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State of the 3Rs in Asia and the Pacific

The People's Republic of Bangladesh

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Disclaimer

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ABBREVIATION

3R	Reduce, Reuse, Recycle
ADB	Asian Development Bank
BAEC	Bangladesh Atomic Energy Commission
BBS	Bangladesh Bureau of Statistics
BMDF	Bangladesh Municipal Development Fund
BPGMEA	Bangladesh Plastic Goods Manufacturers and Exporters Association
CDM	Clean Development Mechanism
DCC	Dhaka City Corporation
DNCC	Dhaka North City Corporation
DoE	Department of Environment
DSCC	Dhaka South City Corporation
ECA	Environmental Conservation Act
ECR	Environmental Conservation Rules
EPR	Extended Producer Responsibility
ESDO	Environment and Social Development Organization
ETP	Effluent Treatment Plant
GDP	Gross Domestic Product
GHG	Green House Gas
GNP	Gross National Product
GoB	Government of Bangladesh
HIW	Hazardous Industrial Wastes
JICA	Japan International Cooperation Agency
JMP	Joint Monitoring Program
LGED	Local Government Engineering Department
MoA	Ministry of Agriculture
MoF&E	Ministry of Forest and Environment
MSW	Municipal Solid Waste
NGO	Non-Government Organization
NNI	Net National Income
PPP	Polluter Pay Principle
SAARC	South Asian Association for Regional Cooperation
SWM	SWM
TWG	Total Waste Generation
UNCRD	United Nations Centre for Regional Development
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WHO	World Health Organization
WRI	World Resource Institute

CONTENTS

A: COUNTRY SITUATION

Demographic, economic, market factors, urbanization and forces of globalization all have influence in waste generation rate and also how are they managed – from practice of separation at source, if at all, to storing, collection, transportation and disposal. Of these, the most important are the demographic and economic factors in that the waste generation volume depends on population size and waste generation rate is strongly associated with level of economic development, measured by per capita income (net national income - NNI, until recently more commonly called GNP per capita). As a country at early stage of development, Bangladesh, being one of the populous countries of Asia and the Pacific, in the course of rapid economic growth that is transforming its age-old rural agricultural economy into an urban-industrial economy, is beset with overwhelming nature of the environmental problems of all kinds. Of these problems most visible one is waste, particularly in its urban environment. For understanding the Bangladesh context of 3R, it is thus important to depict the demographic, economic, market and urban-industrial context of Bangladesh, which is also being influenced by the forces of globalization. The following sub-sections on the country situation thus provide some basic data on demography, economy, market and urbanization that define the 3R status of Bangladesh.

I. Demography

Table A-1 Key demographic indicators

Indicator	Data/Year	Remarks
(i) Huge population base	162 million (2016 estimate)	As per population census of 2011, the number was 149.8 (adjusted)
(ii) Growth rate per year	1.47% (2001-2011)	Adjusted rate: 1.37%
(iii) Child-bearing age group, 15-44	48.1 % (based on 2011 census data)	High proportion of women of child bearing-age is expected to create a new baby boom in Bangladesh unless essential public policy is in place for delayed marriage, increasing school enrolment, stopping dropouts of adolescent girls from schools, and according women priority in job recruitment.
(iv) Working-age group, 15-64	64.2 %	Nearly two-thirds of population belongs in the working age group, which has been the basis of optimism of Bangladesh's prospect for a population dividend.

Source: Based Population and Housing Census 2011, National Report Volume 1: Analytical Report (BBS, 2015).

II. Economy

Table A-2 Structural Composition of GDP and Employment

Sector	Share in GDP				Share in Employment			
	1980	2006	2009	2015	1980	2006	2009	2015
Agriculture	33.0	22.0	18.6	16.0	61.0	48.1	43.6	43.9
Industry	17.0	29.0	28.6	30.4	8.7	11.1	15.6	19.6
Service	49.0	49.0	52.8	53.6	30.3	40.8	40.8	36.5

Source: Based on different Labour Force Surveys of BBS, except GDP data of 2015 which are from World Fact Book.

Table A-3 Level of Development and Economic Growth Rate

Indicator	1970s	1980s	1990s	2006-2015
Per capita income ($)	132-197	242-278	285-398	407-1212
GDP growth rate (%)	(-5.5 – 4.8)%	(7.2 – 2.8)%	(3.5 – 4.7)%	(5.1 – 6.6)%

Source: World Bank Data Bank (http://data.worldbank.org/).

III. Urbanization

Table A-4 Trend in Two Major Urban Indicators

Urban indicators	1961	1974	1981	1991	2001	2011	2013
Level of urbanization (%)	5.2	8.8	15.5	20.2	23.8	28.4	34.3
Urban growth rate (%)	3.7	6.6	10.6	5.2	3.3	4.1	3.6

Source: BBS data based computation provided in Rahman (2012, p.15) except that of 2011data which is from Islam (2013). Data of 2013 are from CIA World Fact Book (2015)

IV. State of the Environment and Waste

The impressive economic growth and rise in level of development, accompanied with structural changes in GDP, employment and human settlements, are having atoll upon the environment of the country. For a long time, the natural environment of Bangladesh has been one of 'shujola-shofola-shoshsho-shamola' (rich water resources, fertile land, crop abundance and lavish greenness), as a poet wrote. In contrast, the environmental degradation in today's Bangladesh is typified by the black tar colour of the river Buriganga that has been the life-line of Dhaka residents for centuries. Other than the contribution of draining wastewater from all around including that of the tanneries, located close to the riverbank, it is the mindless waste dumping that has led to what Burigonga is today. The river bed reportedly has accumulated heaps of plastic bags, several feet high. A long-standing decision to relocate the tanneries from the Hazari Bag area along the river Buriganga to a Savar, 20 km away from the present location has taken many years. It could not be fully implemented so long despite the fact that the government provided land and basic infrastructure in the new location.

Some data and information on pollution indicators are presented by major environmental media to (a) indicate the environmental costs of the on-going economic growth and development, and (b) emphasize the need of public policy and actions for promoting environmental goals in general and 3R in particular for reversing the current unsustainable course of economic growth and development in Bangladesh to a sustainable direction.

1. Waste

- Access to proper waste disposal services is limited, particularly in urban slum and low-income areas.
- Only about 42% of generated waste is collected and dumped at landfill sites, and the rest is left uncollected or undisposed. As much as 400 tons of waste are dumped on the roadside and in open spaces.
- One of the most adverse impacts of poor waste management, especially municipal waste, is the incidence and prevalence of diseases such as malaria and respiratory problems, as well as other illnesses through the contamination of ground water.
- Biomedical waste poses a great danger in Bangladesh as a report estimated that 20% of the biomedical waste is 'highly infectious' and is a hazard since it is often disposed of into the sewage systems or drains.
- Solid waste leads to blockages in the drainage system which lead to flooding in the streets.
- Consequently, mosquitos and bad odor are also among the negative impacts.

2. Water Pollution and Waste

- The most polluted water body in Bangladesh is the river Buriganga.
- Much of the industrial and a substantial portion of municipal and urban waste of Dhaka city are flushed into the Buriganga.
- It is estimated that total organic waste load discharged into the river is around 250 metric tons per day (Reazuddin, 1994).
- According to Department of Environment, Government of Bangladesh (1988), the Buriganga, near Dhaka, shows Biochemical Oxygen Demand between 20-180 mg/l.
- Tanneries all over Bangladesh, particularly those in the Hazaribagh area of Dhaka, contributed to severe water pollution.
- The small cottage tanners of Hazaribagh, which has been producing sandal leather based on cow hides, are probably the only tanning group in the world using waste tanning liquor coming from the modern tanners as their process liquor. After use, the effluents are discharged, as are all other tannery discharges in the tanning area, into the streets, gutters and sewers – all of which ultimately enter the surface and groundwater.
- According to Dittfurth and Röhring (1987) about 250 different toxic chemicals and heavy metals like cadmium, chromium, arsenic, zinc, etc. are used by the leather industry.
- These heavy metals enter the water bodies causing severe consequences in the bodies of living organisms.

Source: Analysis of the causes and impacts of Water Pollution of Buriganga River: A Critical Study' by Chandan Chakraborty, Md Mazaharul Huq, Sobur Ahmed, Taslima Tabassum, Md Rubel Miah (International Journal Of Scientific and Technology Research Volume 2, Issue 9, September 2013).

3. Sanitation

- An estimated population of 56% had access to adequate sanitation facilities in 2010.
- According to the Joint Monitoring Program (JMP) for Water Supply and Sanitation of UNICEF and the World Health Organization (WHO), access to an "improved source of water supply"

increased only slightly from 77% in 1990 to 81% in 2010, whereas coverage of improved sanitation increased from 39% to 46% during the same period.

V. Waste management

For better or worse, Bangladesh has adopted a 3R Strategy before it even has a well-developed regulatory framework or policy on waste management. Until 1970s, Bangladesh was largely a rural-agricultural country (as per 1974 census, Bangladesh's urban population was only about 8.78%. Since waste has largely been an unknown entity in the rural-agricultural society, the issue of waste did not receive much, if indeed any, policy attention until recently.

Bangladesh's urban growth rate (3.6% in 2013) is the highest among the South Asian countries. This growth rate is 2.5 times higher than the national population growth rate of 1.42 %. As a result, the urbanization level increased from 8.8% in 1974 to 15.5% in 1981, then to 20.2% (1991), 23.8% (2001) , 28.4% (2011) to 34.3% in 2013.

Bangladesh is a small country with huge population generating a huge amount of waste every day. There is no specific authority responsible for waste management and disposal in the country and that is why Bangladesh has minimal waste collection coverage which forces majority of the waste to be dumped on open land. This waste is not disposed of properly; rather often mixed with hazardous waste such as hospital waste. However, no waste management rules or policy have been developed here in Bangladesh. The country is a late starter but it is a little ahead here as there is a National 3R strategy for Waste Management and various organizations are working with recycling of waste and integrated waste management. This is a good start because the waste management sector will have the components of 3R and sustainable waste management will be ensured.

1. Waste Management in City Corporation Act 2009

The City Corporation Act, 2009 states the following regarding waste management in urban regions of Bangladesh. It starts with ***"Waste removal, collection and its management"*** and then it continues as follows:

1.4 Corporation will ensure collection of waste and removal of it from all the roads, public toilets, drains, building.

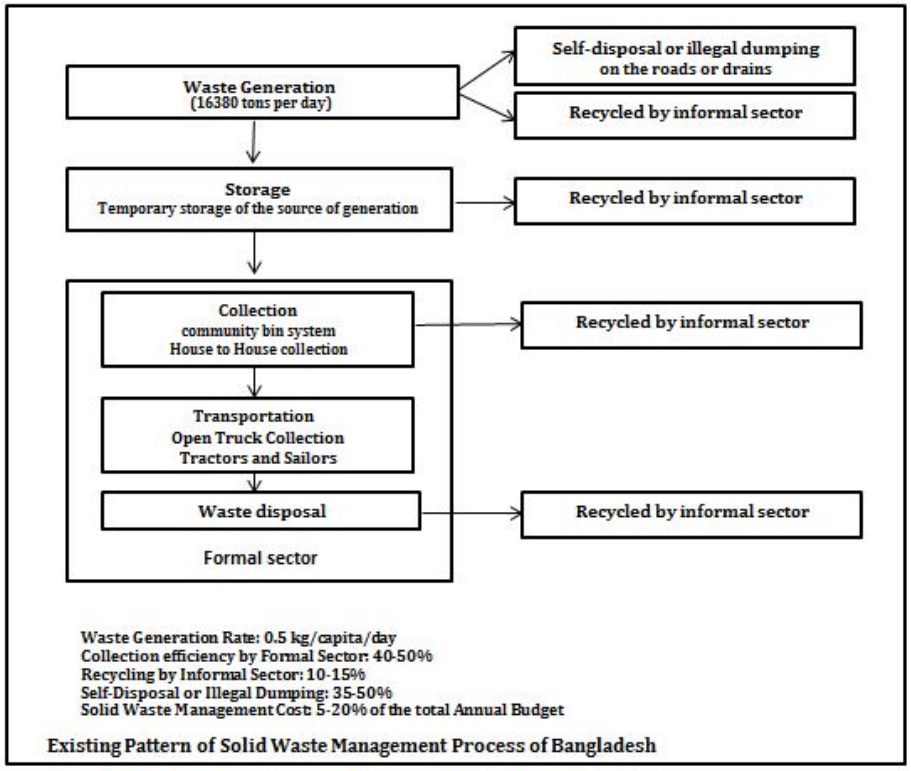
1.5 Corporation will be responsible for collecting waste from all the areas and buildings under its jurisdiction

1.6 Corporation will manage dustbins or other bins in various areas of the city and when there will be dustbins or other bins like those then the Corporation can release orders for the nearby houses and land owners to dump their wastes in the dustbins installed.

1.7 The employees of the Corporation and the waste collected by them or the city corporation and the waste dumped into the dustbins will be considered as their property"

2. Existing Pattern of Solid Waste Management Process of Bangladesh

Figure A-1 below illustrates the existing pattern of solid waste management process of Bangladesh.

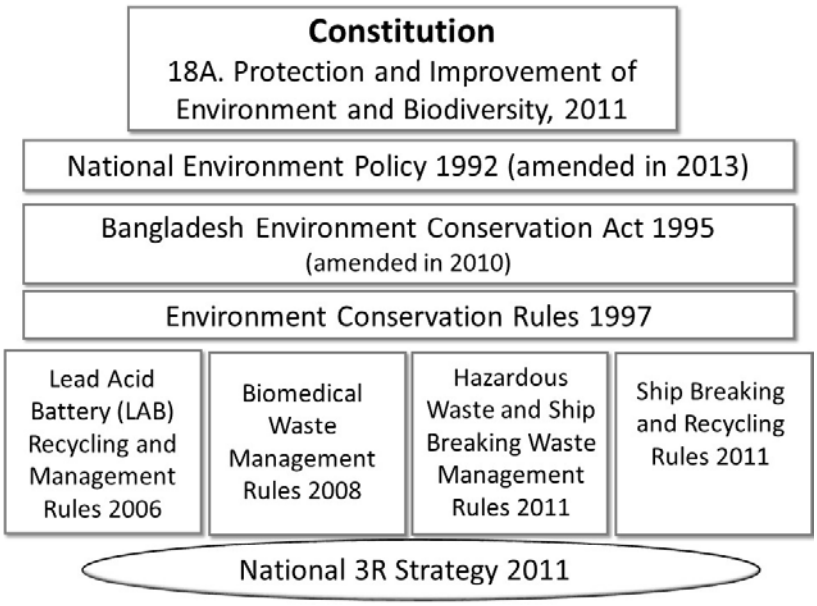


Source: BBS (2010, p.332).

Figure A-1 Existing Pattern of Solid Waste Management Process of Bangladesh

3. Waste management provisions and implications in national environmental policies and acts

Figure A-2 shows the legislative framework of environmental conservation, waste management and 3R. It is discernible from the illustration that the legal framework for environmental protection in general and waste management/3R strategy in particular got a big boost from the 2011 amendment of the constitution which for the first time has created a constitutional foundation to legislation for environmental protection and management. This article states: *Protection and improvement of environment and biodiversity - The state shall endeavor to protect and improve the environment and to preserve and safeguard the natural resources, biodiversity, wetlands, forests and wild life for the present and future citizens (Article 18A, Constitution of Bangladesh, Bangladesh Government, 2011, p. 27).* This constitutional amendment was preceded by (a) Amendment of Bangladesh Conservation Rules 1995 in *2010,* and followed by adoption of (b) Ship-breaking and Recycling Rules *2011,* (c) Hazardous Waste and Ship-breaking Waste Management Rules, both in *2011,* and (d) *2013* amendment of the National Environment Policy 1992. All this legislative development at national level has been mutually reinforcing for providing an essential legal basis for implementing the 3R strategy at sectoral and local levels.



Source: Prepared by author

Figure A-2 Legislative Framework of 3R related policies

Tabular presentation below show the policies, acts and rules on the environmental protection and management having explicit clauses, references and implications for waste management and 3R.

Table A-5 National Environmental Policies, Acts and Rules Having Waste Related Clauses and Implications

Policies, Acts and Rules on the Environment	Waste Related Clauses, References and Implications/Comments
National Environment Policy 1992	One of the objectives states "identify and regulate activities which pollute and degrade the environment".
Environmental Conservation Act 1995	Definition of waste is specified in this act.
Environmental Conservation Rules 1997	These Rules set some limits for industrial waste and effluent discharge, and industries need to follow some rules to gain Environmental Clearance Certificate for their operation.
Environment Court Act 2000	No reference to waste management, environmental pollution is prominently featured.
National Environment Policy 2013	3R Strategy for waste management is recognized.

Source: Prepared by author

It can be seen from the above presentation that the country's undertaking for creation of a regulatory framework for environmental protection and management started from 1992, which may have to do with the preparatory work for, as well as the outcome of, the 1992 Rio summit, i.e., the UN Conference on Environment and Development (UNCED.) Then came the Environmental Conservation Act 1995 that incorporated a definition of waste. The Environmental Court Act of 2000 was a pioneering act for taking action on violations of environmental laws and regulations but waste-related offenses were not specified. It was more directed to polluters or at pollution. A major change however took place in 2013 when the National Environmental Policy recognized the 3R strategy, adopted by the government in 2010, as an appropriate strategy for waste management.

4. Policies, acts, regulations, rules, strategies, action plans, and government guidelines and circular related to waste management and 3R in Bangladesh

Table A-6, Table A-7, Table A-8, Table A-9, Table A-10 and Table A-11 below show policies, laws, regulations, rules, strategies, action plans, and government circular and guidelines with provisions on waste management in general and 3R in particular.

The tables show how an environmental regulatory framework has been evolving in Bangladesh since 1992. The tables show the provisions on waste management in general and 3Rs in particular. This indicates that an adequate regulatory framework is in place for environmental protection and management including waste management and 3Rs. However within the scope of this review it has not been possible to go into the details of each of these regulations spread over the last 25 years.

However, the following points can be safely pointed out:

(i) The overall environmental as well as sectoral laws and regulations have adequate provisions on waste management and 3Rs, particularly since 2010 when the national 3R strategy was adopted;
(ii) It is not clear if incentive-disincentive measures have been incorporated;
(iii) It is also not clear if adequate measures are in place for raising awareness, dissemination of information (e.g., availability of alternative technologies such as for replacing residual-intensive technology by residual technology) education and training; and
(iv) Whereas there are provisions for promotion of composting and other recycling practices, infrastructure requirements are not specified and their provisioning issues are left to an elusive public-private partnership mechanism.

Table A-6 Sectoral policies having provisions and implications on 3R

Policies	Provisions
Revised National Urban Policy 2015	This policy emphasized CDM and recycling
National Renewable Energy Policy 2008	This policy promoted production of biogas and other green energy from waste and also provided incentives for CDM to promote green energy projects.
National Agricultural Policy 2012	According to this policy the government promotes the use of compost/organic fertilizer amongst the farmers to improve the soil productivity and food security
National Industrial Policy 2005	This policy recommended the use of EMS and Cleaner Production practices amongst industries
National Policy for Water Supply and Sanitation 2014	According to this policy the government takes measures for recycling of waste as much as possible, and for using organic waste materials for compost and bio-gas production.
Urban Management Policy Statement 1998	Recommended municipalities for privatization of services as well as giving priority to facilities for slum dwellers including provisions of water supply, sanitation and solid waste disposal.

Table A-7 Acts with the provisions for promotion of compost and setting standards by types of waste disposal

Acts Fertilizer Act 2006	Under this act compost was promoted and standard of compost was set by the government in 2008.
Bangladesh Environmental Conservation Act (ECA) 1995	Recommended standards for disposal of different types of waste.
The Bangladesh Environment Conservation (Amendment) Act, 2010	Amendment of Bangladesh Environmental Conservation Act (ECA) 1995

Table A-8 Rules for waste management and recycling in two key waste sectors and Bangladesh Environmental Conservation Rules (ECR)

Rules Biomedical Waste Management Rules 2008	This rule recommends source separation of hospital waste as well as separate collection, transportation and treatment and disposal of all kinds of hospital and clinical waste.
Lead Acid Battery (LAB) Recycling and Management Rules 2006	These rules brought major improvement in collection and recycling of LAB which used to be opened for lead recovery by informal sector workers with their exposure to serious health hazards.
Draft National Solid Waste Management Rules 2005	3R principle has been adopted explicitly or implicitly
Bangladesh Environmental Conservation Rules (ECR) 1997	Recommends waste disposal standards for mainly industrial wastes.
Hazardous Waste and Ship Breaking Waste Management Rules 2011	Deals with hazardous and ship breaking waste management.
Ship-Breaking and Recycling Rules 2011	Deals specifically with ship-breaking and recycling issues.

Table A-9 Three national strategies having implications for waste management and 3R

Strategies	**Waste Management and 3R Implications**
National CDM Strategy 2005	This strategy promoted pro-poor CDM projects on waste sector by harnessing carbon financing
Poverty Reduction Strategy Paper (PRSP) 2005	This paper promoted EMS. To improve the solid waste management situation, special focus was given to segregation of waste at source along with the promotion of recycle, reduce and reuse of industrial and other solid waste etc.
National Sanitation Strategy 2014	The goal was to achieve 100% sanitation coverage by 2010. Here resource recovery and recycling as given top priority to improve urban sanitation situation instead of disposal.

Table A-10 Government Action Plan on Environment and Waste Management

Action Plan	**Provisions and Requirements for Waste Management and 3R**
Dhaka Environment Management Plan 2005	Waste recycling was promoted, less land filling encouraged, EMS promoted among industries.
Solid Waste Management Action Plan for Eight Secondary Towns in Bangladesh 2005	Under the Secondary Towns Integrated Flood Protection (Phase-2) Project of Local Government Engineering Department, GoB. This action plan is based on 4R principle i.e. reduce, reuse, recycle and recovery of waste.
National Environmental Management Action Plan (NEMAP) 1995	This was a plan of the Government of Bangladesh (GoB), prepared by the Ministry of Environment and Forest (MoEF) in consultation with people from all walks of life. 3R is being promoted under the Sustainable Environment Management Program (SEMP) of NEMAP.

Table A-11 Government Circular and Guidelines for Promoting 3R Practices

Government Circular and Guidelines	**Waste and 3R Related Requirements**
Circular to Promote Compost by the Ministry of Agriculture (MoA), on 23 April 2008	Ministry of Agriculture issued a circular to promote use of compost amongst the farmers to reduce environmental damages from use of chemical fertilizers, which could also reduce government's financial burden for subsidizing chemical fertilizer.
Private Sector Infrastructure Guideline 2004	This guideline of the GOB has recommended private sector investment in waste management sector which includes all types of waste. It has also identified waste sector as one of the priority sector for private investment.
Private Sector Housing Development Guideline 2005	This guideline recommends to space in new housing areas for waste recycling specially composting and biogas generation.
Dhaka Declaration on Waste Management by SAARC countries during 10-12 October 2004	SAARC countries agree to encourage NGOs and private companies to establish community-based composting, segregation of waste at source, separate collection and resource recovery from wastes with particular focus on composting.

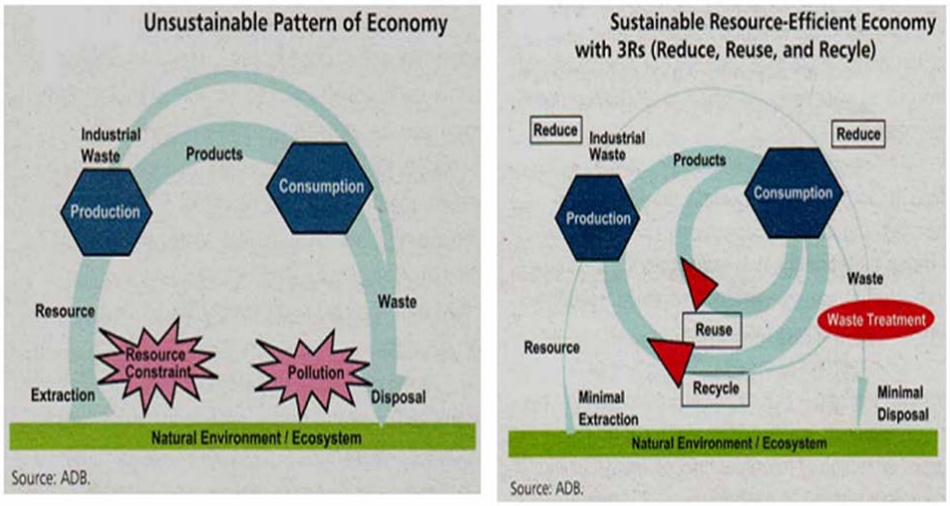
Source: Based on 3R Strategy (GoB, 2010) and information provided by Tariq Bin Yousuf, former Head of the Waste Management Department, Dhaka North City Corporation (DNCC).

VI. 3Rs in Waste Management of Bangladesh

The main features of the national strategy for promoting 3Rs are:

(i) Prioritizing waste avoidance/reduction over recycling, and recycling over all other forms of environmentally-unsound disposal;
(ii) Reusing non-avoidable waste as far as possible;
(iii) Reducing hazardous content in the waste at the lowest possible level;
(iv) Guaranteeing an environmentally-sound residual waste treatment and disposal as basic prerequisite for environmental protection.

As shown below, 3R Strategy of Bangladesh is geared to change from an unsustainable pattern of economy (left-hand side illustration in Figure A-3) to a sustainable resource-efficient economy (right-hand side illustration in the same figure).



Source: National 3R Strategy for Waste Management 2009 (GoB, 2010)

Figure A-3 An Illustration of Unsustainable Pattern of Economy vis-a-vis Sustainable Resource-Efficient Economy with 3Rs

The following waste sectors have been identified for actions:

- Municipal solid waste
- Industrial waste
- Biomedical waste
- Institutional and commercial waste
- Agricultural waste
- E-waste

The above illustration of national 3R strategy for waste management suggests that Bangladesh is very much geared to adoption of 3R in waste management. It is paradoxical that 3R strategy was incorporated into waste management in Bangladesh even before the country had a waste management policy. In fact, even in 2005, Bangladesh did not have a national solid waste management regulatory framework. As the review of national environmental policies and acts for

identification of solid waste management laws and regulations showed (Section A.5.3), a Draft National Solid Waste Management was in place in 2005. By that time, the 3R principle was already a well-known paradigm in solid waste management. Thus 3Rs were incorporated into the draft. In the same year, the solid waste management action plan for eight secondary towns were adopted. In this action plan 4R was adopted, to include 'recovery'.

The point here is not to suggest that Bangladesh did not have any waste management policy or activities before the 2005 draft national solid management rules. Of course whenever a municipality was established, one of its very basic tasks with regard to waste included human excreta collection or removal. The point above rather is that Bangladesh seized on the 3R principle from the beginning of its work for adopting a national level policy on solid waste management. This is perhaps a case in point of the benefits of a later starter in development. Otherwise, a change from an entrenched norm or practice of waste collection, transportation and disposal to 3R perhaps could have been more difficult.

B: WASTE DEFINITIONS

The definitions presented below are based on the prominent government documents. These may or may not be theoretically sound or correct from subject expert perspective.

According to the *Bangladesh Environment Conservation Act, 1995*:

> "Waste means any solid, liquid, gaseous, radioactive substance, the discharge, disposal and dumping of which may cause harmful change to the environment."

I. Municipal solid waste

The above act then specifies that:

> "Municipal solid waste (MSW), commonly known as trash or garbage and as refuse or rubbish, is a waste type consisting of everyday items that are discarded by the public. In Bangladesh municipal solid waste includes not only household waste but also other types of solid waste such industrial waste, hazardous waste, e-waste, agricultural waste, etc."

This definition is thus does not denote a conceptual or desirable definition of municipal solid waste but it denotes the current reality of a mixing-up of more or less of all waste types that are generated in urban areas of the country.

II. Hazardous waste

For hazardous waste definition we utilize the *Bangladesh Country Fact Sheet, 2005* definition. Here the national definition of hazardous waste is used in the context of transboundary movements of such waste entering or existing in Bangladesh. According to this document:

> Hazardous substance means the substance which by reason of its chemical or bio-chemical properties is such that its manufacture, storage, discharge or unregulated transportation can be responsible for the damage of environment.

Bangladesh regulates/controls additional waste as hazardous that is not included in 'Art. 1 (I) a' of the Basel Convention and would be controlled for the purpose of transboundary movements pursuant to the 'Art. 1 (I) b'. Definition of hazardous substance in the Bangladesh Environment Conservation Act, 1995 covers all sorts of hazardous waste. The country fact sheet also states "hazardous substance" means a:

> Substance - the chemical or biochemical properties of which are such that its manufacture, storage, discharge or unregulated transportation can be harmful to the environment.

III. Biomedical Waste

The Medical Waste (Management and Processing) Rules 2008 defines:

> Biomedical waste as any solid, liquid, gaseous or radioactive material which is discharged, thrown away or piled up (dumped) during the medical procedure, vaccination, diagnosis or medical research and causes a harmful change in the environment.

Medical waste also refers to clinical waste. In defining, it is noted that such waste has to be handled and disposed in a proper manner to eliminate the possibility of injury or infection and safeguarding the environment as a whole. The impacts associated with improper management include damage to the environment and adverse effect to public health directly and indirectly.

It is noted that medical waste contains both general waste (75-80 per cent) and infectious waste (20-25 per cent). Although some "medical waste is no more dangerous than household/municipal waste, the hazardous medical waste portion, if exposed to the people or environment in an untreated form, poses various kinds of danger". Thus, the main concern relates to the portion of medical waste that is defined as hazardous. In particular, medical waste poses a special health risk to medical staff, to patients and visitors, to workers collecting, transporting and treating the waste, and to society and the environment in general. It is thus recognized that there is a need for special efforts on proper management of medical waste by the concerned authorities.

Following the World Health Organization, the Environmental Assessment and Action Plan for the Health, Population and Nutrition Sector Development Program (HPNSDP) 2011-2016, prepared by the Ministry of Health and Family Welfare (MOHFW), categorizes medical wastes as follows:

- Infectious: Materials containing pathogen in sufficient quantities, that if exposed can cause diseases.
- Sharps: Disposable needles, syringes, saw, blades, broken glass, nails or any other item that could cause a cut.
- Pharmaceuticals: Drugs and chemicals that return from wards, spilled, outdated, contaminated or are no longer required.
- Radioactive: Solids, liquids and gaseous wastes contaminated with radioactive substances used in diagnosis and treatment of diseases (e.g., toxic goiter).
- Others: Wastes from office, kitchen, room including bed linen, utensils, paper, etc.

IV. E-waste

The e-waste rule is being drafted by the Department of Environment (DoE), the environmental protection agency of Bangladesh, with technical assistance from the *Environmental and Social Development Organization (ESDO).* In this process ESDO suggests:

> "Electronic waste (E-waste) may be defined as all secondary computers, entertainment device electronics, mobile phones, and other items such as television sets and refrigerators, whether sold, donated, or discarded by their original owners" (ESDO, 2010).

E-waste is viewed as a popular, informal name for electronic products nearing the end of their "useful life." Computers, televisions, VCRs, stereos, copiers, and fax machines are common electronic products. Many of these products can be reused, refurbished, or recycled. According to ESDO, electronic discards are one of the growing segments of Bangladesh's waste stream.

C: 3R INDICATORS

Bangladesh has been gearing itself for adopting 3R strategy since 2010. Until then the country's waste management practices have been primarily one of waste collection, transportation and disposal limited to cities and urban areas having municipalities. Other than widespread littering of waste and dumping of waste at primary collection points and open dumping, the most visible activity concerning waste has been the work of waste pickers – locally called "*tokais*". National government involvement in waste management for understandable reason has been limited, if not absent. Sole responsibilities on municipal wastes lie with the city authorities or municipalities. This means national level data on wastes, particularly on the indicators identified for the present purpose, are limited, even if they are not absent. Even when the data are collected, compiled, reported or published by responsible government authority such as Bangladesh Bureau of Statistics (BBS), the reported data is neither national level data nor government institution-based data. The Statistical Year Book data that BBS publishes are also based on surveys conducted by individual researchers or organizations such as Waste Concern. This is however not the case for population, economic, employment, labour force, housing, or economic data since BBS conduct censuses or representative surveys on them.

However the day may not be far off when data on waste and 3R will assume similar importance as population, economic, labour force, employment, and housing. In view of the growing emphasis on sustainable production and consumption (SCP) in general and government commitment to SDGs, 3R related data collection may soon become a routine work of BBS or another government assigned agency such as DoE. For expediting and making this possibility real, the present work on 3R status in Asia Pacific countries in which Bangladesh is a participating member, will have a spurring effect for the country to institutionalize 3R data generation on a national scale.

Having taken note of the present data reality status, let us first list the indicators, to see at a glance which data compilation effort has been made as part of this intercountry work. The data search has been for the following indicators:

- Total and per capita municipal waste generation
  - Total MSW
  - MSW generation per capita
  - MSW composition
- Overall recycling rate and target
  - Waste collection rate
  - Waste separation and resource recovery by the informal sector
  - Waste recycling
- Hazardous waste generated and disposed in an environmentally sound manner
  - Hazardous industrial waste (HIW)
  - Medical waste
  - Hazardous waste management
- Indicator based on macro-level material flows (secondary indicator)
- Amount of agricultural biomass used

- Marine and coastal plastic quantity (primary)
- Amount of e-waste generation, disposal and recycling
- Existence of policies, guidelines and regulations based on the principle of extended producer responsibility (EPR)
- GHG emission from waste sector

I. Total and Per Capita Municipal Solid Waste (MSW) Generation

The National 3R Strategy for Waste Management (GoB, 2010) and the Compendium of Environment Statistics of Bangladesh 2009 (BBS, 2010) are two major official sources of national level data on waste in Bangladesh. As noted above, the Bangladesh Bureau of Statistics (BBS) is the main government agency for compilation of economic, labour, housing and environmental data in Bangladesh.

Of various statistical reports that BBS publishes one is the Compendium on Environment Statistics. This compendium contains one chapter on Solid Waste Management. However these data are, in many instances, based on sources such as Waste Concern, the most well-known organization that has been working on waste related issues in Bangladesh. Waste Safe and Practical Action are two other organizations which are also working in waste related areas. The BBS report also use data generated by these two organizations. JICA provides substantial technical assistance in Bangladesh's waste management, which requires the agency to undertake studies on waste management. As a result, JICA is also a rich source on waste related information.

1. Total MSW

Based on data Table 9.15 (BBS, 2010 p.325), it is estimated that 4.86 million tons of MSW is generated annually in urban Bangladesh which includes the six divisions, all the Pourashavas (municipalities) and other urban centers of the country. As per these data, the amount of daily municipal waste generation is 13,332.89 tons/day. It is projected that this amount will grow to 47,000 tons/day and will reach close to 17.2 million tons per year by 2025, which is almost 3.5 times greater than the existing amount. This projection is based on the ever-increasing growth in both population, urbanization, economic growth – all resulting in increasing per capita waste generation.

2. MSW Generation Per Capita

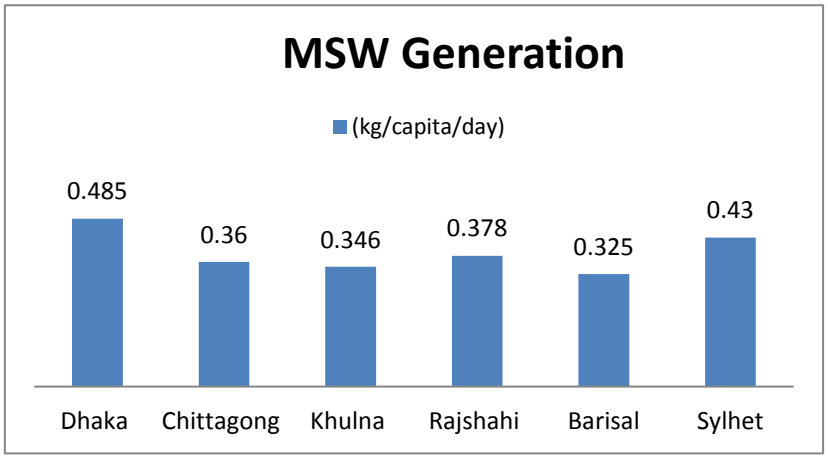
According to the National 3R strategy for Waste Management (GoB, 2010) the amount of per capita waste generation for urban area is 0.41 kg/per/day and for Dhaka city it is 0.56 kg/per/day. In an overcrowded city with 11 million urban dwellers in municipal areas of the city alone, Dhaka, stands out in waste generation amount which is actually four times greater than the second largest city, Chittagong, the port city of Bangladesh.

Table C-1 presents the daily solid waste generation in six major cities as divisional headquarters[1] of Bangladesh. Its data are also illustrated in Figure C-1. Waste collection rate ranges from 44.30% to 76.47% in major cities. Waste generation rate is estimated as 0.41 kg/capita/day in urban areas of Bangladesh.

Table C-1 Daily solid waste generation in six major cities, divisional headquarter of Bangladesh

Population/MSW generation amount per day/generation per capita per day	Dhaka	Chittagong	Khulna	Rajshahi	Barisal	Sylhet
(i) Population(in millions in municipal areas of each city)	11.00	3.65	1.50	0.45	0.40	0.50
(ii) MSW generation (tons/day)	5,340	1,315	520	170	130	215
(iii) MSW generation(kg/capita/day)	0.485	0.360	0.346	0.378	0.325	0.430

Source: Bangladesh Compendium of Environmental Statistics 2009 (BBS, 2010, p. 324).



Source: Based on Bangladesh Compendium on Environmental Statistics 2009 (BBS, 2010, p. 324).

Figure C-1 Daily solid waste generation in six major divisional cities

[1] Bangladesh is a unitary state. Thus the country has neither province nor state as it is the case in federal state. However the country is divided into administrative units. Until recently the divisions were six as it is in the table. Two more divisions have been added recently. These are Rangpur, in 2010, and Mymensingh, in 2015. It may be noted that Rangpur was part of Rajshahi until 2010, and Mymensingh was part of Dhaka division until 2015.

Table C-2 Waste generation rate in Bangladesh by year and source

Year	Rate per capita/per day	*Area or cities* / Source
1991 2004 2014 2025	0.283 0.369 0.512 0.547 (estimate)	***Urban Bangladesh, 1991-2015*** Calculated from data contained in Waste Concern (2016).
2005	0.41	***Urban Bangladesh*** National 3R Strategy for Waste Management (GoB, 2010)
1991 2005 2013 2025	0.31 0.41 0.50 0.60 (estimate)	***(All) urban centers, 1991-2025*** BBS and World Bank cited in Practical Action (2016)
2005	0.56	***Dhaka*** JICA (2005) cited in National 3R Strategy for Waste Management
2005	0.485 (Dhaka) 0.360 (Chittagong) 0.346 (Rajshahi) 0.378 (Sylhet) 0.325 (Khulna) 0.430 (Barisal)	***Six major cities, Dhaka, Chittagong, Rajshahi, Sylhet, Khulna and Barisal*** Bangladesh Compendium of Environmental Statistics (BBS, 2010)

Table C-3 Percentage distribution of MSW generation in six major cities of Bangladesh by source

Source	Distribution of MSW generation by source (%)					
	Dhaka	Chittagong	Khulna	Rajshahi	Barisal	Sylhet
Residential	75.86	83.83	85.87	77.18	79.55	78.03
Commercial	22.07	13.92	11.60	18.59	15.52	18.48
Institutional	1.17	1.14	1.14	1.22	1.46	1.29
Municipal services	0.53	0.51	1.02	1.24	1.15	0.80
Others	0.37	0.60	0.37	1.77	2.32	1.40
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.0**

Source: Bangladesh Compendium of Environmental Statistics, 2009 (BBS, 2010, p 323).

Table C-4 Total waste generation, population and rate of generation

Year	Total waste generation (tons)	Population (m)	Waste generation rate (kg/per capita/per day)
1991	6493	20.80	0.31
2004	13330	32.76	0.41
2014	23688	41.94	0.56
2025 (Predicted)	47300	78.44	0.60

Source: Based on Waste Concern (2015).

Figure C-2 and Table C-5 show the relationship between waste generation and GDP per capita. Table C-6 shows, as expected, the amount of waste generation in Bangladesh is also increasing with increasing population. On the basis of the trend of actual data of 1991, 2004 and 2014, projection is made for year 2025.

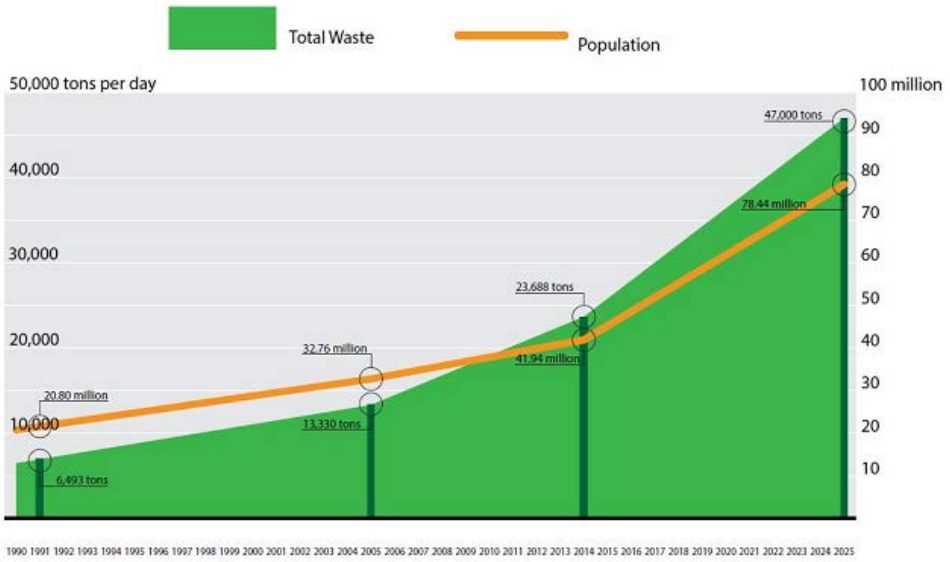


Figure C-2 Waste generation by GDP in Bangladesh for 1990 to 2025 (projected).

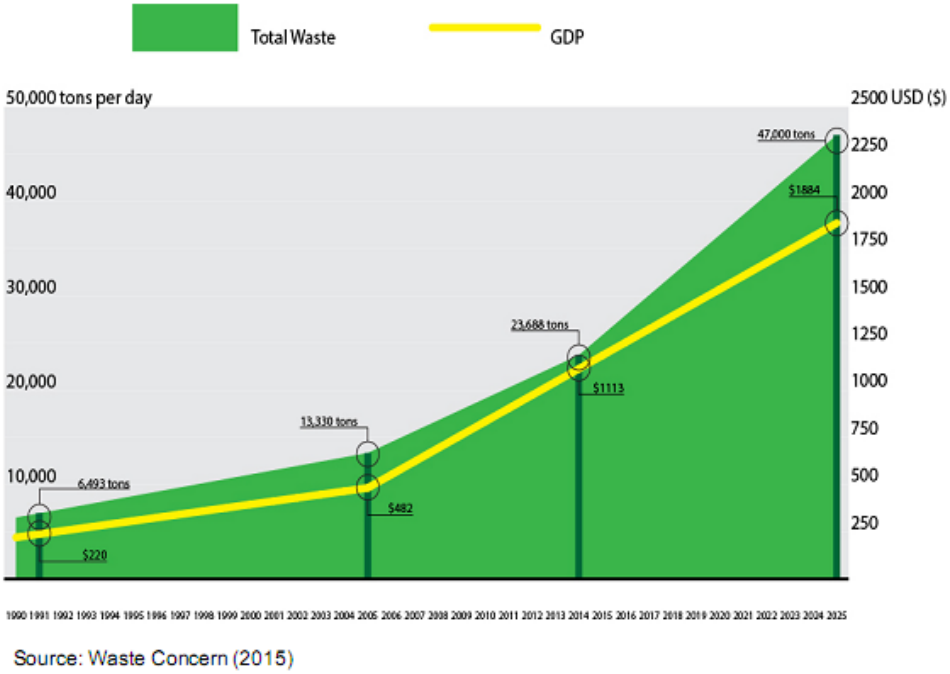


Figure C-3 Waste generation by population in Bangladesh for 1990 to 2025 (projected)

Table C-5 Waste Generation by GDP per capita

Year	Total waste generation (tons)	GDP per capita ($)
1991	6,493	220
2004	13,330	482
2014	23,688	1,113
2025 (Projected)	47,300	1,884

Source: Based on Waste Concern (2015).

Table C-6 Waste generation in urban centers

Year	Urban population (million)	Waste generation (ton/day)	Waste generation (kg/per capita/day)	GDP per capita
1991	20.8	6493	0.31	US $ 220
2005	32.76	13330	0.41	US $ 482
2013	40.00	20000	0.50	US $ 1190
2025	78.44	47000	0.60	----

Source: Practical Action (2016), based on BBS and World Bank data.

The relationship of waste generation rate with population, income, and level of urbanization is shown respectively in Figure C-4, Figure C-5 and Figure C-6.

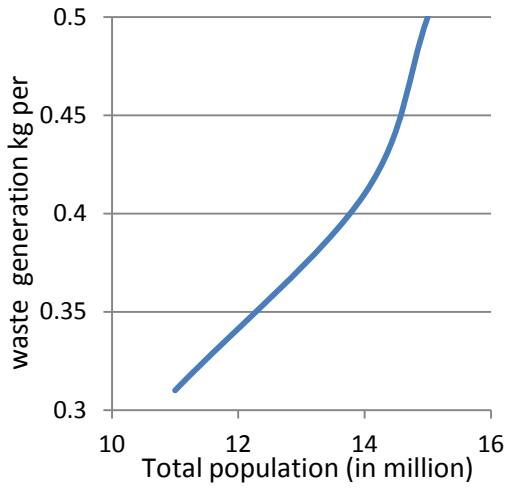


Figure C-4
Relationship between waste generation (kg/per (kg/per capita/day) and total population

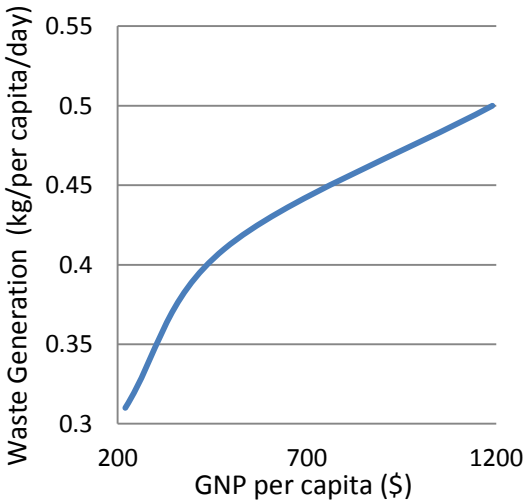


Figure C-4
Relationship between waste generation capita/day) and GNP per capita ($)

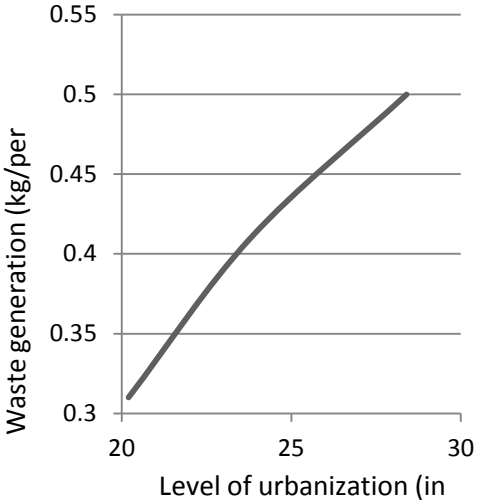


Figure C-5 Relationship between waste generation (kg/per capita/day) and level of urbanization (i.e., urban population as proportion of total national population)

3. MSW Composition

Municipal solid waste management is a major problem in the City Corporations in terms of its volume and quality, equipment and infrastructure, and manpower and budget. Public awareness and policy intervention is negligible. City Corporations are following the pathway of collection, transportation and disposal. Resource recovery and sound waste disposal is hardly practiced. Informal sectors are vibrant in waste collection and recycling. However, due to lack of source-segregation, the resources present in waste are wasted. There is an opportunity of recovering and reusing these resources. In this case, public co-operation in source segregation of waste into bio-degradable and non-biodegradable, recyclable and non-recyclable in separate bags/containers is essential. There are some good practices for the management of bio-degradable waste by composting, bio-gas etc. and for recycling of inorganic waste such as plastic, glass, metal etc. by the informal sector. All kinds of recycling activities can contribute towards greenhouse gas mitigation and potential for Clean Development Mechanism (CDM) funding.

Waste generated in institutes such as schools and offices is mostly made up of papers, plastics and electrical and electronic wastes and some organic wastes from canteens etc. The 3Rs can be easily promoted for institutional waste management. Institutional waste can be segregated by the active participation of students, teachers and other staff and later sold to waste dealers. Recycling of organic waste by composting in the institution can have demonstration effect towards environmentally-friendly institutions. 3R can be promoted through environmental education in schools (MoLGRD&C, 2012).

Table C-7 Solid Waste Composition of City Corporations and Municipalities in Bangladesh

City/town	Component %													Total	Com-posta-ble %	Non com-postable %
	Food and vege-table waste	Bones	Paper products	Plas-tic	Rags. Tex-tiles. Jute.	Glass	Leather rubber	Metals	Ce-ram-ics	Soil. Ash.	Wood/ grass/ leaves	Medic-inal/ chem-ical	Rocks, dirts and misc			
Dhaka	70.12	0.85	4.29	4.1	4.57	0.12	0.61	0.13	0.13	6.43	0.16	3.46	5.01	100.0	74.85	25.15
Chittagong	69.45	0.36	5.73	4.31	4.73	0.23	0.48	0.14	0.18	2.86	4.84	2.34	4.35	100.0	79.02	20.96
Rajshahi	62.43	0.48	6.32	7.99	3.41	1.34	0.00	0.00	0.00	2.75	11.00	0.10	4.18	100.0	76.84	23.16
Khulna	84.57	0.77	3.75	2.02	5.19	0.61	1.5	0.17	0.22	0	0.93	0	0.27	100.0	90.68	9.32
Sylhet	53.55	0.55	28.65	7.16	0.81	1.38	0.28	0.04	0.00	1.30	0.33	0.05	5.89	100.0	54.69	45.31
Barisal	75.77	1.65	5.22	5.34	1.64	0.89	0.64	0.24	0.65	2.59	3.67	0.12	1.38	100.0	81.28	18.72
Munici-palities	70.70	0.90	8.96	3.58	3.37	2.02	0.39	0.63	0.33	3.32	3.33	0.46	2.02	100.0	77.40	22.60
Urban center	62.93	0.31	11.25	3.47	0.75	0.06	0.13	0.02	0.02	11.25	5.74	0.44	3.62	100.0	69.42	30.56
Average	68.69	0.73	9.27	4.75	3.06	0.83	0.50	0.17	0.19	3.81	3.78	0.87	3.34	100.0	75.52	24.48

Source: Enayetullah, Sinha and Khan (2005) cited BBS (2010, p.322).

Table C-8 Percentage distribution of total MSW by generation source

MSW Generation Source	% distribution of total MSW generated daily of major cities by waste generation sources					
	Dhaka	Chittagong	Khulna	Rajshahi	Barisal	Sylhet
Residential	75.86	83.83	85.87	77.18	79.55	78.04
Commercial	22.07	13.92	11.60	18.59	15.52	18.48
Institutional	1.17	1.14	1.02	1.22	1.46	1.29
Municipal services	0.53	0.51	0.55	1.24	1.15	0.80
Others	0.37	0.60	0.96	1.77	2.32	1.39
Total	100	100	100	100	100	100

Source: Bangladesh Compendium of Environmental Statistics, 2009 (BBS, 2010, p 323).

II. Overall recycling rate and target

1. Waste Collection Rate

Although waste collection, transportation and disposal do not go well with the 3R goals and strategies, the 3R practices to an extent are prevalent throughout each of these processes of waste management. Waste collection rate, at 55% on average for urban Bangladesh, implies that a lot of uncollected waste contribute to environmental rot in Bangladesh. The informal sector involvement in resource recovery (estimated at 15% for Dhaka city) reduces the problem associated with uncollected waste to an extent.

Table C-9 Urban solid waste collection rate

City/Town	TWG* (ton/day)	Waste collection rate (%)
Dhaka	4,634.52	37.00
Chittagong	1,548.09	70.00
Rajshahi	172.83	56.67
Khulna	321.26	47.70
Barisal	134.38	44.30
Sylhet	142.76	76.47
Other municipalities	4,678.40	54.42
Other urban centers (not with municipality status)	1,700.65	52.00
Total/overall average	13,332.89	55.00

Source: Enayetullah, Sinha and Khan (2005: p.12).

2. Waste Separation and Resource Recovery by the Informal Sector

Separation of waste and recycling in Bangladesh is still largely an informal phenomenon. As a labour-abundant and capital & material resource-scarce economy, reuse, separation and recycling practices are widespread in the country. However macro-scale documentation of this widespread practice is limited, if not absent. Individual researcher's study report on partial case study-based information.

One macro level estimate on the extent of recycling by the informal sector is available in Waste Concern's work (Enayetullah, Sinha and Khan 2005), which reports that the informal sector is responsible for recycling from 4% to 15% of the total solid waste generated in different cities and urban centres. This recycled amount saves about Tk 10,705.5 million (15.29 million US $) annually, the study reports (Enayetullah, Sinha and Khan 2005).

Waste separation for reuse, selling and recycling currently take place at the following level or sources of waste separation:

- Household/at source of waste generation
- Neighborhood/community/primary collection point
- During the process of waste collection
- During transportation of wastes by municipal workers to dumping sites
- Finally from the dumping sites.

At source, the waste generators separate waste which has higher market value such as newspapers, bottles and plastic containers and sell them to street hawkers. Waste pickers look for recyclable wastes in and around waste bins at primary collection points for collecting materials with low market value such as broken glass, cans, and polythene which are discarded by households. The final phase of the collection of recyclable materials by the waste pickers is from the waste vehicles immediately after unloading at dumpsites that continues until nothing appears of worth to be recovered.

3. Waste Recycling

It is important to recognize that the informal waste separation and recycling sector has established and developed itself as a market response from demand for recyclable materials by the industrial sector due to rising prices of imported materials such as plastic resin, glass or paper. Separation and recycling contribute to the collection challenge by reducing amounts of refuse to be collected.

However despite the demand for recyclables, large volumes of materials which could be of value to the recycling industry are still mixed with other refuse and thus damaged or soiled, and lose part of their initial value. Recycling such materials entails a time consuming sorting and cleaning process whereby the material quality remains low-grade, obtaining a lower price. This is the reason why a lot of materials are not recycled and a large volume ends up discarded in dumpsites or landfills (Swiss Contact, 2012**).** However, 120,000 urban poor from the informal sector are involved in the recycling trade chain of Dhaka City. About 15% of the total generated wastes in Dhaka (mainly inorganic) amounting to 475 tons/day are recycled daily.

The national 3R goal for waste management is to achieve complete elimination of waste disposal on open dumps, rivers, flood plains by 2015 (reality suggests this remains far away) and promote recycling of waste through mandatory segregation of waste at source as well as create a market for recycled products and provide incentives for recycling of waste.

At least 80-90% of the total waste can be recycled, experts suggest, of which much now goes to dump sites or landfills in the absence of the practice of separation of waste at source. The quality and efficiency of the recycling plants highly depend on the quality of the separated wastes.

Table C-10 Informal recycling of inorganic solid waste and savings through recycling in 2005

City/Town	TWG (Ton/Day)	Number of city/town	% of inorganic waste recycling	Savings through recycling per year (Tk.million)
Dhaka	4,634.52	1	15.00	170.00
Chittagong	1,548.09	1	12.45	28.96
Rajshahi	172.83	1	6.7	1.00
Khulna	321.26	1	6.00	6.94
Barisal	134.38	1	5.42	5.14
Sylhet	142.76	1	4.23	3.44
Municipalities	4,678.40	298	3.89	8,862.52
Other urban centers	1,700.65	218	4.00	1,627.50
Total	13,332.89	522	-	10,705.5 (15.29 million US $)

Source: Enayetullah, Sinha and Khan (2005, p.10).

Plastic waste recycling

Despite good business globally centering on recycling of plastic waste, in view of its contribution to economy as well as the environment, in Bangladesh, plastic waste recycling until recently was largely based on rudimentary technology and dominated by the informal sector. Out of a total of 3315 tons of waste generated per day in Dhaka City Corporation (DCC) in 2005, 4.15% was composed of plastic materials, i.e., plastic waste generation is 137.57 tons per day. Thus 50,214 tons of plastic waste are generated in the city annually.

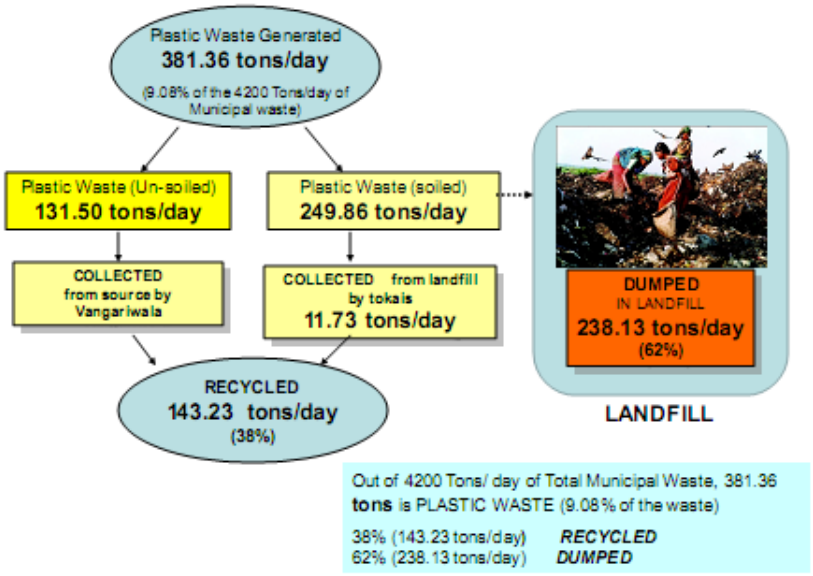
About 51% of total plastic waste is recycled in DCC area. However much of this is done by the informal sector which exposes the informal sector participants to health hazards. Health and safety issues related to this activity needs urgent attention.

A 2005 study shows that during 2005, 45% of the plastic waste was recycled by the informal sector which resulted in savings of US$ 350 million which allowed the import of virgin resin to be avoided (GoB, 2009).

An estimate for 2010 reports that 60% of post-use plastic waste was recycled in Bangladesh, which results in a saving of US $600 million on import of virgin materials (Islam and Emon, 2016, p.33). Another 2016 paper reports that national consumption of plastic waste in Bangladesh amounted to 545,000 tons, estimated on the assumption of 3.5 kg per capita consumption). Taking the data on actual recycling figure of plastic waste of 50,213 tons, the authors note that these are indicative of the fact that only 9.2 % of total plastic consumption was available for recycling (Moazzem, 2016, p. 56.).

A 2016 study of Waste Concern reports that the amount of plastic waste generated is 381.36 tons/day which is 9.08% of the total waste generated in the Dhaka city, which includes both DCCs - Dhaka

North City Corporation (DNCC) and Dhaka South City Corporation (DSCC). The accompanying figure (see above, Figure C-7) show that the amount of plastic waste recycled is 143.23 tons/day which is 38%. The remaining amount - 238.13 tons (62%) - is dumped in landfill.



Source: Waste Concern (2016).

Figure C-5 An illustration of amount plastic waste recycled in Dhaka City

III. Hazardous waste generated and disposal in an environmentally sound manner

1. Hazardous Industrial Waste (HIW)

As per a Waste Concern-ADB study of 2008, hazardous waste generated from the industrial sector is as follows: 109.47 million/cubic meter/year of wastewater, 0.113 million tons/year, sludge, and 26,884 tons/year solid waste (Waste concern-ADB 2008). Seven types of hazardous industrial wastes (HIW) generating industries identified were textile, hospital clinics, tannery, pesticides, fertilizer, oil refinery and paper and pulp (Waste concern and ADB, 2008). The study projected annual HIW generation by 2025 will be in the order of 2472.07 million/cubic meter/year waste water, 2.81 million metric ton/year sludge, and 53,874 metric ton/year solid waste.

Table C-11 Hazardous industrial waste generation, 2008 and 2025 (estimated)

Year	Wastewater	Sludge	Solid waste
2008	109.47 million/cubic meter/year	0.113 million tons/year	26,884 tons/year solid waste
2025 (estimated)	2472.07 million/cubic meter/year	2.81 million metric ton/year sludge	53,874 metric ton/year

Source: Waste Concern and ADB (2008).

Industrial waste is a major threat to the eco-system. Untreated discharge of waste water and disposal of hazardous waste from the manufacturing processes of industries are polluting the land and water

resources. There is insufficient political commitment to the national program to reduce, reuse and recycle industrial wastes, even though the Government has instructed mandatory installation of effluent treatment plants (ETP). However, this is hardly practiced or monitored. Cleaner technology can be adopted in the production processes to the final disposal throughout the life cycle of the product. For the successful implementation of the 3Rs in industrial waste management, proper regulatory mechanisms and principles such as extended producer responsibility (EPR) should be introduced. There are some exemplary programs of waste minimization and reduction which can have a demonstrative effect on local circumstances. Industrial symbiosis such as exchange of industrial waste and by-products from one industry as inputs for other industry through resource productivity.

Table C-12 A comparative scenario of change, 2007 and 2012, in three types of hazardous wastes by their sectoral origin

Sectors	HIW Type					
	Wastewater (mil m^3/year)		Sludge (mil MT/year)		Solid MT/year	
	2007	2012	2007	2012	2007	2012
Textile sector - *Annual growth*: 90% - *Sludge*: 17.14 m^3/1000m - *Wastewater*: 1.14 kg/ m^3	99.75	2470.4	113720 (MT/yr)	99.75	-	-
Hospital and Clinics - *Annual growth*: 8.18% - *Waste*:2.2kg/patient/day			-	-	12045	16972 (2013)
Tannery - *Annual growth*: 5% - *Wastewater*: 4litre/sq.ft.of hide processed - *Solid waste*: 350 kg/ton of hide processed	1.3	1.66 mil	-	-	22,500	34212
Pesticides - *Annual growth*: 5.2% - *Wastewater*: 0.85 m^3/MT of finished product - *Solid waste*: 30 MT of finished product	10.920	17.261	-	-	53.58	68

Source: Waste Concern (2008).

2. Medical Waste

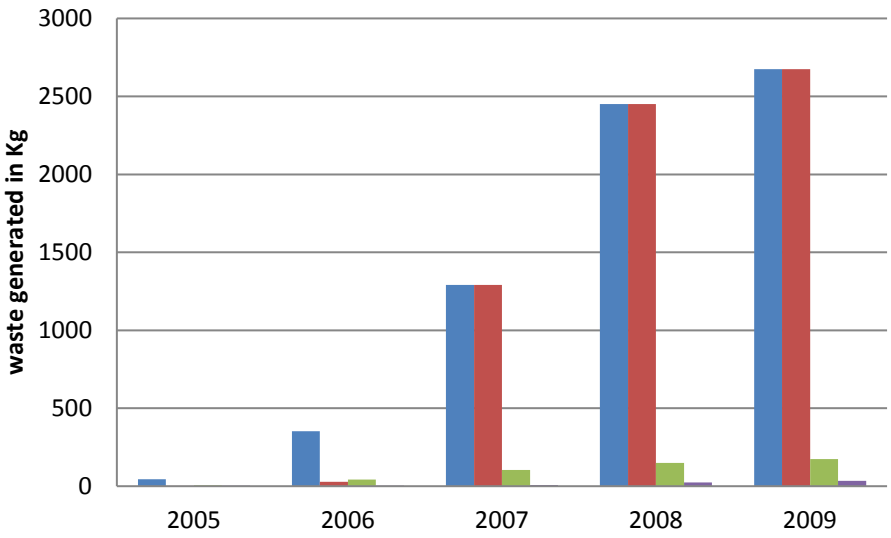
Medical or clinical waste, dangerous in nature, has been increasing in Bangladesh rapidly because of the rapid increase in private hospitals and clinics. Many of these are located in the heart of residential areas. Most of these do not have safe disposal system of their own. In many instances, clinical waste materials are disposed as household waste and get mixed with MSW.

According to PRISM Bangladesh (2009), the amount of infectious waste in 2009 was 2675kg, sharp waste was 107kg, and recyclable waste was 173kg which was an increase compared to 2005.

Table C-13 Average daily hazardous waste collection and management, 2009

Types of waste	2005 (kg)	2006 (kg)	2007 (kg)	2008 (kg)	2009 (Jan-Aug) (kg)
Infectious waste	45	352	1290	2450	2675
Sharp waste	2	29	66kg	95	107
Recyclable waste	6	42	105	150	173
Other	3	3	7	25	35

Source: PRISM Bangladesh's data as provided in the Compendium of Environment Statistics of Bangladesh, 2009 (BBS, 2010, p. 334).



Source: Based on data provided in BBS (2009, p.334).

Figure C-6 Hazardous waste generation, 2005-2009

3. Management of Hazardous Waste Management

Sound management of Hazardous Industrial Waste is at the very rudimentary stage in Bangladesh. The public and private sectors have begun to act on hazardous waste management. A regulatory framework is in place for management of Hazardous Industrial Waste (e.g., Lead Acid Battery Recycling and Management Rules 2006; Medical Waste – Management and Processing – Rules 2008; Hazardous Waste and Ship-Breaking Waste Management Rules, 2011).

In recent years the requirement for installing effluent treatment plants (ETP) has been tightened but operation of the plants by respective factories cannot be ensured due to lack of adequate inspection and monitoring. Citizen awareness is still not satisfactory, even amongst the educated social strata, to which waste generators such as hospital staff belong.

The problem of illegal dumping by foreign ships into the territorial seas of Bangladesh, an action in breach of the Basel Convention. Exposure of workers to serious health hazards associated with ship-breaking remains widespread.

Financial constraints at technological facilities mean that safe disposal of hazardous waste, using incinerators and autoclaves is difficult. Regulations regarding hazardous waste exist in Bangladesh,

but it is the enforcement of regulations that is of greater concern.

At present there is no secured landfill site available in the country for disposal of hazardous industrial waste. There is also no facility in the country for treatment and recycling of hazardous waste.

The Ministry of Industries acts as the administrative authority for industrial waste management, while the Ministry of Forest and Environment (MoF&E) acts as the regulatory body for the waste stream. The Environmental Conservation Act (1995) and the Environment Act (2000) delegate implementation and enforcement of laws and policies to the Department of Environment (DoE), a subordinate office of MoF&E. However, DoE's functioning as the Environmental Protection Agency (EPA) is constrained by insufficient skilled human resources, advanced technological facilities, and logistical support to access areas where industrial units. Despite donor support to the DoE, funds for managing industrial waste are still scarce. DoE appears to be not adequately equipped to deal with the untreated industrial waste from the private sector.

IV. Amount of agricultural biomass used

As a developing country, biomass use in rural Bangladesh remains the most common fuel (more than 80% of energy is accounted by agricultural bio mas) which is comprised of livestock and poultry manure, agricultural residual materials (straw, rice husk, jute sticks, bagasse, twigs and leaves) in liquid or solid form generated from the production and marketing of crops, agricultural inputs (chemical fertilizers, pesticides, herbicides, etc.) poultry, livestock, furbearing animals, are the some of the potential sources of agriculture waste. Agricultural waste per capita kg/per/day 1.68 (GoB, 2010).

Recycling of pesticide waste is not viable due to product quality requirements and the environmental risks involved. As part of government's 3R strategy, it seeks to promote technologies such as efficient stoves to minimize the use of agricultural waste as domestic fuel sources and encourage surplus biomass for production of compost or energy.

Of 65 million tons of agricultural waste generated in the country, 90% issued as domestic fuel in an inefficient manner. There is no clear government policy or guideline on efficient use of agricultural waste for production of energy or fertilizer (GoB, 2010).

Agricultural residual materials such as straw, rice husk, twigs and leaves along with poultry and livestock waste are potential agriculture waste and can be effectively utilized. Biogas production from cow dung and poultry litter is very popular in Bangladesh. Commercial scale power generation from biomass in the off-grid area is drawing attention from the general public.

Use of biomass for energy can thus reduce dependency on the consumption of fossil fuel, and contribute to energy security and climate change mitigation. Although there is an emerging trend on

the utilization of biomass into energy, biomass is still largely under-utilized, and left to rot or openly burned.

Table C-14 Use of agricultural waste as fuel (million metric tons)

Year	Cow dung	Jute stick	Rice straws	Rice hulls	Bagasse	Fire wood	Twigs leaves	Other wastes	Total
2000-01	8.2	2.2	18.75	6.4	1.3	6.2	3.1	2.8	48.95
2001-02	8.2	2.3	18.49	6.5	1.4	6.4	3.2	2.9	49.29
2002-03	8.2	2.2	18.60	6.6	1.4	6.6	3.2	3.0	49.80
2003-04	8.3	2.1	18.60	6.5	1.5	7.2	3.3	3.1	50.50
2004-05	8.4	2.0	18.5	6.5	1.5	7.8	3.3	3.2	51.20

Source: BBS(2007).

V. Marine and coastal plastic quantity (Primary)

Bangladesh's coastal belt is 710 km long. Similar to other coastlines of the world, the rivers and coastlines of the country are clogged with plastic debris. Reportedly Bangladesh is among the top 20 countries which are responsible for global ocean plastic pollution. The trash encompasses just about anything made of plastic including shopping bags, bottles, toys, food wrappers, fishing gear, cigarette filters, sunglasses, buckets and toilet seats (Dhaka Tribune - http://www.dhakatribune.com/world/2015/feb/14/millions-tonnes-plastic-trash-clog-oceans).

Oil tanker accidents have also started to strike Bangladesh coastline. The 2014 (December 9) accident has been the worst so far. This accident released 358,000 liters of heavy fuel oil into the river and mangrove ecosystem of the Sundarbans of Bangladesh (Joint United Nations-Government of Bangladesh Mission, 2014, p.5). Efforts of the nearby communities and Department of Forest (DoF) reduced the impacts and led to a reported collection of 68, 200 litter of oil.

VI. Amount of E-waste generation, Disposal and Recycling

According to ESDO (2010), every year Bangladesh generates roughly 2.8 million metric tons of e-waste. Much of which, having harmful effects, is disposed into open landfills, farming land and water bodies. E-waste generated from ship-breaking yards alone accounts for more than 2.5 million metric tons of toxics e-waste each year (ESDO, 2010).

Bangladesh has generated 10,504 metric tons of toxics e-waste in the form of cell phones alone in the last 21 years. Every year around 296,302 TV sets are scrapped and generate approximately 0.17 million metric tons of e-waste.

In recent years due to technological developments and the steady growth of the economy, a market has grown for mobile, computers, consumer electronic products and home appliances. This growing market results in an increase in the amount of local consumer products in the market and a

significant amount of electronic products are being disposed of after several years of use which ultimately cause a new environmental challenge.

Largely due to lack of awareness about the hazards associated with electronic wastes, they are reused, broken down for parts or disposed of completely. The prevailing informal practice of recycling is not carried out safely. Knowledge is largely absent about danger to human health and the surrounding environment.

Reuse of e-equipment is a common practice in Bangladesh. Equipment recycling and dismantling is a continually growing business, yet a formal recycling sector does not exist. All the recycling is being carried out by the informal sector. It is estimated that 120,000 urban poor from the informal sector are involved in the recycling trade chain in Dhaka city. About 15% of the total waste generated in Dhaka is inorganic, which would amount to 475 tons per day. Of this amount, only 20% to 35% is recycled, while the remainder is disposed of in landfills, rivers, ponds, drains, lakes and open spaces (ESDO, 2010).

There are no specific laws or ordinances for e-waste management and recycling. But the country has the Bangladesh Environment Conservation Act of 1995, the Environmental Court Act of 2000, and the Environmental Conservation Rules of 1997, which together provides a basic regulatory framework that can be the basis of deriving rules for e-waste management. For example, the Environment Conservation Act of 1995 authorizes the Director General to undertake any activity necessary to conserve and enhance the quality of the environment and to control, prevent and mitigate pollution.
The National 3R-Strategy states:

> "The recycling of e-waste is required to be regulated due to presence of hazardous constituents in the components of waste electrical and electronic assemblies. Governments should encourage e-waste recycling projects under public-private partnership mode" (ESDO, 2010; GoB, 2010).

The available information thus suggests that there is not only a recognition of the increasing importance of e-waste and the need of its recycling but the government has been working to develop strategy for public-private sector partnership for increasing e-waste recycling.

VII. Policies, Guidelines and Regulations with EPR Implications (There is no specific policies related to EPR)

Although economists have emphasized the need of internalizing the environmental costs (ECs) for long, a new impetus in this direction, particularly for waste management, has come from the introduction of extended producer responsibility (EPR), which is a strategy designed to promote the integration of ECs associated with goods throughout their life-cycles into the market price of products. Assigning such responsibility bears potential to (i) prevent waste at source, (ii) promote environmentally sound product design and (iii) support recycling by public. EPR can thus serve as policy for industry to drive recovery and recycling rates.

One attractive feature of EPR policies is that they can shift the waste management cost or physical collection of used goods partially or fully from local governments to producers.

Although there are no specific legislations or policies related to Extended Producer Responsibility (EPR) in Bangladesh yet, national government sectoral, urban and environmental policies do have provisions or implications of EPR nature. This section lists general policies, regulations and guidelines related to environmentally-sound waste management and the 3Rsin Table C-15, Table C-16, Table C-18 and Table C-19.

The tabular presentations below show that the already existing national regulatory framework does have bearing for EPR to serve as a tool or strategy for ensuring 3R practices at product manufacturing stage. However, because of potential disincentive to the business and industrial activities or because of limited power of the policy implementing agencies such as DoE to serve as an effective EPA, EPR strategy has yet to become an effective tool for ensuring 3R practices at product manufacturing stage or to financially and technologically support the municipalities to promote 3R practices effective at consumer or citizen level.

Table C-15 National government policy having provisions on and implications for extended producer responsibility (EPR)

Policy	Provisions
1999 National Agriculture Policy	- Promotes use of compost and organic fertilizer by farmers to improve soil productivity and food security
2006 National Urban Sector Policy	- Proposes public utilities adopt user pays principle to extend services and reduce burden on municipal budgets - Government support for recycling by imposing user fees for waste disposal, encouraging composting and formalizing the function of waste pickers/ informal sector
1998 Urban Management Policy Statement	- Supports private sector participation in SWM and recycling services
1998 National Policy for Water Supply and Sanitation	- Sanitation includes Solid Waste Management - States measures should be taken for recycling of waste as much as possible.
1992 National Environment Policy	- Restrict use of chemical fertilizers and pesticides that pollute water or damage ecosystem - Encourage the use of organic fertilizers and promotes organic farming
2005 National Industrial Policy	- This policy is recommended use of EMS and Cleaner Production practices amongst the industries
2008 National Renewable Energy Policy	- This policy is promoting production of biogas and other green energy from waste and also providing incentive such CDM to promote green energy projects.

Table C-16 Acts and rules with provisions on Extended Producer Responsibility (EPR)

Acts	Provisions
2009 Local Government (City Corporations) Act 2009 Local Government (Municipality) Act	- The occupiers of all other buildings and land within the City Corporation/ municipality shall be responsible for the removal of refuse from such buildings and lands subject to the general control and supervision of the city corporation/municipalities.
2006 Fertilizer Act	- Makes provisions for the development of a compost standard, which was circulated in 2008.
1995 Bangladesh Environmental Conservation Act	- Identifies need to control discharge, disposal and dumping of solid and other types of waste which may cause harm to the environment; - Enacts 'polluter pays' principle whereby originator of the pollution must pay for mitigation; - Allows for formulation of environmental guidelines and rules for control and mitigation of environmental pollution, conservation and improvement of the environment.
2010 National Solid Waste Management Handling Rules	- Identifies the following objectives for SWM in Bangladesh: ・ Encouraging recycling, resource conservation and recovery; ・ Encouraging private sector participation and citizen participation in SWM/ - Identifies responsibilities of residents, municipal authorities and Department. - Sources Segregation: Encourages reduction of waste at the source, and highlights segregation of biodegradable, non-biodegradables and hazardous waste at source to assist in recycling.
Fertilizer Management Rules 2007	- Emphasizes fertilizer quality management and standardization

Table C-17 National strategies with provision on extended producer responsibility (EPR)

Strategies	Provisions
National 3R (Reduce, Reuse and Recycle) Strategy for Waste Management 2010	Guiding principles include: - Source separation of waste - Selection of appropriate, affordable and emission reducing technology - Industrial symbiosis and by product exchange - Polluters Pay Principle and take back provisions - Linking service provision with payment (user pays)
Poverty Reductions Strategy paper (PRSP) 2005 and the Sixth Five-year plan (FY2011-2015)	- Emphasis on source segregation and 3R approach
National Sanitation Strategy 2005	- Resources recovery and recycling as alternative to disposal identified as key to improve urban sanitation

Table C-18 National environmental plans with provisions on extended producer responsibility (EPR)

Plans	Provisions
National Environmental Management Action Plan 1995	- Promotion of waste reduction and recycling of waste
Environment Management Plan 2005	- Waste reduction and recycling identified as a priority

Table C-19 Government circular with provisions or having implications for extended producer responsibility (ERP)

Circular	Provisions
Circular to promote compost by the ministry of Agricultural 2008	- Promote use of compost by farmers

VIII. GHG Emissions from waste sector

Inefficient and dirty technology should be avoided and replaced by efficient and less Green House Gas (GHG) emitting technologies. A carbon project refers to a business initiative that receives funding because of the cut emission of GHGs (greenhouse gases) that will result. They have become increasingly important since the advent of the Clean Development Mechanism (CDM) under Phase I of the Kyoto Protocol-the international protocol of the Framework Convention on Climate Change (UNFCCC) toward reducing GHGs. Under CDM activity a developing country can harness foreign Direct Investment from annexed developed countries in those projects where GHG emission can be mitigated. CDM can promote technological improvement by encouraging energy conservation, adaptation of renewable energy, and recovery and utilization of methane from landfill, thus contributing to sustainable development in the developing countries. It can also help improve the energy supply mix, source energy supply, reduce local pollution, and help reduce GHG emissions.

Table C-20 Greenhouse gas emission potential of urban solid waste

City/Town	*Total Waste Generated (Ton/day)*	*GHG emission potential, million ton CO_2/year*
Dhaka	4634.52	0.76
Chittagong	1548.09	0.25
Rajshahi	172.83	0.03
Khulna	321.26	0.05
Barisal	134.38	0.02
Sylhet	142.76	0.02
Other municipalities	4678.40	0.77
Other urban centers	1700.65	0.28
Total	13332.89	2.19

Source: Compendium of Environment Statistics of Bangladesh 2009 (BBS, 2010, p.327).

D: CONCLUDING OBSERVATIONS

In view of the fact that Bangladesh's institutional adoption of 3R as a strategy towards waste management took only in 2010, it can be said that the country is in its infancy in terms of gearing itself to adoption of 3R regulatory framework and more so in terms of 3R practices. Yet there is a positive element here. The 3R concept has been incorporated in Bangladesh's overall environmental regulatory framework even before it geared itself well with its waste management tasks or requirements. This is a positive development in that once the tasks of waste management would have become entrenched in waste collection, transportation, treatment and disposal, moving away from such laws and regulations and their implementation practices to 3R strategy could have been more time-consuming. This bypassing of waste management of course has been possible because of international cooperation and tangible technical support of organizations such as UNCRD and IGES.

On the other hand, in terms of 3R practices, Bangladesh has been well-ahead because of its factor endowment, i.e., 'labour abundance' and 'capital/material resource scarcity'. This economic fundamental has given rise to a vast size of urban informal sector, which has been playing a vanguard role in reducing wastes by buying and selling of reusable goods and materials by going door to door and thereby promoting reuse and recycling. Even the formal industries such as newsprint and glass-ware industries have been able to rely upon discarded papers and broken glasses because of the presence of informal sector. In fact such 'recycling' can be considered 'recycling before recycling' (drawing a parallel with the "industrialization before industrialization", as it is famously referred to the industrialization in the colonized countries before modern industrialization, originating from the European industrial revolution in the early 19th century, swept the latter set of countries by destroying their pre-colonial period's industrialization.

Contemporary challenge for 3R to be widely practiced arises from the political economy reality. Bangladesh is at an early phase of free market capitalistic economy, closely integrated with the globalized economy that has made (i) movement of labour, capital, technology mobile to an unprecedented scale and (ii) emulation of production, consumption and life-style easy. All this is occurring in a situation when public policy and regulatory system to tame the profiteering at the cost of environment cannot take strong foothold. To make it worse, the political economy is also largely controlled by business interest. It is in this background that international cooperation and technical support, as it has been occurring through the present process of 3R promotion in Asia and Pacific countries, has assumed such significance. Bangladesh government has thus seized this opportunity to work with its international partners for adopting 3R practices.

As the review of the existing environmental regulatory framework in this chapter has shown, Bangladesh has been strongly gearing itself towards strengthening its regulatory framework for promoting 3R practices at production, consumption and waste generation levels. This is evident in its 3R strategy, environmental policies, sectoral policies and adopting EPR strategy. In two fronts Bangladesh appears to behind. One is in performance assessment, which requires monitoring and data generation. Unlike its demographic, economic, and labour force data generation on a routine

basis, no system is yet in place for data generation on 3R outcomes. If government data generating institution, Bangladesh Bureau of Statistics (BBS), along with its other data generation tasks on behalf of the national government, will step in or will also be tasked by government to collect 3R related data on a routine basis, the monitoring and performance assessment of 3R practices will be a reality. To give an example, currently waste generation, collection and recycling data are available mostly for major cities and other municipalities or urban centers in some instances only. These data show wide variation among the cities. This variation suggests also good scope to improve in the sense that if it can be better performance in one city, why can it not be in the other case. But such assessment comparison is not possible if data are not available. Consequently, policy lessons cannot be drawn.

The present review has also revealed that the on-going institutional arrangement and policy interventions are largely regulatory in nature. Incentive-disincentive measures are not adequate, or are absent. The same appears as the case with persuasive and information dissemination measures. Even instances of the use of regulatory measures (targeting the fear element of the human mind), economic/incentive-disincentive measures (targeting the human mind's economic and material interest), and persuasive measures (for nurturing the moral and ethical sense of the human mind), they are used in a piecemeal, partial or sequential way as opposed to their simultaneous and holistic use as a policy package. Such a holistic approach, based on the understanding of elements in human mind, is essential for ensuring behavioral change towards a lasting effect instead of one-shot change. The change in on-going non-optimal outcome with regard to 3R practices also can be improved by infrastructure support, which can be as modest as three waste bins instead of one waste bin as has been placed in Dhaka streets for facilitating waste separation at waste generation level. Investment for R&D for innovating and using the technology required for ensuring 3R practices and production, consumption and waste generation level is another key area for increasingly complex economy and urban-industrial living that has overtaken the country.

REFERENCES

BBS (2015). Labour Force Survey, 2013-14, Dhaka, Bangladesh Bureau of statistics.

BBS (2015). Population and Housing Census 2011, National Report Volume-1, Analytical Report, Oct 2015, Ministry of Planning, Government of Bangladesh.

BBS (2010). Compendium of Environment Statistics of Bangladesh 2009, Dhaka: Bangladesh Bureau of Statistics (BBS), Ministry of Planning, Government of Bangladesh.

BMDF (2012). Study on Municipal Solid Waste Management, Bangladesh Municipal Development Fund (BMDF), Dhaka, Ministry of Finance, Government of Bangladesh.

Chakraborty, C., Huq, M. M., Ahmed, S. Tabassum, T.,and Miah R. M.,(2013)."Analysis of the Causes and Impacts of Water Pollution of Buriganga River: A Critical Study",*International Journal of Scientific and Technology Research,* Volume 2, Issue 9.

CIA World Fact Book (https://www.cia.gov/library/publications/the-world-factbook/)

Dhaka Tribune -http://www.dhakatribune.com/world/2015/feb/14/millions-tonnes-plastic-trash-clog-oceans

DoE (1995). Bangladesh Environment Conservation Act 1995, Department of Environment (DoE), Ministry of Environment and Forest, Government of Bangladesh, Dhaka.

DoE (1997). The Environmental Conservation Rules, 1997, Department of Environment (DoE), Ministry of Environment and Forest, Government of Bangladesh, Dhaka.

DoE (2000). The Environmental Court Act, 2000, Dhaka: Department of Environment (DoE), Ministry of Environment and Forest, Government of Bangladesh, Dhaka.

DoE (2006). Hazardous Waste Management in Bangladesh: A Country Inventory (2006), Dhaka: Department of Environment (DoE), Ministry of Environment and Forest, Government of Bangladesh, Dhaka.

DoE (2008). Medical Waste Management and Processing Rules 2008, Department of Environment (DoE), Ministry of Forestry and Environment, Government of Bangladesh, Dhaka.

DoE (2011). Hazardous Waste and Ship-breaking Waste Management Rules 2011,,Department of Environment (DoE), Ministry of Environment and Forest, Government of Bangladesh, Dhaka.

Enayetullah, I., Sinha, A.H.M.M, Khan, S.S.A. (2005). Urban Solid Waste Management Scenario of Bangladesh: Problem and Prospects, Waste Concern, Dhaka.

ESDO (2010). Study on E-waste: Bangladesh Situation, Environment and Social Development Organization (ESDO), Dhaka.

GoB (2010). National 3R Strategy for Waste Management 2010, Department of Environment, Ministry of Environment and Forest, Government of Bangladesh, Dhaka.

Hussain, M.F. (2006). *"Arsenic Contamination in Bangladesh – An Overview"*, Agriculture, Ecosystems and Environment,Volume 113,pp. 1-16.

Islam, M.S., and Emon, M.M.H.(2016). "Current Status with Facing Challenges by Entrepreneurs and Future Prospect of Plastic Sector in Bangladesh" paper presented to the International Plastic Summit 2016, Bangladesh Plastic Goods Manufacturers and Exporters Association (BPGMEA), Dhaka.

Islam, N. (2013). *Dhaka Ekhon O Agamite , Issues 1-4,*Center for Urban Studies (CUS) Dhaka.

Mahadi (n.d): www.bangladeshenvironment.comhttp://goo.gl/XHj2UF

Moazzem, K.G. (2016). "Plastic Waste Management in Bangladesh: In Search of an Effective Operational Framework" in International Plastic Summit 2016, Bangladesh Plastic Goods Manufacturers and Exporters Association (BPGMEA), Dhaka.

Mowla, Q. A., and Islam, M. S. (2013).*Natural Drainage System and Water Logging in Dhaka: Measures to address the Problems, Journal of Bangladesh Institute of Planners*, Vol 6, pp**.**23-33.

Practical Action (2016). Integrated Solid Waste Management, a power point presentation to a validation workshop on waste management organized by Practical Action and Bangladesh Waste Management Foundation, 9 February.

Sinha, A. H. M. M. and Enayetullah, I. (2016). "Problems and Prospects of Plastic Waste Recycling in Bangladesh", a presentation to the Seminar on Plastic Waste Management: Going Beyond and Observation, International Plastic Summit, Dhaka, January 21. Dhaka.

The New Age, a Dhaka English daily, Wednesday, 17 February2016 (http://newagebd.net/204539/noise -level-must-brought/)

UNCRD (2011). Country Analysis Paper 2011, prepared for 3R Regional Forum in Singapore, sponsored by United Nations Centre for Regional Development, Nagoya, Japan.

UNEP (n.d.). Global Partnership in Waste Management- Bangladesh, United Nations Environment Program (UNEP). Available at website, http://www.unep.org/gpwm/InformationPlatform/CountryNeedsAssessmentAnalysis/Bangladesh/tabid/106525/Default.aspx, (Accessed on 12/02/2016).

World Bank Data Bank (http://data.worldbank.org/)

Yousuf, T. B. (2014). "3Rs in (Reduce, Reuse and Recycle) Bangladesh" in A. Pariatam by and M. Tanaka (eds.) *Municipal Solid Waste Management in Asia the Pacific Islands,*Singapore:Springer-Verlag, pp 61-75.

Yousuf, T. B. (2014). Composting Sector Overview for Bangladesh, prepared by former lead waste management staff of Dhaka City Corporation.

Yousuf, T. B. Huda, K. M. N. and Rahman, M. M., (**2010**). "Municipal Solid Waste Management in Bangladesh", Agamuthu Pariatambe and Masaru Tanaka (edited).*Municipal Solid Waste Management in Asia and the Pacific Island, Bandung, ITB, Penerbit,*, pp. 20-49.