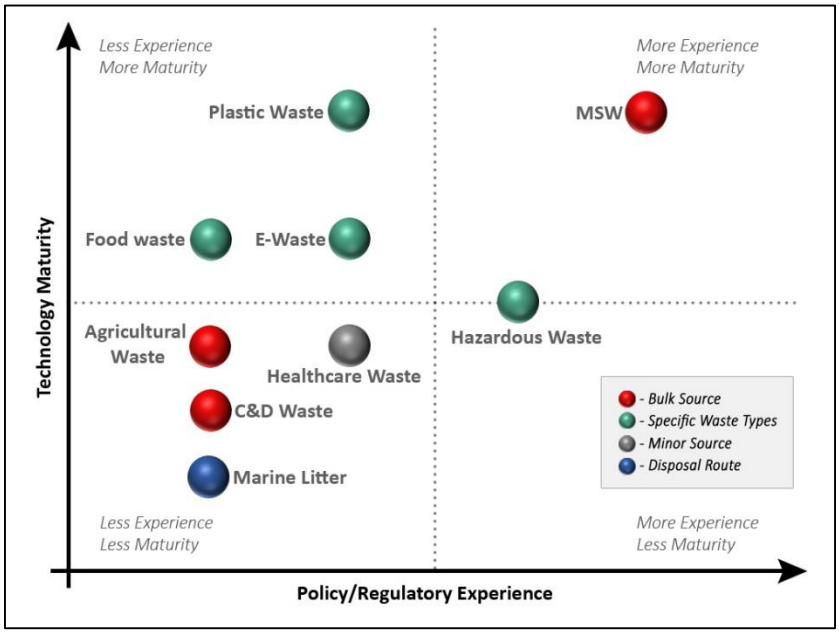


Figure 42 Policy/Regulatory Experience and technology maturity for various waste streams

Source: Environmental Management Centre (EMC), Mumbai, India

Three kinds of policy instruments are generally used for the promotion of 3Rs. Direct regulations make sure that there is a shift from end-of-pipe solutions to more proactive measures that reduce waste at the source. Economic instruments bring about behavioral change through incentives and disincentives. Pay-as-you-throw (PAYT) and EPR are examples of economic instruments that promote good waste management practices. On the other hand, prohibiting and imposing fines on informal recycling have not helped in countries like PR china and India since poor informal workers are unable to pay.[94] Social instruments bring in a community perspective. A policy that

[93] (a) Christian N. Madu, Chu-Hua Kuei (2012), Handbook of Sustainability Management (b) http://www.unmillenniumproject.org/goals/. Accessed on August 4th, 2015.

[94] Business and Economic Potential of Resource Recovery and Recycling from E-waste by Dr Sunil Herat. Background Paper for Parallel Roundtable 4 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

encourages community involvement gains a greater acceptance from the community. Public participation, conflict resolution and collective problem solving relieves the apprehension of a new technology.

Table 9 shows policies that encourage and discourage resource intensive activities. Coupled with this is the issue of ambiguity. Laws and supporting mechanisms need to be clear with objectives that otherwise lead to contradicting activities.[95]

Table 9 Policies that encourage and discourage resource intensive activities

Policies that encourage resource intensive activities	Policies that discourage resource intensive activities
Perverse subsidies such as: • primary industries including mining and energy generation are subsidized in some countries • subsidies on gasoline and other fossil fuels or electricity which encourage higher usage in production and in household consumption • policy related to distribution of subsidized fertilizers which require farmers not to remove the waste agricultural biomass from fields	• Green budget and tax reform • Carbon pricing (trade and cap) • Investing in the green economy • Creative schemes such as 'Recycle for Education' • Subsidies that increase good practices such as subsidizing of composting bins in Canada

Source: (a) Enabling Frameworks for Promotion of 3R Science and Technologies and Technology Transfer by UNEP-IETC. Background Paper for Plenary Session 2 of the Programme. Final Draft for the 6th regional 3R Forum in Asia and the Pacific (b) Resource efficiency and waste minimization achieved through the 3Rs: A core element of Asia-Pacific governments' economic growth strategies by Heinz Schandl Commonwealth Scientific and Industrial Research Organisation, Canberra. Background Paper for Plenary Session 1 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific (c) Business and Economic Potential of Resource Recovery and Recycling from E-waste by Dr Sunil Herat. Background Paper for Parallel Roundtable 4 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

Countries, all over the world are recognizing the importance on incorporating the 3Rs as a part of their national strategies. **Table 10, 11, 12, 13** shows the policies of various APAC countries focusing of 3R promotion, into four regional groupings: Eastern Asia, South-eastern Asia, South-central Asia and Oceania.

Table 10 3R Policies in Eastern Asia

Country	3R Policies/Laws/Rules/Programmes in Eastern Asia
PR China	1. Law of the People's Republic of China on the Promotion of Clean Production (2002) 2. Law of the People's Republic of China on Environmental Impact Assessment (2002) 3. Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Wastes identified "3R" as the basic principle in the management of solid wastes and extending producers' responsibility in the management of major solid wastes (2004) 4. Circular Economy Promotion Law 5. Solid Waste Pollution Control Law 6. "Twelve Five" national plan on the urban-rural garbage treatment facilities construction
Mongolia	1. Law on Waste (2012) 2. In July, 2015, the governmental cabinets approved the regulation on waste management 3. National Green Development policy 2014 4. Regulation on waste inventory (2014)

[95] Contribution of 3Rs in Sustainable Tourism Development and Protection of Marine Ecosystem ~ Win-Win Solutions through 3R as an Economic Industry by Prof. Shun Fung Chiu. Background Paper for Plenary Session 3 of the Programme. Pre-Final Draft for the 6th regional 3R Forum in Asia and the Pacific

Country	3R Policies/Laws/Rules/Programmes in Eastern Asia
	5. Regulation on waste management incentives (2014)
The Republic of Korea	1. Revision of Waste Management Act, 1995 2. Act on the Promotion of Saving and Recycling of Resources and the Ordinance on the Standards of Packaging Methods and Material, 1993 3. Guidelines for Industrial Waste Reduction in cooperation with the Ministry of Commerce, Industry, and Energy (MOCIE), 1996 4. Act on the Promotion of Construction Waste Recycling, 2005 5. Act on the Promotion of Green Product Purchase, 2004 - Makes it mandatory for public organizations to purchase eco-friendly products and to reflect the record of eco-friendly product purchase on their performance review. 6. Act on the Promotion of Saving and Recycling of Resources - Any producers and importers of automobiles and electronic appliances are required to consider ways to use less kinds of materials, opt for recyclable materials, curb the use of hazardous substances, reduce product weight, and make products easier to dismantle. **Reduce policies** • Volume-Based Fee System: Introduced in 1995, it helps reduce household wastes considerably by using a special plastic bag for discharge of unrecyclable waste. • Waste Charge System: ADF imposed on producers/importers of hazardous or hard-to-recycle products. (Chewing gum, diapers, etc.) • Industrial Waste Reduction Program: Introduced in 1996, businesses set goals for waste reduction and report the result annually to the Government. **Reduce policies** • Deposit-Refund System: For containers of soft drinks and alcohol, a deposit is made at purchase and refunded when the container is returned by a consumer. They are then sent to the production for reuse. • Recyclable Resources Market (www.re.or.kr): An on-line Marketplace where businesses and individuals trade waste resources and used products. It helps increase reusing and recycling of e resources. **Recycle policies** • EPR System : Tack-back obligation for the items with recycling goals is given to producers.(5 products and 4 packaging materials) • Eco-Assurance System: Ex ante regulation for DfE and ex post tack-back obligation imposed on producers of consumer electronics and vehicles • Collection and Treatment of Agricultural Waste: Waste agricultural plastic films and agrochemical containers are collected and treated nationwide for recycling and energy-recovery.
Japan	1. Fundamental Law for Establishing a Sound Material-Cycle Society (June 2000) 2. Waste Management Law 3. Law for Effective Utilization of Resources (originally enacted as the Law for Promotion of Utilization of Recyclables in April 1991 and amended in June 2000) 4. Containers and Packaging Recycling Law (June 1995) 5. Home Appliance Recycling Laws (TV sets, air conditioners, refrigerators, washers; June 1998) 6. Construction Material Recycling Law (May 2000) 7. Food Recycling Law (June 2000) 8. End-of-Life Vehicles Recycling Law (July 2002) 9. Green Purchasing Law (May 2000) 10. Environmental Education Promotion Law (July 2003)

Country	3R Policies/Laws/Rules/Programmes in Eastern Asia
	11. Environmental Awareness Promotion Law (June 2004) Japan's policy for dealing with mercury waste is a good example of science-based policy making in 3R.

Table 11 3R Policies in South-east Asia

Country	3R Policies/Laws/Rules/Programmes in South-east Asia
Indonesia	1. Encourage principles of 5R (Re-think, Reduce, Reuse, Recycle, Recovery) through the National Policy on Cleaner Production (2003) 2. Promoting & implementing of Bank Sampah (Waste Bank) Programme. 3. Promoting & implementing EPR Policy. 4. Promoting & implementing community-based composting (TPS3R) 5. Green Industry Standard which regulates the origin of the raw material as one of the criteria 6. 10-Year Roadmap for EPR Implementation 7. Indonesian National Standard (SNI) 8. Green Industry Standard (SIH)
Malaysia	1. Formulation of the 3R policy 2. Formulation of Solid Waste Management Bills promoting 3R practices 3. The National Strategic Plan on Solid Waste Management (2005) 4. The Study on National Waste Minimization Plan in Malaysia (2006) 5. The National Solid Waste Management Policy (2006) 6. The Solid Waste and Public Cleansing Management Act (2007) (Act 672) and the associated Regulations (2011) 7. The National Strategic Plan for Food Waste Management in Malaysia (2011) 8. The National Recycling Target of 22% of the total solid waste recycled by the year 2020 9. Regulations on Scheme for Household Solid Waste (2011) 10. Regulations on Licensing Collection for Household Solid Waste Services (2011) 11. Mandatory Separation at Source by Sept 2015
The Philippines	1. Ecological Solid Waste Management Act of 2000 (Republic Act 9003) This mandated the establishment of "Materials Recovery Facilities" (MRF) by the Local Government Units (LGUs) strengthening the enforcement and institutionalization of the principles of 3R 2. Toxic Substances and Hazardous and Nuclear Waste Control Act of 1990 (Republic Act 6969) – mandated industrial facilities to implement hazardous wastes segregation and recycling program 3. Guidelines on the Phasing Out of Non-Environmentally Acceptable (NEA) Products and 4. Packaging Materials. 5. Adoption of the National Solid Waste Management Strategy 6. Guidelines for Mandatory Solid Waste Segregation at Source, Segregated Collection and Recovery 7. Adoption of the Guidelines on the Clustering of Local Government Units (LGUs) for Common Ecological Solid Waste Management Facilities 8. Nationwide Implementation of the Establishment of an Appropriate Ecological Solid Waste 9. Management System for Home Owners Association (HOAs), Public Markets and Commercial Establishments and the Eco-saver Program for Public Schools 10. Guidelines Prescribing Deadlines on the Submission of Ten Year SWM Plans

Country	3R Policies/Laws/Rules/Programmes in South-east Asia
	11. Declaration of every month of January as Zero Waste Management Month in The Philippines 12. Amending Resolution No. 26 series of 2009, Changing the Term Ecology Park or Eco-Park to Ecological Solid Waste Management Park or Eco-SWM Park and Providing Clarifications 13. Creation of the Multi-Agency Sub-Group (MASG) to develop the guidelines on the Waste 14. Analysis and Characterization Study (WACS) and Computation of Waste Diversion 15. Creation of the MASG to develop the guidelines on Composting, Compost Quality and Market Development (CCQMD) 16. Creation of the MASG to develop the guidelines on the establishment and operation of best available Waste to Energy (WTE) Technologies for the Country 17. Implementation of the Memorandum of Agreement between the NSWMC through the DENR and the Tarlac College of Agriculture for a Satellite Ecology Center 18. Full Waste Recovery and Recycling Program 19. Declaration of every month of January as Zero Waste Management Month in The Philippines 20. 17 going to 24 Environmentally Sustainable Cities assisted nationwide. 21. The National Eco-Labeling Program- Green Choice Philippines (NELP-GCP) Science based 3R policy making is being addressed by the Philippine through National Solid Waste Management Strategy Component No. 5 Support for Knowledge Management on Technology, Innovation and Research
Singapore	1. Singapore Green Plan (SGP) 2012 2. National Recycling Programme (NRP) for households 3. Singapore Packaging Agreement (SPA) 4. Mandatory Provision of Recycling Receptacles in Condominiums 5. Mandatory Waste Reporting for Large Commercial Premises 6. Pilot Save-As-You-Recycle (SAYR) at selected premises in 2015 7. Community 3R Outreach Programme (CROP)
Thailand	1. Natural Resources and Environmental Policy 2. National Integrated Waste Management Plan 3. National Master Plan On The Cleaner Production And Cleaner Technology 4. National Strategic Plan For The Environmentally Sound Management Of E-Wastes 5. Strategic Plan on Packaging and Packaging Waste Management 6. Green Manufacturing Technical Assistance Program 7. Fluorescent Lamp Partnership Program 8. Construction and Demolition Waste Management System 9. Packaging Waste Project a. Guideline, measure, and standard related to the 3Rs b. Industries Waste Exchange Program c. Green Label Scheme -Thai Green Label Scheme d. Used lead-acid batteries recycling program e. Promotion of Material Recovery, Energy Recovery and Replacement in Cement Kiln f. Take-Back Program on End-of-Life Products g. Pilot Program on Plastic and Foam Waste Management Pilot Program 10. The National 3R Strategy and plan 11. Government Green Procurement programme 12. National Environmental Basic Plan (2012-2016) 13. Waste and Hazardous Waste Management Road Map 14. National Roadmap for the Development of Bioplastics Industry (2008 - 2015)

Country	3R Policies/Laws/Rules/Programmes in South-east Asia
	15. Coastal and Marine Environmental Protection Plan 16. The National Park Act 17. National Integrated Waste Electrical and Electronic Equipment Management Strategy 2014-2021 18. Guidelines and criteria for product standard 19. Promotion for government green procurement 20. Government energy saving plan and energy efficiency label on home appliances 21. Green Industry Policy 22. Government Green Procurement and Green label Schemes 23. Green Public Procurement Promotion Plan 2008-2011 24. Green Public Procurement Promotion Plan 2013-2016
Myanmar	1. To develop systematic waste disposal and collection system in order for the city to be free of repulsive dumpsites and conducting Community-based 3Rs Practices 2. Green Economy and Green Growth Programme 3. Industrial policy for the use of renewable energy: To develop the sustainable green industry and environmental conservation, effective use of renewable energy is essential. 4. Myanmar Chemical law (2013)
Viet Nam	1. National Strategy for Integrated Solid Waste Management to 2025 2. Law on Environment Protection 2014 3. Decree on solid waste management and scraps 4. Decision on collection and treatment of discarded products (extended producers responsibility - EPR) 5. Law on Environmental Protection Tax regulates some plastic bags have to be liable to tax 6. Waste management/recycling has been addressed in National Climate Change strategy 7. Vietnam Green Label Program
Timor Leste	1. Health care asistance program for labor dealing with waste 2. Green Procurement Policy 3. Penal code on environmental crime 4. Water body management procedure 5. Decree law for EIA

Table 12 3R Policies in South-central Asia

Country	3R Policies/Laws/Rules/Programmes in South-central Asia
Afghanistan	1. Medical waste regulations in place since 2011
Bangladesh	1. Seventh Five Year Plan is in the final stage that inculcated 3R/4R options for waste management and low carbon path. 2. National 3R Strategy for Waste Management, 2010 3. The National Clean Development Mechanism (CDM) Strategy 2004 4. Private Sector Infrastructure Guideline 5. National Renewable Energy Policy- 2008 6. Policy Strategies for Small & Medium Enterprises (SME) Development January 2005 7. Hazardous Waste and Ship Breaking Waste Management Rules 2012 8. National Fisheries Policy 1998 9. Integrated Coastal Zone Management Policy 2005 10. Environment Conservation Act 1995 11. National Action Plan on Coastal and Marin Pollution from Land based Activities

Country	3R Policies/Laws/Rules/Programmes in South-central Asia
	12. Medical Waste (Management and Processing) Rules, 2008 13. Environmental Conservation Act 1995 (Last Amendment in 2010) 14. National Water Policy 1999 15. Natural Water Body Protection and Preservation of Open space and Playground Act 2000 16. Water Act 2013 17. Import Policy Order 2012-2015
Bhutan	1. National Integrated Solid Waste Management Strategy, 2014 2. Waste Management and Prevention Act 2009 3. Waste Management and Prevention regulation 2012 4. National Strategy and Action Plan on Integrated Solid Waste Management 2007 5. Water Act 2011 and regulation 2014

Table 13 3R Policies in Oceania

Country	3R Policies/Laws/Rules/Programmes in Oceania
Tuvalu	1. Waste Operations and Services Act 2. Diversion of Green Wastes for Composting Programme 3. Scrap metals and aluminum can recycling programme – Katoaga Recycling Company 4. Environment Protection Litter and Waste Control Regulation 5. Awareness programmes for communities on waste management including the 3Rs 6. Agriculture National Strategic Plan 2014-2023
Solomon Islands	1. National Solid Waste Management Strategy Programmes 2. Solid Waste Management Workshops and Waste Characterization Studies 3. National Solid Waste Management Strategy and Action Plan 2009-2014 4. Honiara Litter Ordinance 5. Solomon Islands Climate Change Policy 2012-2017 6. National Development Strategy 2011-2020 7. Health Care Waste Policy
Samoa	1. National Waste Management Policy 2001 2. Waste Management Act 2010 3. Occupational and Health Safety Policy 4. Land, Survey and Environment Act 1989
Niue	1. Niue Coastal Policy 2. Niue Climate Change Policy 3. Draft National Integrated Strategic Plan 4. National Integrated Waste Strategy

Sources: (a) Ministry of the Environment, Government of Japan. Good practices to promote the 3Rs[96] (b) Country Report for the 6th regional 3R Forum in Asia and the Pacific by The Republic of Korea, Bhutan, Solomon Islands, Myanmar, Samoa, Niue, Mongolia, The Philippines, Singapore, Vietnam, Malaysia, Afghanistan, Thailand, PR China, Timor Leste, Indonesia.

[96] Ministry of the Environment, Govt. of Japan
http://www.env.go.jp/recycle/3r/en/info/05_03.pdf, http://www.env.go.jp/recycle/3r/en/info/05_06.pdf,
http://www.env.go.jp/recycle/3r/en/info/05_08.pdf, http://www.env.go.jp/recycle/3r/en/info/05_09.pdf,
http://www.env.go.jp/recycle/3r/en/info/05_11.pdf, http://www.env.go.jp/recycle/3r/en/info/05_12.pdf,
http://www.env.go.jp/recycle/3r/en/info/05_13.pdf, http://www.env.go.jp/recycle/3r/en/info/05_15.pdf

PPP is an effective economic model for managing wastes and is reflected by the adoption of PPP laws in many countries in the APAC region. (**Table 14**)

Table 14 Countries that have PPP laws in APAC countries

Country	Public-Private Partnerships Laws / Concession Laws
Australia	National Public Private Partnership Policy and Guidelines
	State of Victoria: The Partnerships Victoria policy, introduced in 2000, provides the framework for a whole of government approach to the provision of public infrastructure and related ancillary services through public private partnerships.
Cambodia	Law on Concessions
Fiji	Public-Private Partnership Act 2006
India	India National Public-Private Partnership Policy
	Haryana, India: Public-Private Partnership (PPP) Policy
Indonesia	Indonesia Concession Regulation
The Philippines	PPP Regulatory Framework
The Republic of Korea	Act on Private Participation in Infrastructure
	Enforcement Decree on the Act on Private Participation in Infrastructure
Sri Lanka	Public Utilities Commission of Sri Lanka Act
Timor Leste	Decreto-Lei No. 42/2012 Regime Jurídico das Parcerias Público Privada (PPP Act 42/2012) of 7 Septembre 2012 (Portuguese).

Source: PPPIRC, World Bank[97]

1.1 Sustainable Consumption and Production

Waste reduction is extremely important and Sustainable Consumption and Production (SCP) plays a big part in this. In fact, the 3R economy is strongly driven by SCP.

Sustainable consumption is not about consuming less, as it will be a deterrent to the development of countries, especially those who have just begun to develop. It is about making the most out of the least, by optimizing resource consumption which results in high resource productivity. In order to do this, several instruments exist and one of these is Green Public Procurement (**Figure 43**).

Green procurement (GP) in the public sector is a powerful economic instrument that can drive the market for environment-friendly products and services. It can encourage appropriate technologies and innovative solutions that lead to the creation of such products. Governments need to have a strong policy framework with clearly defined green procurement standards, in order to divert the government spending that hinders the transition to a greener economy.[98]

[97] http://ppp.worldbank.org/public-private-partnership/legislation-regulation/laws/ppp-and-concession-laws. Accessed on 4th August 2015

[98] UNESCAP. Low Carbon Green Growth Roadmap for Asia and the Pacific Fact Sheet: Green Public Procurement http://www.unescap.org/sites/default/files/33.%20FS-Green-Public-Procurement.pdf

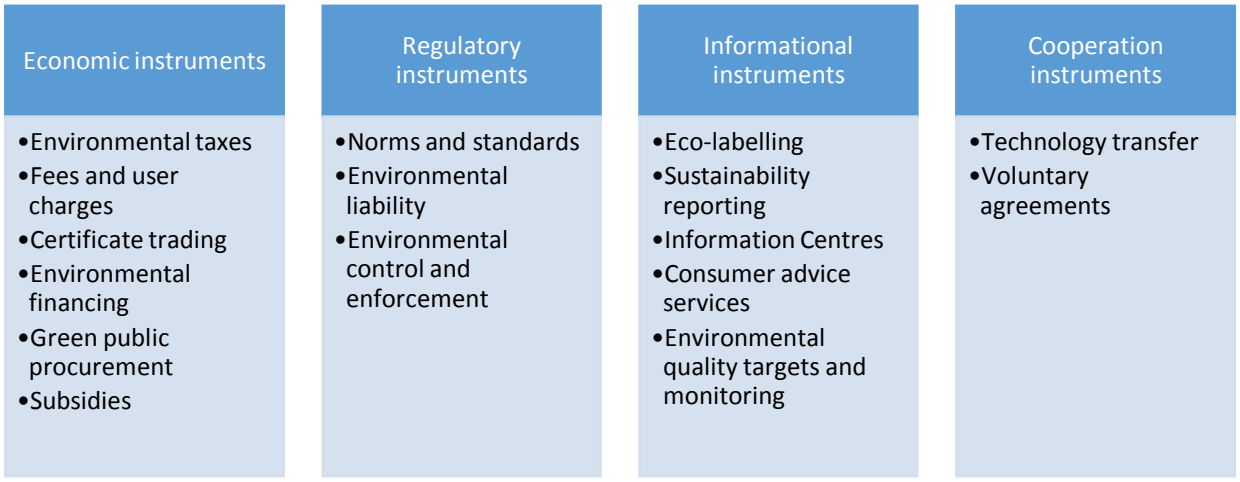


Figure 43 SCP policy tools

Source: Promoting Sustainable Consumption and Production, the Eco-competitiveness of Industries and Green Factories by Dr. Chaiyod Buyagidj, APO 3rd World Conference on Green Productivity APO Center of Excellence on Green Productivity: Milestone of APO movement Nov 4-6, 2014, Taipei, Taiwan Province of China. http://www.apo-tokyo.org/wedo/wp-content/uploads/sites/3/2014/12/4-2-Dr.-Chaiyod-Bunyagidj.pdf

Asian countries have been promoting SCP as a part of their legal frameworks (**Table 15**). This is also reflected in their annual Green Public Procurement (GPP) spending.[99]

Table 15 Laws and guidelines for SCP in countries

Country/Organization	Laws and guidelines
United Nations	UN sustainable procurement guideline
European Union	Public Procurement Legislation
Japan	Green Purchasing Law (May, 2000) Basic Policy on Promoting Green Purchasing (Updated annually, last updated Feb., 2012)
Republic of Korea	Act on the Promotion of the Purchase of Environment-Friendly Products (July, 2005)
PR China	Government Procurement Law (Jan., 2003) Cleaner Production Promotion Law (2002 issued; 2012 revised) Circular Economy Promotion Law (Aug., 2008) Notice of State Council on Printing and Distributing the Comprehensive Work Scheme of Energy Conservation and Reducing the Discharge of Pollutants (May, 2006) GPP has been adopted into PR China's 12th five-year plan on national economic and social development
Thailand	Government Management Plan required all agencies to buy green products within four years

Source: Adapted from 'The structure, content and implementation of green procurement'. Jiangwen GUO Institute for Global Environmental Strategies (IGES), Japan[100]

As green products and services have higher prices than the products already in the market, higher cost of implementation continues to be the biggest challenge for GPP. A solution to this is the use of non-price criteria

[99] UNEP (2013), Sustainable Public Procurement: A Global Review | Full Report http://www.unep.org/resourceefficiency/Portals/24147/SPP_Full_Report_Dec2013_v2%20NEW%20(2).pdf
[100] http://pub.iges.or.jp/modules/envirolib/upload/4354/attach/3R_09.pdf

and incorporation of green criteria in the procurement process. Fostering innovation to maintain or even reduce the costs is the way.

There is a lack of awareness of GP practices among governmental authorities who need training for acquiring green products. A market for supplying green products also needs to be developed. A step-by-step approach to tackle these issues is shown in **Figure 44**.[101]

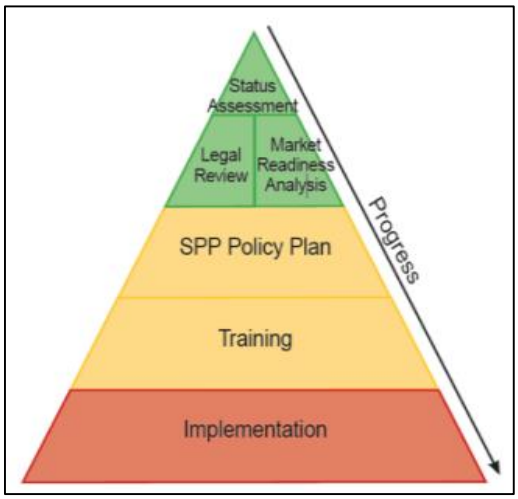


Figure 44 Developing a green, or sustainable, public procurement scheme

Source: Low Carbon Green Growth Roadmap for Asia and the Pacific: Fact Sheet - Green public procurement[102]

4.2 Technologies

Policies that promote technologies for 3R are extremely important as governance influences the process of technology selection.[103] In order to do so, a Gaps Assessment needs to be carried out in order to implement the 3R principles. This assessment reveals the barriers in the process of selection of an appropriate technology as well as other policy gaps. **Tables 16 and 17** show such an exercise carried out in Bangladesh. Bangladesh now has a strong foothold in composting and formalization of the technology implemented by workers in the waste management sector (**Table 16**). The national policies, legislative measures and other initiatives in Bangladesh reflect the nascent nature of the application of 3R principles (**Table 17**).

[101] UNESCAP. Low Carbon Green Growth Roadmap for Asia and the Pacific Fact Sheet on Green Procurement http://www.unescap.org/sites/default/files/33.%20FS-Green-Public-Procurement.pdf
[102] UNESCAP. Low Carbon Green Growth Roadmap for Asia and the Pacific Fact Sheet: Green Public Procurement http://www.unescap.org/sites/default/files/33.%20FS-Green-Public-Procurement.pdf
[103] Sections 8.6.1 and 8.6.2 in Annexure F discuss worldwide 3R policies deriving the importance of 3R policies in governance and business opportunities

Table 16 Technology status for implementation of 3R in Bangladesh[104]

TECHNOLOGY STATUS FOR IMPLEMENTATION OF 3R IN BANGLADESH

Waste Category	Technology	Status
Urban Municipal Waste	Thermal Recovery	O
	Fuel Recovery	O
	Material Recovery	O
	Sorting	○
	Pulverizing	O
	Composting	●
	Incineration	⊙
	Collection	⊙
E-Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	⊙
	Collection	⊙
Healthcare Waste	Material Recovery	⊙
	Sorting	⊙
	Pulverizing	⊙
	Incineration	⊙
	Collection	⊙

● Formal and Strong
O Formal but weak
⊙ Informal but Weak
O Informal and Strong
☒ Technology Gap

[104] 3RKH Secretariat, Asian Institute of Technology (2008) http://www.faculty.ait.asia/visu/Prof%20Visu's%20CV/Books%20and%20research%20reports/3R%20Gap%20Analysis%20Book%20(Printed%20Version).pdf

Table 17 Current situation of national policies, legislative measures and other initiatives in Bangladesh[105]

3R Management Aspects			Status
Systems for Integrating Environmental Considerations into Socio-economic Activities	Framework	National Environmental Policy 1992 National Environmental Management Action Plan (1995-2005)	O
	Direct Regulatory	• The Bangladesh Environment Conservation Act 1995 • The Environment Conservation Rules 1997 • The Environment Pollution Control Ordinance 1977 • City Corporation Ordinances and Pourshava Ordinance 1977 Draft "Solid Waste Management Handling Rules" • The Environment Court Act 2000 • Development of "Battery Waste Recycling Rules 2006"	O
	Economic	No specific economic instruments observed	☒
	Voluntary	Voluntary Initiatives by Government & Industry • Promotion of Cleaner Technology & Waste Minimization	O
	Information	Sustainable Environment Management Programme (SEMP) Dhaka Declaration 2004	O
	Procedural	Decisions on banning Polythene Shopping Bags	O
Support for 3R-related Activities		• Solid Waste Management Cell, Dhaka City Corporation • No specific support for 3R-related activities except few initiatives such as community-based waste recycling and resource recovery	O
Environmental Education		No specific programs emphasizing environmental education	☒
Scienc and Technology		• Implementation of a National Program for Recovery and Recycling of Refrigerants	O
Reduction of Barriers to International Flow		• Acceded the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal in 1993	O
International Cooperation		• Bangladesh Environmental Management Project funded by CIDA • Master Plan for the Solid Waste Management of Dhaka - Dhaka City Corporation with support from JICA • Community-based Composting Projects and Barrel Type Composting-UNICEF with 14 city corporations and Engineering • Solid Waste Management Plan for eight secondary towns of Bangladesh -Local Government Engineering Department (LGED) with support form ADB • Recycling Centers in 24 city corporations/municipalities as well as preparation of solid waste management plan-UNICEF • Urban Solid Waste Management Handling Rules of Bangladesh, and UNDP • Bio-medical Waste Handling Rules - Ministry of Environment and Forest and UNDP.	O
Cooperation of Stakeholders		Lack of cooperation among the stakeholders within the country	O
Promotion of Science and Technology for 3R		Under implementation level	☒

● Sufficient O Insufficient ☒ Gap

In India, a decision support matrix was developed with experts' consultation for identifying the suitability of centralized and decentralized systems in waste management. **Table 18** shows scoring for the unit operations or steps involved in MSW management given in the range of 1 to 10 (1 being the least beneficial). Experts recommended decentralized approach for segregation at source, transportation, preprocessing of wastes, biomethanation, conventional composting and vermi composting and centralized approach for incineration,

[105] 3RKH Secretariat, Asian Institute of Technology (2008) http://www.faculty.ait.asia/visu/Prof%20Visu's%20CV/Books%20and%20research%20reports/3R%20Gap%20Analysis%20Book%20(Printed%20Version).pdf

pyrolysis, gasification, RDF production, mechanical compost, C&D waste processing and engineered sanitary landfill.[106]

Table 18 Decision support matrix for selection of centralized (C) and decentralized (D) approaches based on experts' valuation

S. No	Attributes Unit Operation or Step in MSW Management	Technical Feasibility		Managerial Feasibility		Social acceptability		Low Capital Cost Advantage		Low O & M Cost Advantage		Recycling Potential	
		C	D	C	D	C	D	C	D	C	D	C	D
1	Segregation at Source	5	8	8	6	6	6	5	8	6	8	6	8
2	Transportation	7	8	8	7	7	7	5	7	5	7	4	6
3	Pre-processing of Wastes	6	7	6	6	7	6	6	6	6	6	5	7
4	W to E: Biomethanation	7	8	7	7	7	6	6	7	6	7	7	8
5	Conventional Composting	6	6	6	6	7	6	5	7	6	7	6	7
6	Vermi-Compostiing	4	7	4	7	6	6	5	7	5	7	5	7
7	Mechanical Composting	6	6	7	6	6	5	5	6	5	6	5	6
8	W to E: RDF Production	7	5	7	5	8	6	6	5	6	5	6	6
9	W to E: Incineration	9	3	8	4	6	4	6	4	7	4	6	4
10	W to E: Pyrolysis / Gasification	8	5	7	4	6	4	5	4	6	3	6	5
11	W to E: Plasma Arc Gasification	6	3	5	3	7	4	4	3	4	3	6	3
12	Disposal of Road Sweeping & C&D	7	5	6	5	6	5	6	5	6	5	5	5
13	Engineered Sanitary Landfill	9	4	8	4	8	3	7	4	7	4	4	2

May be treated as indicative.

Source: Report of the Task Force on Waste to Energy (Volume I), Government of India

The Bali Strategic Plan for Technology Support and Capacity Building (BSP) is an inter-governmentally agreed framework for strengthening the capacity of governments in developing countries and countries with economies in transition to coherently address their needs, priorities and obligations in the field of the environment. The BSP was adopted by the 23rd Session of UNEP's Governing Council in February 2005.[107]

Compendium of technologies for waste management have been developed by UNEP-IETC, viz. Compendium of Recycling and Destruction Technologies for Waste Oils, and Compendium of Technologies for Treatment/Destruction of Healthcare Waste.

Chapter 34 of Agenda 21 defines Environmentally Sound Technologies (ESTs) as those technologies that "protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products and handle residual wastes in a more sustainable manner than the technologies for which they are substitutes." According to the Chapter, these are not just "individual technologies, but total systems which include know-how, procedures, goods and services, and equipment as well as organizational and managerial procedures". This requires both the human resource development (including gender relevant issues) and local capacity building aspects of technology choices. There is also the need to ensure that ESTs are compatible with nationally determined socio-economic, cultural and environmental priorities and development

[106] Planning Commission. Government of India (2014), Report of the Task Force on Waste to Energy (Volume I) http://planningcommission.nic.in/reports/genrep/rep_wte1205.pdf

[107] Six years into the Bali Strategic Plan – what has worked and what hasn't? http://www.unep.org/gc/gc26/docs/SideEvent_Bali_Strategic_Plan.pdf

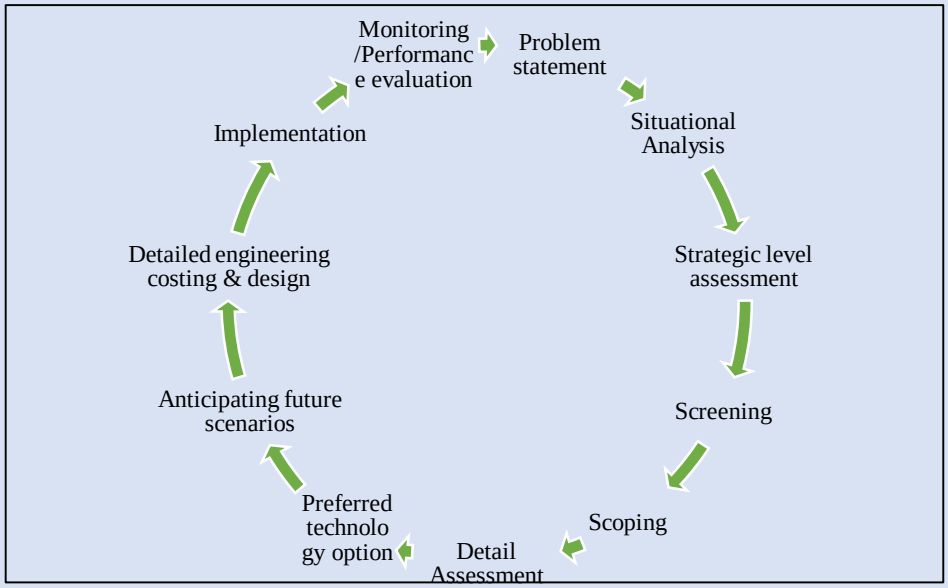
goals. **Box 7** provides information on the SAT Framework that helps find country specific technological solutions.

Box 7 SAT Framework

In accordance with this plan of action and a need for Technology Assessment (TA) framework, The International Environmental Technology Centre (IETC) of the United Nations Environment Programme (UNEP) initiated the development of a methodology for the Environmental Technology Assessment (EnTA). Along the way, EnTA underwent metamorphosis with improvements that led to SAT – Sustainability Assessment of Technology, a better version of EnTA. Improvements focused on decision making – something that makes SAT user friendly and paves way for stakeholders to find a solution specific to their country.

SAT methodology helps organizations, big or small, to achieve the triple bottom line by finding the right technological solution to waste treatment. The evolution of SAT starts with Agenda 21 adopted at the United Nations Conference on Environment and Development (UNCED) in the year 1992. It highlighted the necessity of Environmentally Sound Technologies (ESTs) with the intent to take into account the environmental and social factors. These factors have not been recognized for a long time, the result of which has been environmental degradation.

Understanding the technicalities that built the user-friendly SAT model software for all types of stakeholders



SAT methodology is a step-by-step decision making hierarchy forming the plan-do-check-act cycle. This cycle undergoes continuous improvements that reflect at each stage of the process.
Key characteristics of SAT methodology are:

- Built on existing Environment Technology Assessment (EnTA) framework.
- Undergoes progressive assessment thereby optimizing information requirements.
- Operates on strategic as well as operational level. It is a quantitative procedure allowing objective assessment, sensitivity analyses and incorporation of scenarios.
- Incorporates Plan-Do-Check-Act (PDCA) cycle.
- It is not an automated process thereby making country specific adaptation possible.

Technology selection followed through the SAT methodology can avoid many such trade-offs through proper evaluation of technical, social, environmental and financial criteria clubbed together.

Investments in 3R technologies

Recycling is an important solution for the conservation of natural resources and reduction in waste generation. **Table 19** shows national recycling targets of Asian countries, which are set with the purpose of improving and promoting recycling.

Table 19 National recycling targets of Asian countries

Country	National recycling targets
Japan	Fundamental Plan for Establishing a Sound Material Cycle Society - Cyclical Use Rate [cyclical use amount/(cyclical use amount + amount of natural resource input)]
The Philippines	Ecological Solid Waste Management Act - Diversion Rate: 25% of all solid waste, through re-use, recycling and composting, and other resource recovery activity by 2004
Malaysia	Tenth Malaysia Plan (2011-2015) - Increased household recovery of waste from 15% to 25% by 2015
Singapore	A Lively and Livable Singapore: Strategies for Sustainable Growth 2009 - Recycling rate = Total Waste Recycled/Total Waste Generated (70% in 2030) 56% in 2008
Viet Nam	National Strategy for Integrated Management of Solid Waste Up to 2025 - To collect and treat, within environmental standards, 100% of daily life solid waste in urban centers, 90% of which will be recycled, reused as recovered energy or used as input for organic fertilizer production

Source: Discussion Paper 3R Policy Indicator Factsheets. Ver. 1. Asia Resource Circulation Policy Research Group. Feb 2014[108]

Figure 45 and **Figure 46** show the investment in the waste management sector for the entire world. PR China, Japan, and India have been investing the most, among the top 10 countries worldwide. Data suggests that many countries in this region have gone for thermal technologies with energy recovery.

In India, there are 80 compositing plants, and 7 refuse derived fuel (RDF) and waste-to-energy (WTE) projects.[109] Of these, the large scale projects seeking huge investments work on the Public Private Partnership (PPP) model. Centralized waste recycling and treatment facilities endorsed through special purpose vehicles (SPV) are gaining traction as more municipal bodies are keen to adopt centralized, technology heavy, waste management systems that can handle bulk quantities of waste. Initiatives like the popular 'Swach Bharat Abhiyan' launched by Govt. of India in 2014 and the 'Smart Cities Mission' will increase the financial influx to municipal bodies mainly from private sources such as Corporate Social Responsibility funds for waste management.[110]

[108] IGES (2014) 3R Policy Indicator Factsheets: Asia Resource Circulation Policy Research Group http://pub.iges.or.jp/modules/envirolib/upload/4977/attach/3RIndicator_B5report_web.pdf

[109] Annepu, R. K. (2012), Sustainable Solid Waste Management in India, Department of Earth and Environmental Engineering, Fu Foundation School of Engineering and Applied Science, Columbia University, New York.

[110] Ministry of Urban Development (MoUD) (2014), Mission objectives, Swach Bharat Abhiyan, Government of India, viewed on 25 July 2015. https://swachhbharaturban.gov.in/ISNAHome.aspx

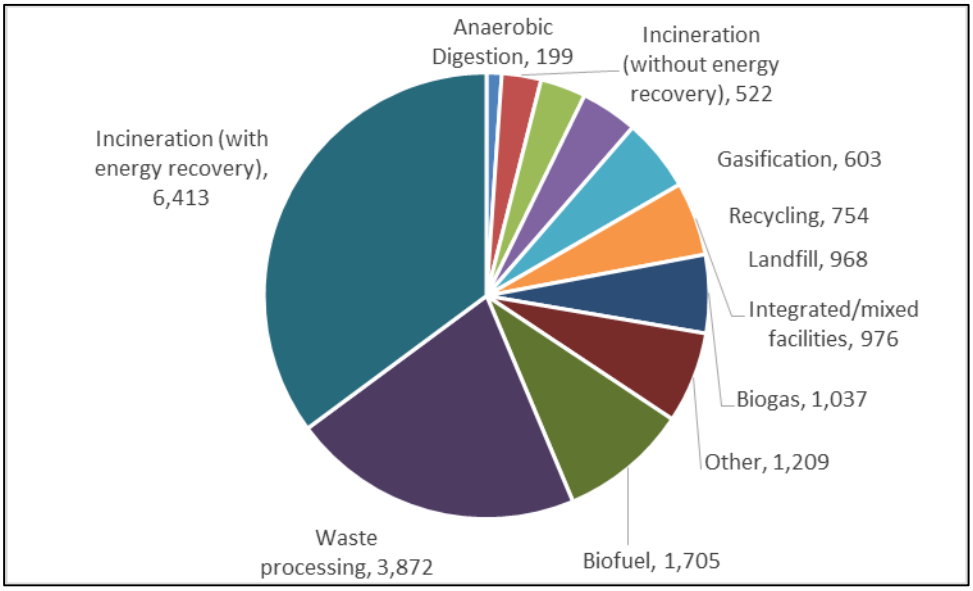


Figure 45 Estimated value and number of projects worldwide (US$ million, country, no. of projects)

Source: Extracted from AcuComm's Waste Business Monitor. Data covers March 2015.[111]

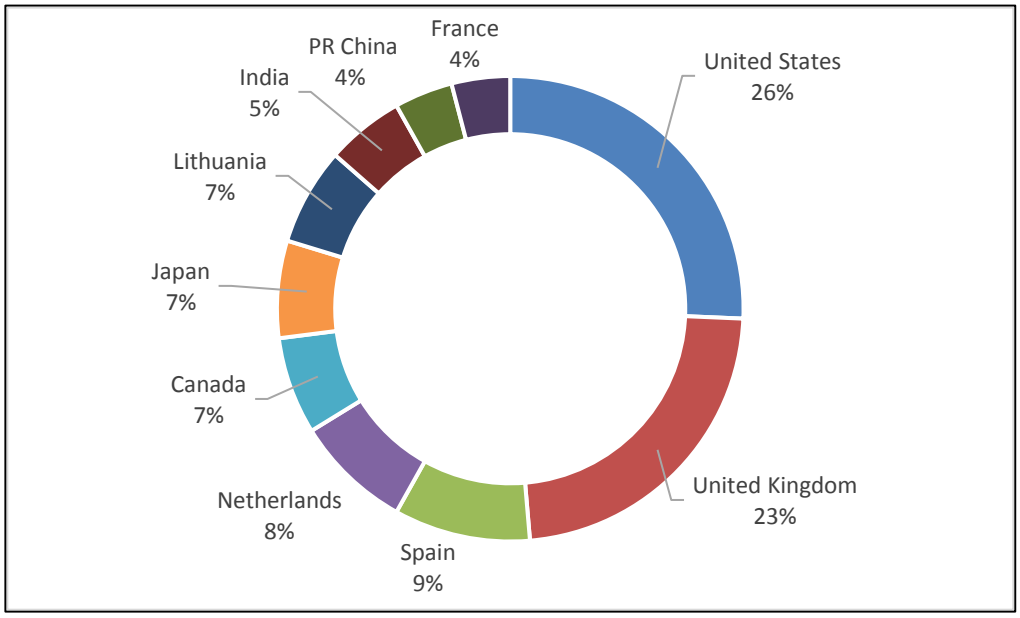


Figure 46 Investment in technologies worldwide (by type) US$ million

Source: Extracted from AcuComm's Waste Business Monitor. Data covers March 2015.[112]

[111] AcuComm's Waste Business Finder (2015) Waste Monitor Issue No 07 http://www.iswa.org/fileadmin/galleries/Blasts%202014/Waste%20industry%20sales%20monitor/Issue_7_Mar_2015_ISWA_.pdf

[112] AcuComm's Waste Business Finder (2015) Waste Monitor Issue No 07 http://www.iswa.org/fileadmin/galleries/Blasts%202014/Waste%20industry%20sales%20monitor/Issue_7_Mar_2015_ISWA_.pdf

4.3 Financing

Waste and resource management financing options are adaptable to specific conditions and therefore there is no silver bullet to all the financing needs. **Figure 47** shows four basic components of a waste management financing model.

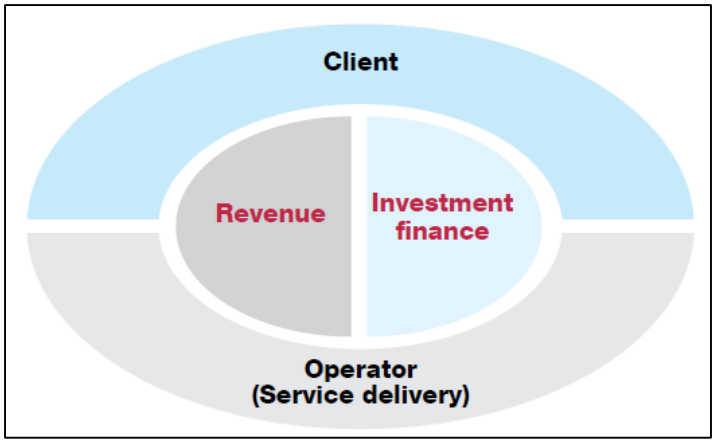


Figure 47 Components of a waste management financing model[113]

Notes: The client is either the waste generator, or the municipality which has assumed responsibility for municipal SWM. The operator delivers the waste management service 'on the ground'. Revenue needs to be raised to pay for the costs of the service; investment finance is required to pay for the capital costs if any new infrastructure is required.

Most countries in APAC do not enjoy sufficient financial resources for the implementation of waste management infrastructure. Further, fees for waste handling are also not charged. In the last two decades, several Public Private Partnership (PPP) models have emerged who apart from financing offer the "efficiency" advantage. These models have on the ground however provided mixed results due to poorly drafted contracts between the Urban Local Bodies (ULB) and private sector operator and often due to non-cooperation and protests from the staff at ULB and waste pickers. **Table 20** presents features of public vs private ownership of solid waste management facilities.

Table 20 Features of public versus private ownership of solid waste management facilities

	Public ownership	Private ownership
Procurement options	A/E (Architect/Engineer)	Full service
	Turnkey	
	Full service	
Financing options	General obligation bonds (GO)	Private activity bonds (PAB)
	Government-purpose bonds (GPB)	Taxable bonds
	Private activity bonds (PAB)	Private equity
	Taxable municipal bonds	Traditional loans
	Traditional loans	
	Federal/state grants	
	Public funds	
Operation	Public (typically) with A/E	Private
	Public/private with turnkey	

[113] UNEP (2015) Global Waste Management Outlook

	Private with full service	
Public risk	Similar*	Similar*
Implementation time	Less than with private ownership	Greater than with public ownership

*Notes: * Applies primarily to facilities/systems financed with large bond issues.*

Source: Franklin Associates, Ltd. as it appears in Handbook of Solid Waste Management, 2nd ed. George Tchobanoglous and Frank Kreith. McGraw-Hill

Table 21 provides various financing sources and mechanisms. **Figure 48** shows the contribution of international financial institutions (IFIs) to the financing of SWM in developing countries.

Table 21 Financing sources and mechanisms for solid waste management[114]

Private sector participation (PSP)	**Debt - combination of municipal bonds model**
• Can bring in capital and expertise • Focus on operation, not overall responsibility for planning, monitoring etc. • Open, competitive bidding • Clarity on tasks, risks and cost recovery • Various forms of PPP – contracting, concession (BOO, BOT), franchising, open competition/free subscription	• Municipal banks model • Municipal development funds • Pooled financing • Credit enhanced/risk mitigation financing
Financing through land use (remediation and control)	**Multilateral Banks**
Land banking Land remediation for brownfield use	• Long tenor, low interest loans • Specialized funds, usually with sector focus • Urban Financing Partnership Facility (UFPF), ADB • Carbon market program, ADB • Sector focused (e.g. Carbon Market Initiative Funds, Clean Energy Partnership Facility, CC Fund) , ADB • Public Private Infrastructure Advisory Facility (PPIAF), ADB, WB and 15 donors • Sector focused (e.g. Global Environmental Facility, Special CC Fund, Clean Technology Fund)

[114] Built based on presentation by Karin Eberle Senior Urban Environmental Engineer, CDIA See http://citynet-ap.org/wp-content/uploads/2013/07/Financing_solid_waste_management_prospects__challenges.pdf

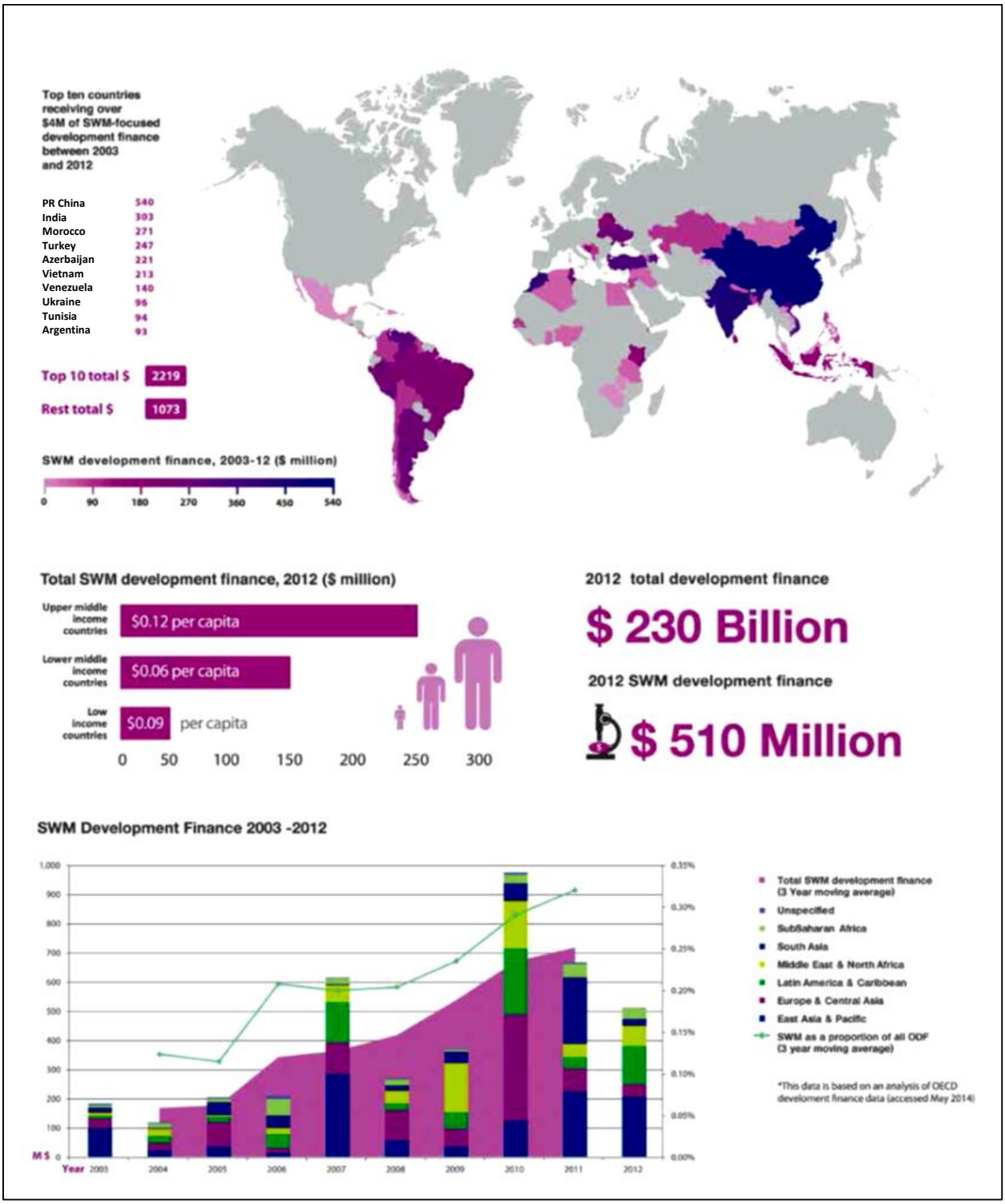


Figure 48 International development finance for solid waste management[115]

Table 22 provides an overview of the range of financing options available for solid waste management. Systems financing for integrated solid waste management projects (ISWM) or Material Recovery Facility (MRF) and

[115] UNEP (2015) Global Waste Management Outlook

composting facilities can be done through project revenue bonds, a type of tax-exempt bond. A combination of mentioned financing options can be applied in cases where public demand and more privatization exist. Results-based-financing (RBF) is another attractive option wherein services are delivered to the citizens and their results are demonstrated to attract financing.[116]

[116] "World Bank (2014), Results-Based Financing for Municipal Solid Waste. Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/20792 License: CC BY 3.0 IGO."

Table 22 Financing options for solid waste management

<table>
<tr><th colspan="3">Tax-exempt bonds</th><th>Private equity</th><th colspan="2">Traditional loans</th><th>Taxable bonds</th><th>State grants/loans</th><th>Public funds</th></tr>
<tr><td colspan="3">Issued by a government agency</td><td>Privately owned facilities are financed</td><td colspan="2">More common with private ownership than public ownership</td><td>Taxable municipal bonds (TMBs)</td><td></td><td>General or special reserve funds that a local government possesses may sometimes be used to pay for a publicly owned project</td></tr>
<tr><td>General obligation bonds (GO)</td><td colspan="2">Project revenue bonds</td><td>Private owner equity</td><td>Construction loans</td><td>Permanent loans</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Government pledges "full faith and credit" and taxing power. Therefore it is more secure and has low interest rates.</td><td colspan="2">• High interest rate as compared to GO bonds.
• For projects that do not qualify for tax-exempt revenue bonds e.g. WTE facilities producing energy as a product. Better for small recyclables processing facilities.</td><td rowspan="2">For projects that do not qualify for tax-exempt revenue bonds e.g. WTE facilities producing energy as a product. Better for small recyclables processing facilities.</td><td rowspan="2">• Provided by lenders such as commercial banks, finance companies, thrift institutions etc.
• Short term loans - 1 to 3 years</td><td rowspan="2">• Provided by lenders such as insurance companies , pension funds, other financing institutions
• Long term loans - 20 years or longer</td><td rowspan="2">• For projects that do not qualify for Private Activity Bonds
• Higher interest rates than tax-exempt bonds</td><td rowspan="2">Can be coupled with local funding</td><td rowspan="2">• For projects that do not qualify for Private Activity Bonds
• For low capital cost projects</td></tr>
<tr><td>Governmental bonds</td><td>Private activity bonds (PAB)</td></tr>
<tr><td></td><td>Low interest rates</td><td>• Only means of obtaining tax-exempted financing for privately owned projects
• High interest rates</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Source: Compiled from Handbook of Solid Waste Management, 2nd ed. George Tchobanoglous and Frank Kreith. McGraw-Hill

5 The 3R Asia Initiative

Part V presents the 3R Asia Initiative through its evolution over the years and the progress it has made so far. It discusses its thematic areas of work across various cross-cutting themes such as resource and energy efficiency; climate change mitigation/co-benefits; socio-economic issues (health, labor, safety) in informal waste sector; sustainable urban management; and multi-stakeholders partnerships. This part provides highlights of the various Regional 3R Forums that have taken place in the past by providing a snapshot in terms of highlights, recommendations, progress made, along with a distillation of the outcomes of each Forum.

The 3Rs refer to restricting generation (Reduce), promoting reuse (Reuse) and regeneration (Recycle) of wastes. They represent the concept of decoupling environmental conservation and economic growth through the effective use of resources.

Goal of the Regional 3R Forum in Asia and the Pacific is to achieve low carbon and sound material cycle societies in Asia facilitating bilateral and multilateral cooperation by increasing resource and energy efficiency using the 3Rs, and for promoting environmentally sound management of wastes. It intends to set in motion a regional mechanism to address 3R issues, needs and priorities in Asian countries, including emerging issues of concern in waste management.

5.1 Genesis and progress of the Regional 3R Forum

At the East Asia Environment Ministers Meeting held in October 2008 in Hanoi, Vietnam, the inauguration of the Regional 3R Forum in Asia was proposed by Japan and endorsed by the leaders of participating countries. 3R Forum was conceived as the platform to promote the 3Rs in the Asian developing countries in corporation with the governments, international organizations and donor communities. The Inaugural Meeting of the Regional 3R Forum in Asia was held on November 11 and 12, 2009, in Japan with the participation of delegates from 15 Asian countries governments, international organizations, and 3R experts.

Subsequently in 2009, Tokyo 3R Statement on the establishment of the Regional 3R Forum in Asia was adopted by the participants.

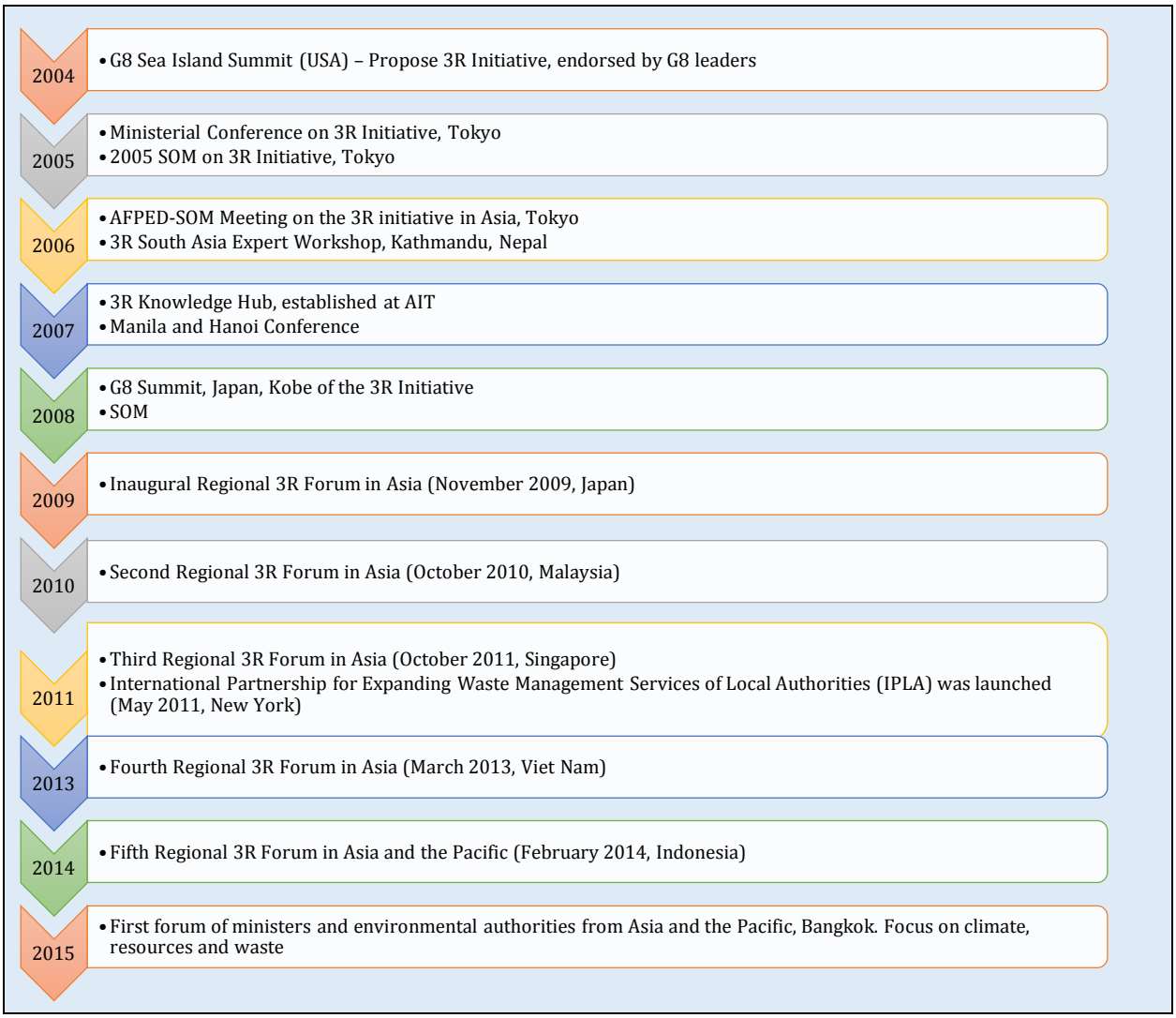
The Regional 3R Forum in Asia was established in November 2009, with the objective of becoming a knowledge networking platform for disseminating and sharing best practices, technologies, and tools on various aspects of the 3Rs. This platform was also expected to facilitate a high-level policy dialogue to address the linkages of 3R with concepts such as Integrated Solid Waste Management (ISWM), Sustainable Consumption and Production (SCP), and Sound Material-Cycle (SMC) on a regular basis.

Since the inception of Forum UNCRD has successfully conducted five 3R Forums. These Forums have influenced waste management policies and practices of the region, led to new partnerships and networking and laid down road maps to direct waste and resource related economies towards sustainable development. UNCRD is now holding the 6th 3R Forum in August 2015 in Maldives.

The geographic coverage of the Forum was gradually expanded to encompass more than thirty APAC countries, including the ten member countries of the Association of Southeast Asian Nations (ASEAN), Australia, Bangladesh, PR China, India, Japan, The Republic of Korea, Mongolia, New Zealand, Timor-Leste, selected SIDS of the Pacific, and other member countries of South Asia Cooperative Environment Programme (SACEP) such as Afghanistan, Bhutan, Maldives, Nepal, Pakistan, and Sri Lanka.

Box 8 shows the various 3R initiatives from 2004 to 2014.

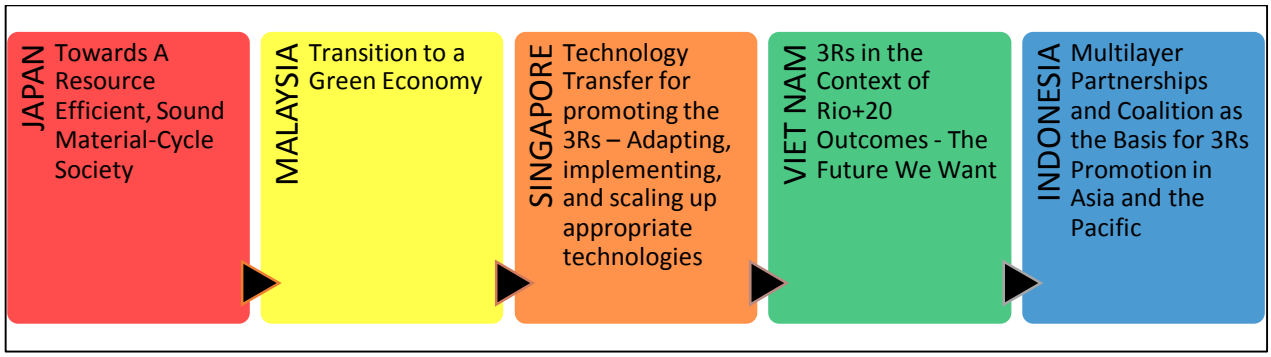
Box 8 3R initiatives in Asia



Given the track of 3R events, emphasis of the 6th Forum centers on the themes of Waste to Resource, 3Rs, Resource Security and the Enabling Framework of Policies, Partnerships and Practices (3Ps).

5.2 Overview of 3R Forums

Over the course of five years, various milestones were achieved through the Regional 3R Forums.



The number of participants to the Forum have more than doubled since the 1st Regional Forum held in 2009. Participation in the Forum is by invitation only and includes high-level government representatives from APAC countries, City Mayors, international experts and resource persons, and others as listed below attend the Forum:

- High level government representatives and policy makers from relevant Ministries such as - Ministry of Environment, Ministry of Public Works, Ministry of Local Government, Ministry of Urban Development, Ministry of Industry, etc.
- City Mayors/Local Government representatives
- Experts and international resource persons, including representatives of scientific and research and development (R&D) institutions in the areas of 3Rs/resource efficiency/waste management
- Representatives of UN and international organizations, including international financial institutions, multi-lateral development banks and donor agencies
- Representatives of the private and business sector
- NGOs and CBOs, etc.

Figure 49 Geographical locations of the six Regional 3R Forums

Figure 50 Themes across all six Regional 3R Forums

5.2.1 Key themes and Cross-cutting areas of the Forum

The Forum intends to link traditionally disparate areas to address global challenges in waste and resource scarcity: resource and energy efficiency; 3R; illegal trade of wastes; climate change mitigation; social aspects; R&D. In order to do so, efforts should spread across levels and across borders. For example, on a micro level, research and development addresses the core issues of waste generation through green chemistry or cleaner production that focus on the development of energy and material efficient processes, which in turn minimizes the formation of by-products. On a macro level, integration of waste heat and material recovery, through energy and material analysis and management, warrants a closed-loop system that is essential for the existence of a circular economy.

The above mentioned examples are specific to scientific analysis whereas waste management is not limited to only technological solutions. Systems such as institutions, governance, occupational safety, and financial instruments also play a key role. Binding these factors calls for multi-stakeholder involvement. Stakeholders include local and international organizations, governments, businesses, academia, local authorities, informal sector, public and NGOs.

Multi-stakeholder partnerships are a mix of collaboration, expertise, representation and decision making. The fact that all stakeholders are connected makes waste management a complex process. This is why a multi-stakeholder discussion combining governance; economic and social instruments; scientific expertise; and institutionalization will be better than single-stakeholders working independently.

The nature of all stakeholders involved in this process i.e. their differences and similarities, and the different ways in which each of them work should be acknowledged and understood. This way consensus on ideas and their subsequent delivery is faster and more effective. Stakeholders that focus on ‘Reduce’ are different from those who focus on ‘Reuse’ and ‘Recycle’. For example, the ones that ‘Reduce’ are designers. The diversity of stakeholders and the multilayer partnerships that form are different for different ‘Rs’ in the 3Rs. Regional 3R Forum hopes to bring these stakeholder together. **Figure 51** shows the various stakeholders for each of the 3Rs.

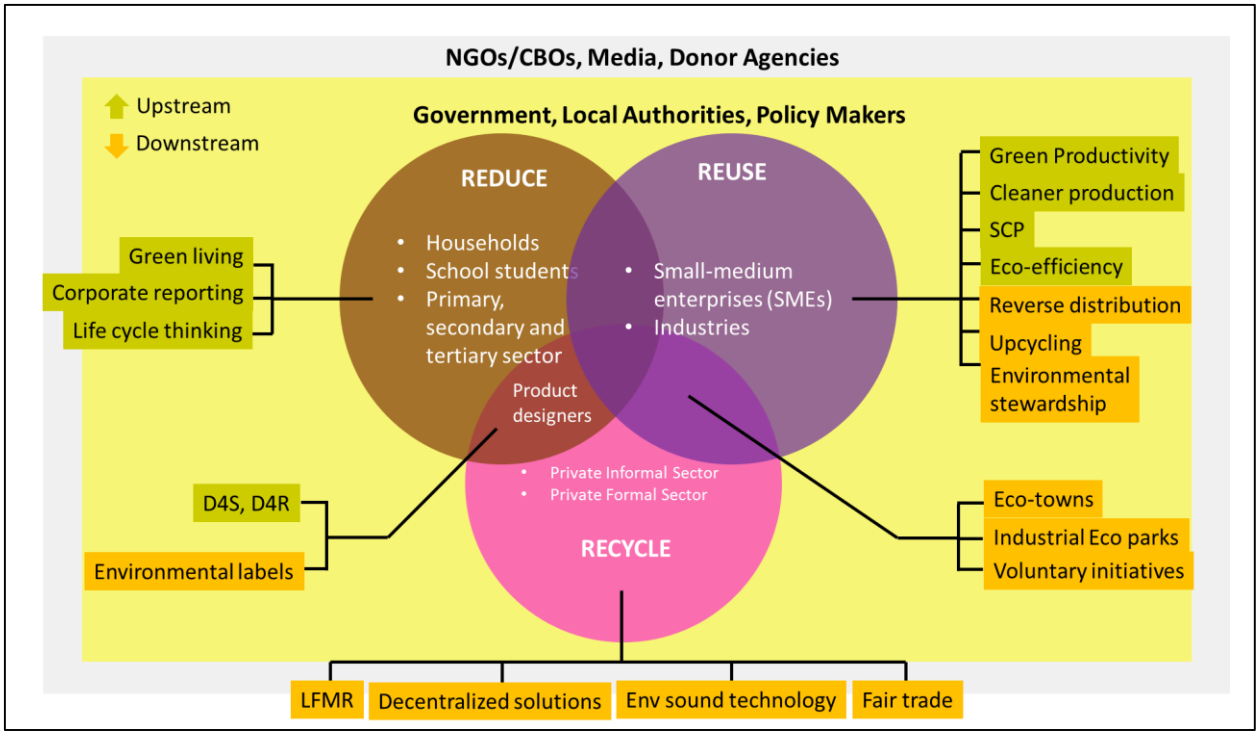


Figure 51 Stakeholders of 3Rs

Each of these stakeholders has a different role to play and sometimes these roles overlap and need synergies. **Table 23** shows the roles of stakeholders involved in 3Rs.

Table 23 Roles of stakeholders of 3Rs

Government, Local Authorities, Policy Makers	Waste generators (Public and Industries/Commercial establishments/Institutions)	Private Sector/ Waste management companies
• Development of policies, guidelines and rules and regulations, action plans • Help local authorities as well as industries • Arrange for financial mechanisms. Subsidies and preferential taxation for facilities • Integrate the informal sector • Ensure enforcement of laws • Green purchasing • Information disclosure • Development of hubs for 3R related business	• Segregation of waste at household as well as factory/commercial and institutional level • Small and Medium Enterprises (SMEs) and Industries using recyclables as raw material • Use cleaner technology to reduce the waste at source • Reconsideration of one's lifestyle • Participating in 3R related policy making	• Sorting and recycling activities - Take back and reuse/recycling of used products in keeping with EPR • Investment in 3R related projects • Development of infrastructure facilities in collection, transportation and recycling of waste at industry as well as public level • Provide environmentally sound goods and services • Environmentally sound management of wastes • Establishment of an environmental management system • Environmental labels and environmental reports

• Promotion of international cooperation		
NGOs and Media	**Informal Sector**	**Product Designers**
• Community mobilization • Awareness creation • Coverage of 3R activities • Publicity of good 3R practices • Work with the informal sector	• Promote separation and collection of waste at primary level • Improve waste management and recycling system • Work in partnership other stakeholders • Improve the working conditions	• Produce environment friendly products designed for reuse and recyclability

Source: Adapted from Ministry of Environment, Japan[117] and improved upon.

Partnerships vary with goals such as development of strategies and guidelines, information exchange and sharing of scientific knowledge, coordination between various stakeholders, development of indicators and benchmarking systems, or identifying actions and their implementation. Global partnerships and partnerships specific to the APAC region are shown in **Table 24**.

Table 24 Partnerships in Waste Management[118]

APAC	Global
• Aloha+ Challenge: A Culture of Sustainability – He Nohona ʻAeʻoia • Bringing Biogas to Samoa • Japanese Technical Cooperation Project for Promotion of Regional Initiative on Solid Waste Management in Pacific Island Countries (J-PRISM) • Pacific Waste Solutions • Samoa Solid Waste Management (SWM) Partnership • Sustainable Consumption and Production for SIDS Initiative (within the 10YFP) • The UK/Samoa Biogas project • Travel Foundation, The (formerly The Sustainable Tourism Initiative) • University Consortium of Small Island States (UCSIS) • Waigani Convention • Waste Management and Sanitation Improvement (WMI) Programme • Zero Hunger Challenge (ZHC)	• Global Partnership for Oceans • Global Partnership on Waste Management (GPWM) • Global Partnership on Marine Litter (GPML), also functioning as one of the thematic areas under GPWM • International Partnership for Expanding Waste Management Services of Local Authorities (IPLA) by UNCRD

Waste management activities contribute to GHG emissions. For example, composting, combustion, landfilling and recycling, all produce GHGs along with some amounts of particulate emissions and other gases. As a matter of fact, these activities offer a way to reduce the net GHG emissions, instead of adding to them, through indirect GHG reductions. For example, replacing synthetic fertilizers with compost reduces the energy requirement associated with fertilizer production, thereby reducing the GHG emissions. Energy obtained from combustion

[117] Japan's efforts to establish a sound material cycle society http://www.env.go.jp/recycle/3r/en/approach/02.pdf
[118] Adapted from SIDS Action Platform http://www.sids2014.org/partnerships. Accessed on 4th August 2015

of waste and methane capture from landfills can replace energy obtained from fossil fuels.[119] The 3R Forum therefore addresses linkages between waste management and climate change as effects of climate change do not recognize borders.

Initiatives and linkages under the Regional 3R Forum and the key thematic areas addressed by the 3R Forum areas are shown in **Table 25** and **Table 26**.

Table 25 Initiatives and linkages under the Regional 3R Forum

Solid & Hazardous Waste Thematic Working Group (under the Ministerial Regional Forum on Environment and Health)	Thematic Working Group on solid and hazardous waste (Waste TWG) deals with municipal waste and medical waste which are common issues to the member countries. The member countries of Waste TWG include: Brunei Darussalam, Cambodia, PR China, Indonesia, Japan, The Republic of Korea, Lao PDR, Malaysia, Mongolia, Myanmar, The Philippines, Singapore, Thailand, and Viet Nam.
3R Knowledge Hub (3rKH)	During May – July 2006, ADB, Asian Institute of Technology (AIT), UNEP Regional Resource Centre for Asia and the Pacific (UNEP RRC.AP), and United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) discussed and agreed to begin the establishment of a joint regional knowledge hub on 3R (3RKH) by the support providing from technical assistance.
Basel Convention	The Tokyo 3R Statement noted the Forum's relevance in achieving the goals of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.
ASEAN Working Group on Environmentally Sustainable Cities (AWGESC)	The Association of South East Asian Nations (ASEAN) works to ensure that cities/urban areas in ASEAN are environmentally sustainable, while meeting the social and economic needs of the people are outlined in the ASCC Blueprint (2009 – 2015).
Commission on Sustainable Development (CSD)	The United Nations Commission on Sustainable Development (CSD) was established by the UN General Assembly in December 1992 to ensure effective follow-up of United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit. From its inception, the CSD was highly participatory in structure and outlook, by engaging in its formal proceedings a wide range of official stakeholders and partners through innovative formulae.
Millennium Development Goals (MDGs)	The eight Millennium Development Goals (MDGs) – which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015 – form a blueprint, agreed to by the world's countries and leading development institutions. They have galvanized unprecedented efforts to meet the needs of the world's poorest.

[119] Vital Waste Graphics http://www.grida.no/publications/vg/waste/page/2871.aspx. Accessed on 4th August 2015

Table 26 Cross-cutting areas and Key thematic areas of the Regional 3R Forum

Key thematic areas
Municipal solid waste: Less than half of the municipal solid waste goes uncollected in the entire world and open dumping is stilled practiced on a large scale. Increase in the number of diseases and environmental degradation is caused by this largest stream of waste.
Medical/Healthcare waste: Medical waste is a biohazard that causes spread of deadly diseases. Reports suggest children in open dump areas are prone to get exposed to used syringes.
Agricultural/Bio-mass waste: A waste stream with a great potential of energy recovery, agricultural/bio-mass waste also contributes to greenhouse gas emissions.
Electrical and Electronic waste (WEEE): A highly trafficked stream of waste, WEEE (or e-waste) is a hazardous stream loaded with heavy metals. E-waste is very difficult to trace and mostly ends up in the general municipal waste stream.
Industrial and hazardous waste: Every industry produces hazardous waste laden with chemicals that can destroy ecosystems and also persist in the environment for a long time. Rapid industrialization in developing countries is difficult due to lack of resources and the infrastructure to tackle it. It also is an occupational hazard for the workers in these industries.
Construction and demolition waste: Construction waste is a highly voluminous waste stream that comes from construction sites and demolition activities. It is also a consequence of natural disaster. Migration of population from rural to urban areas has caused an upsurge in construction waste.

Cross-cutting areas					
Resource Efficiency, Energy Efficiency (including CP aspects)	Climate Change Mitigation/Co-benefits/CDM	3R/Waste Management	Social aspects/Poverty/MDG/Informal sectors	Illegal trade/ trans-boundary movement of hazardous wastes	Research and development (3R technology assessment & evaluation, and resource cycle)

6 Way ahead

It is evident that 3Rs will play a key and pivotal role in the Planets future.

3Rs will lead to sustainable development, provide security to our precious and limited resources, generate employment, foster innovation and usher the regime of green economy. Given the rising population, consumption and generation of waste in the APAC region, 3Rs must be adopted and mainstreamed in the national policies.

The elements of Reduce, Reuse and Recycle connect diverse stakeholders from Government (G), Business (B) and Community (C). It is only the partnership approach between the GBC that will help 3R succeed from policies to actions. Regional forums like 3R have therefore an important role to play for sharing of knowledge and experiences. Over the last several forums, a lot has been achieved in this direction.

There are however several challenges to be addressed and questions to be discussed.

a. We lack a reliable or credible inventorization of waste. To achieve this objective, we need to arrive at a consistent or harmonious definition of waste. How can this be done? Should the 3R Forum set up a Task force?

b. We need to address immediate concerns of dumpsites in the region and take action to protect human health and ecosystems. Techniques like LFMR will need to be given more attention with innovative financial engineering. Principles of 3R can be applied.

c. Amongst the new waste streams, Industrial and Hazardous waste, E-waste, Plastic and C&D waste form priority waste streams for the APAC region. How do we stimulate investment flows from the private sector to manage these streams? How do we tame generation of these waste streams through Sustainable Consumption & Production (SCP)?

d. To promote SCP, we must make efforts to introduce 3Rs in the national policies. How can this be achieved? Should the 3R Forum take on a project on Comparative Analyses of Waste Management Policies in the APAC region and come up with recommendations and a guidance with case studies? Could a Policy roundtable be organized where such a comparative assessment be presented?

e. In the past decade, a number of waste processing technologies have emerged that help in implementation of 3Rs. Many of these technologies are however not independently assessed and some are not relevant to the waste volumes and characteristics in the APAC region. There is no independent technology assessment and guidance Centre that can help the Urban Local Bodies (ULBs) in technology selection. Can we think of setting such a Centre with national nodes to address this need?

f. Training of human resources is going to be an important activity for promotion of 3Rs. Training will have to be imparted to staff at the ULBs, Community based Organizations and NGOs, professionals, bankers/investors, planners, regulators and policy makers as well as elected representatives. There are several efforts being made in the APAC region in this direction. We will need to inventorize these efforts and establish learning network to connect them so that we do not duplicate efforts and strike a synergy. How can this be done?

The above questions and challenges could be taken up for framing the 7th 3R Forum.

Finally, it is now timely that the 3R Asia Forum sets up national 3R nodes to increase national presence, assist modernization of waste and resource related policies, provide technology advice and facilitate financing. Efforts should be taken up in this direction.

7 Annexure A: Some definitions related to resource consumption

- **Material intensity**[120]**:** Ratio of Domestic Material Consumption (DMC) to GDP at constant prices.
- **Domestic Material Consumption**[121]**:** DMC is an indicator derived from national material flow accounts. DMC subtracts the direct mass of exports from Domestic Material Intensity (DMI), thus illustrating the consumption of materials by the domestic economy.
- **Material efficiency**[122]**:** Material efficiency in industrial production focuses on the amount of a particular material needed to produce a particular product. Mathematically it is the ratio of the product divided by the raw materials used – so the number is never smaller than one.
- **Resource Efficiency**[123]**:** Resource efficiency means using the Earth's limited resources in a sustainable manner while minimizing impacts on the environment. It allows us to create more with less and to deliver greater value with less input.
- **Eco-efficiency**[124]**:** Eco-efficiency is achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the Earth's estimated carrying capacity." In short, it is concerned with creating more value with less impact.
- **Resource Productivity**[125]**:** Resource productivity is the quantity of good or service (outcome) that is obtained through the expenditure of unit resource. This can be expressed in monetary terms as the monetary yield per unit resource.
- **Material productivity**[126] **:** At the company level, material productivity expresses the amount of economic value generated by a unit of material input or material consumption. On the economy-wide level it is calculated as GDP per material input/consumption.
- **Green Productivity**[127]**:** Green Productivity is a strategy for enhancing productivity and environmental performance for overall socio-economic development. It is the application of appropriate productivity and environmental management policies, tools, techniques, and technologies in order to reduce the environmental impact of an organization's activities.
- **Cleaner Production**[128]**:** Cleaner Production is the continuous application of an integrated preventative environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment.
- **Oceans Economy**[129]**:** The Ocean Economy is defined as the economic activity, which indirectly or directly uses the ocean (or Great Lakes) as an input. The Coastal Economy is defined as all activity, which takes place in the coastal areas.

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120 United Nations, Sustainable Development Indicator Methodology Sheet
www.un.org/esa/sustdev/natlinfo/indicators/methodology_sheets/consumption_production/material_intensity.pdf
121 Eco-Innovation Observatory, Accessed on August 3, 2015,
www.eco-innovation.eu/index.php?option=com_glossary&letter=D&id=39&Itemid=126
122 UNEP, Report on Resource Efficiency, Chapter 6
http://www.unep.org/resourceefficiency/Portals/24147/scp/presme/pdfs/UNEP_PRE_SME_ITH_Chapter_6.pdf
123 European Commission, accessed on August 3, 2015, http://ec.europa.eu/environment/resource_efficiency
124 World Business Council for Sustainable Development.
http://www.wbcsd.org/pages/EDocument/EDocumentDetails.aspx?ID=13593
125 Hawken, P., Lovins, A. and Lovins, L.H. (1999) Natural Capitalism: Creating the Next Industrial Revolution. Earthscan, London
126 Eco-Innovation Observatory, Accessed on August 3, 2015
www.eco-innovation.eu/index.php?option=com_glossary&letter=M&id=44&Itemid=126
127 Asian Productivity Organization
128 UNIDO. http://www.unido.org/en/what-we-do/environment/resource-efficient-and-low-carbon-industrial-production/cp/cleaner-production.html. Accessed on September 10, 2015
129 A Guide to the Measurement of the Market Data for the Ocean and Coastal Economy in the National Ocean Economics Program Charles S. Colgan Chief Economist, Market Data National Ocean Economics Program January 2007

- **Circular Economy[130]:** A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.
- **Sustainable Tourism[131]:** Tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities.
- **Life cycle thinking[132]:** Life cycle thinking means taking account of the environmental, social and economic impacts of a product over its entire life cycle.
- **Design for Environment (DfE)[133]:** DfE bears in mind the potential environmental impact throughout the life cycle of the product: emission of harmful substances, excessive use of energy or nonrenewable energy sources. It also considers the life cycle of the materials from extraction to disposal. In this way the designers do not create just a product but a whole life cycle.

[130] Waste & Resources Action Programme http://www.wrap.org.uk/content/wrap-and-circular-economy. Accessed on September 11, 2015.
[131] UNTWO. http://sdt.unwto.org/content/about-us-5. Accessed on September 10, 2015.
[132] International Council of Chemical Associations. An Executive Guide: How to Know If and When it's Time to Comission a Life Cycle Assessment http://www.icca-chem.org/iccadocs/acc_icc_lifecycle_2013.08.pdf
[133] M. Bevilacqua et al., Design for Environment as a Tool for the Development of a Sustainable Supply Chain, DOI: 0.1007/978-1-4471-2461-0_2, Springer-Verlag London Limited 2012

8 Annexure B: Key Databases used in this Report

1. Master Country Database by Environmental Management Centre (EMC), LLP, India. It compiles data from UN Statistics, Eurostat and the OECD. The latest data available varied between countries. Data on population and gross national income (GNI)/gross domestic product (GDP) uses data published by the World Bank.
2. Waste Atlas - University of Leeds is another country-level database, a project undertaken at the University of Leeds, which collated and cross-checked country level data from the Waste Atlas.