BANGLADESH WASTE DATABASE 2014

WASTE CONCERN

Bangladesh Waste Database 2014

Waste Concern Technical Report Series

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Introduction

The prompt economic and population growth of Bangladesh, coupled with rapid urbanisation, has seen the country progress greatly since its independence in 1971. Despite leaps forward in health, education and quality of life, the people of Bangladesh are still facing great development challenges in other areas, such as waste management and sanitation. An increasing and increasingly urban population means that Bangladesh is now generating more municipal solid waste in its urban areas than ever before. Sooner than later, investment into improving the existing municipal solid waste management systems is required so as allow for the sustainable growth of Bangladesh without compromising the liveability of its urban areas.

This report, published in conjunction with the *Bangladesh Sanitation Database 2014*, follows on from the findings in the 2005 study conducted by Waste Concern in *Urban Solid Waste Management Scenario of Bangladesh: Problems and Prospects*. A picture is painted of the state of the country's solid waste management system in 2014, with a focus on the urban areas of Bangladesh; its pourashavas and cities. The report explores solid waste production in Bangladesh, the composition of this solid waste, the calorific value of waste, the country's landfill requirements, and greenhouse gas emissions from waste, not only to establish the 2014 benchmark, but to project the state of the country's solid waste management system in to the future. Projections are made for the year 2025, marking another 10 years ahead.

The findings of this report are made available so as to assist relevant local government bodies, decision-makers, non-government organisations and community groups in developing sanitation policies informed by research. Data analysis and data synthesis for each of the 271 pourashavas and cities in this report is accessible from Waste Concern.

Objectives

The objectives of this report are:

- Estimation of the total quantities of waste generated in urban areas of Bangladesh
- Analysis of the composition of waste in urban areas of Bangladesh
- Estimation of land area required for landfilling in Bangladesh
- Estimation of greenhouse gas emissions from landfilling activities in Bangladesh
- Identification of co-benefits of emissions reductions through improved waste management practices in Bangladesh

Methodology

This report covers 271 urban localities in Bangladesh of which 10 are cities/city corporations, 106 are Category A pourashavas, 96 are Category B pourashavas, 56 are Category C pourashavas, and 3 are defined as a special category.

The study utilises domestic urban waste generation rates surveyed by BMDF (2012), CEGIS (2013), Swiss Contact (2013) and UNICEF (2012) for 42 urban localities, including both city corporations and pourashavas, to estimate average waste generation rates for the remaining of the 271 urban localities.

The sum of all total waste generation amounts of the 271 pourashavas was added to the estimated total waste generation amount of non-pourashava urban areas, in order to establish a figure for the

total domestic urban waste generation; 11,808.463 tons per day during the dry season.

In order to include the portion of waste generated from non-domestic sources in the estimates, the total domestic urban waste generation amount is multiplied by a factor to produce an estimate for the amount of total urban waste generation; 20,900.98 tons per day during the dry season, or 29,261.37 tons per day during the wet season.

The study recognises that waste generation rates during wet season are estimated to be approximately 40% higher than during the dry months of a year. Accordingly, to estimate the total daily urban average waste generation rate, the wet season is assumed to last for 120 days, while the dry period is assumed to last for 240 days.

Thus the total daily urban waste generation average is estimated to be 23,687.78 tons per day, or 0.56kg per capita per day.

Calculations for greenhouse gas emissions from municipal solid waste were made using the "Simulation for quantification of GHG emissions from solid waste management options in a life cycle perspective" spreadsheet template for Microsoft Excel, published by the Institute for Global Environmental Strategies.

Co-benefits of municipal solid waste management utilise a calculation methodology developed by Waste Concern to quantify the impacts of co-benefits in financial terms.

A previous field survey conducted by Waste Concern in 2005, and published as *Urban Solid Waste Management Scenario of Bangladesh: Problems and Prospects*, acts as a comparative backdrop and a scale against which the findings in this report are compared. The 2005 field survey involved a questionnaire and physical measurements of waste at households and at landfills.

Waste Generation

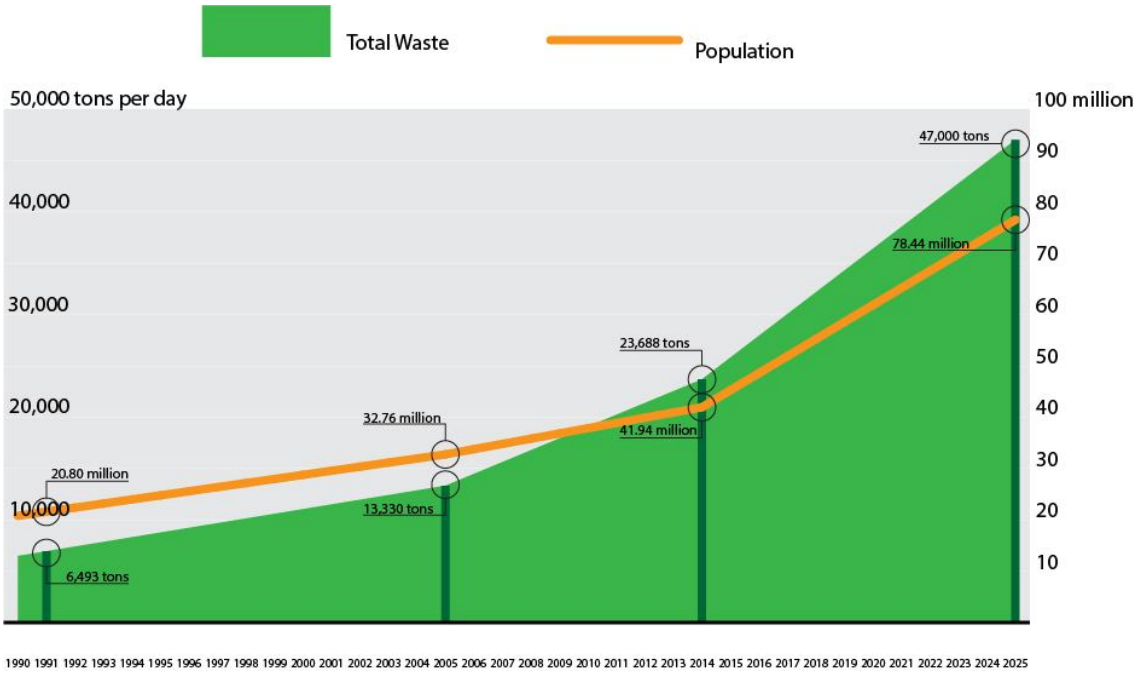


Figure 1: Total Waste Generation vs. Urban Population

The total amount of waste generated every day in Bangladesh has been increasing annually since 1991. Whereas in 1991 the urban areas of Bangladesh were generating approximately 6,493 tons per day of municipal solid waste, by 2005 that figure had more than doubled to reach 13,330 tons per day. In 2014, it is estimated that Bangladesh generated 23,688 tons per day in its urban areas. At the same time the total urban population of Bangladesh has been increasing, from 20.8 million in 1991 to 32.76 million in 2005 to 41.94 million in 2014 due to rapid urbanisation. The total urban population is estimated to be as high as 78.44 million by 2025, and the total waste generation is expected to reach 47,000 tons per day. There is an obvious link between greater amounts of waste generated and a higher urban population. Interestingly, since 2005 the rate of change of total waste generated daily has exceeded the rate of change of the population growth, due to an increased average daily per capita waste generation rate.

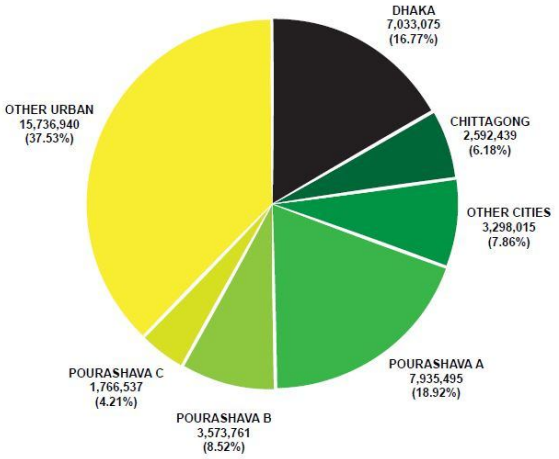


Figure 2: Urban Population of Bangladesh

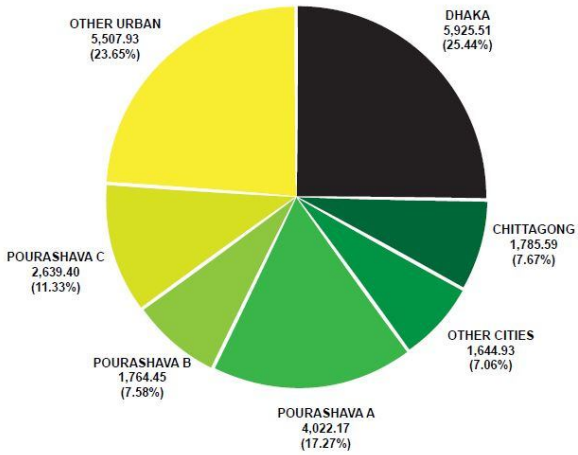


Figure 3: Urban Waste Generation (tons per day)

When comparing the percentages of the urban population with the percentages of waste generation, interesting patterns emerge in the case of the two largest cities in Bangladesh; Dhaka and Chittagong. Although Dhaka is inhabited by 16.77% of Bangladesh's urban population, being the most populous city in Bangladesh, the capital city generates 25.44% of the country's urban waste. Similarly, as the second largest city in Bangladesh, Chittagong is populated by 6.18% of the country's urban population, but in fact generates 7.67% of its urban waste. Alternatively, other much smaller urban areas, those not categorised as cities or pourashavas, collectively make up 37.53% of the urban population of Bangladesh, but only generate 23.65% of its urban waste.

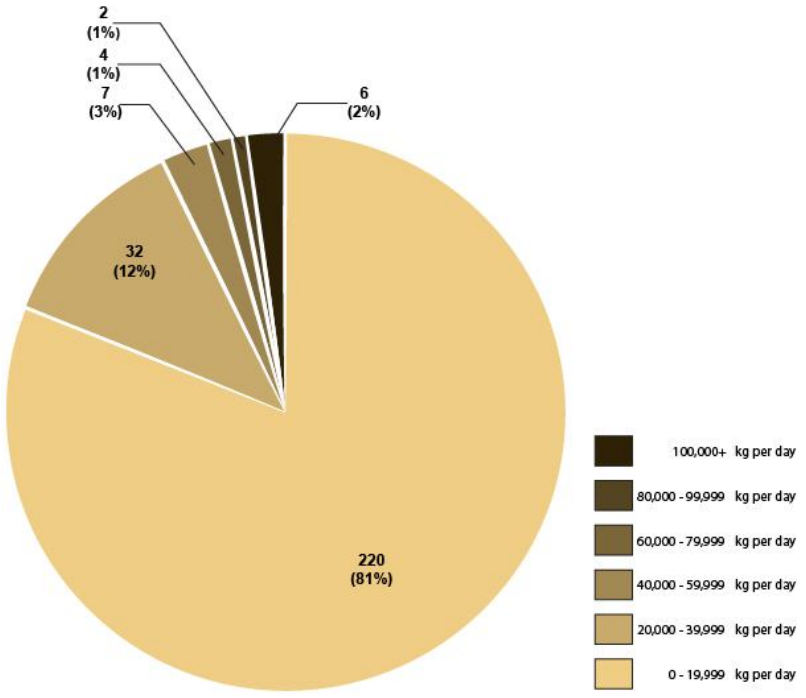


Figure 4: Number of pourashavas by waste generation amount (kg per day)

Out of the 271 pourashavas and cities surveyed in this study, a total 220 pourashavas from categories A, B and C produce up to 20 tons per day each, amounting to 81% of the 271 surveyed urban areas. This means that 81% of the surveyed pourashavas, due to their total daily waste generation rate, are suitable locations for the implementation of a decentralised integrated resource recovery centre model.

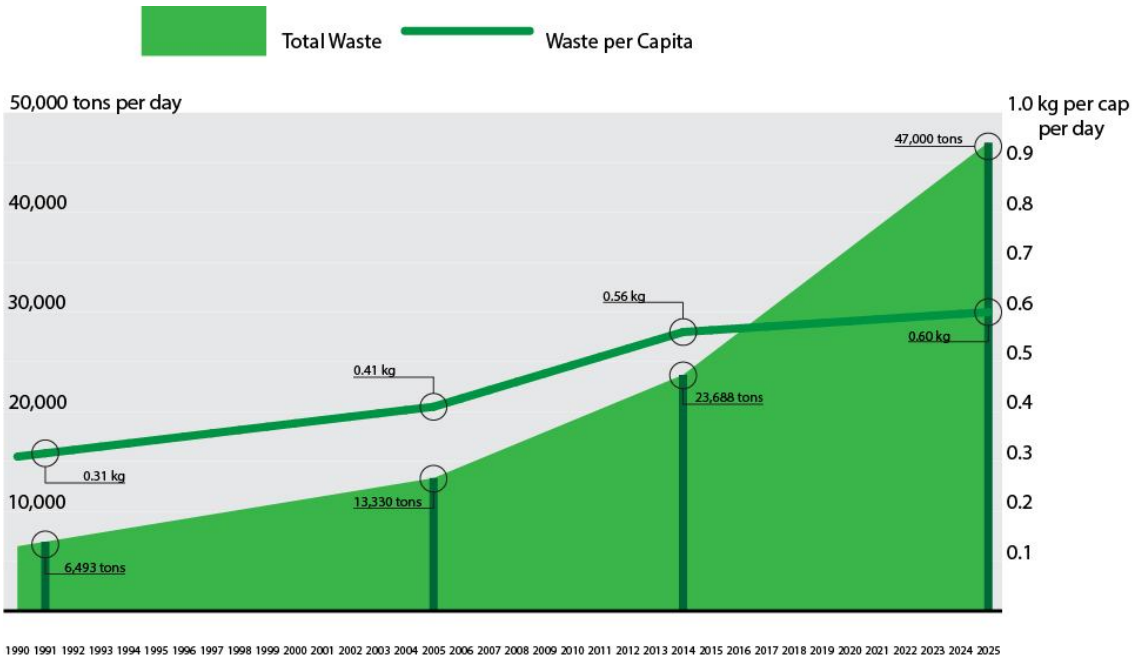


Figure 5: Total Waste Generation vs. Per Capita Waste Generation Rate

In 1991, the daily waste generation rate per person was estimated to be 0.31kg per capita per day (World Bank, 1998). By 2005, this rate had increased to 0.41kg per capita per day (Enayetullah et al. 2005), and as revealed by this latest study, in 2014 the rate of daily waste generation per person was estimated to be 0.56kg per capita per day. According to projections made before the change of millennia, the daily waste generation rate is expected to reach 0.60kg per capita per day by 2025 (UMP, 1999). A more recent projection by the World Bank estimates the daily waste generation to reach 0.75kg per capita per day by 2025 (Hoornweg & Bhada-Tata, 2012).

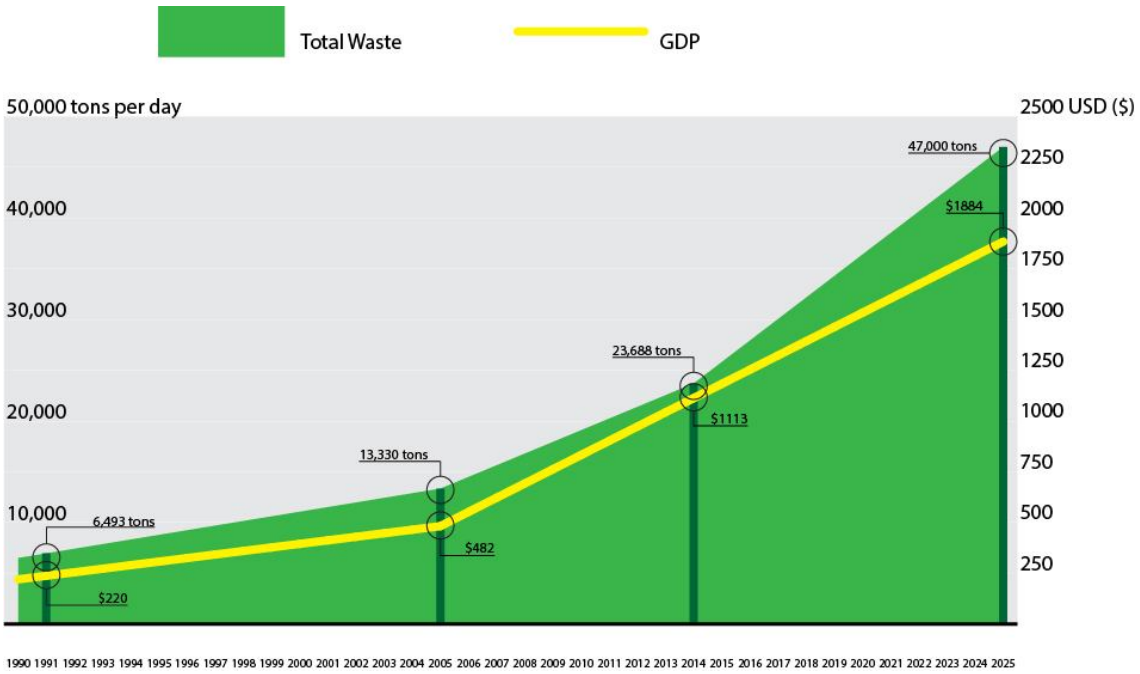


Figure 6: Total Waste Generation vs. GDP

While the per capita per day waste generation rate has been increasing, the GDP of Bangladesh has similarly experienced growth. From 1991 to 2005, the GDP of Bangladesh increased from $220 (World Bank, 1998) to $482 (UMP, 1999). The rate of GDP growth increased from 2005 onwards, reaching $1,113 by 2014 (Bangladesh Bank, 2015). A distinct correlation exists between an increasing waste generation rate and a higher GDP. Arguably, if the rate of GDP growth remains at the same level from 2014 to 2025 as it did from 2005 to 2014, resulting in a significantly higher per capita GDP for Bangladesh, it can be estimated that the earlier projections for per capita waste generation rates will similarly be exceeded.

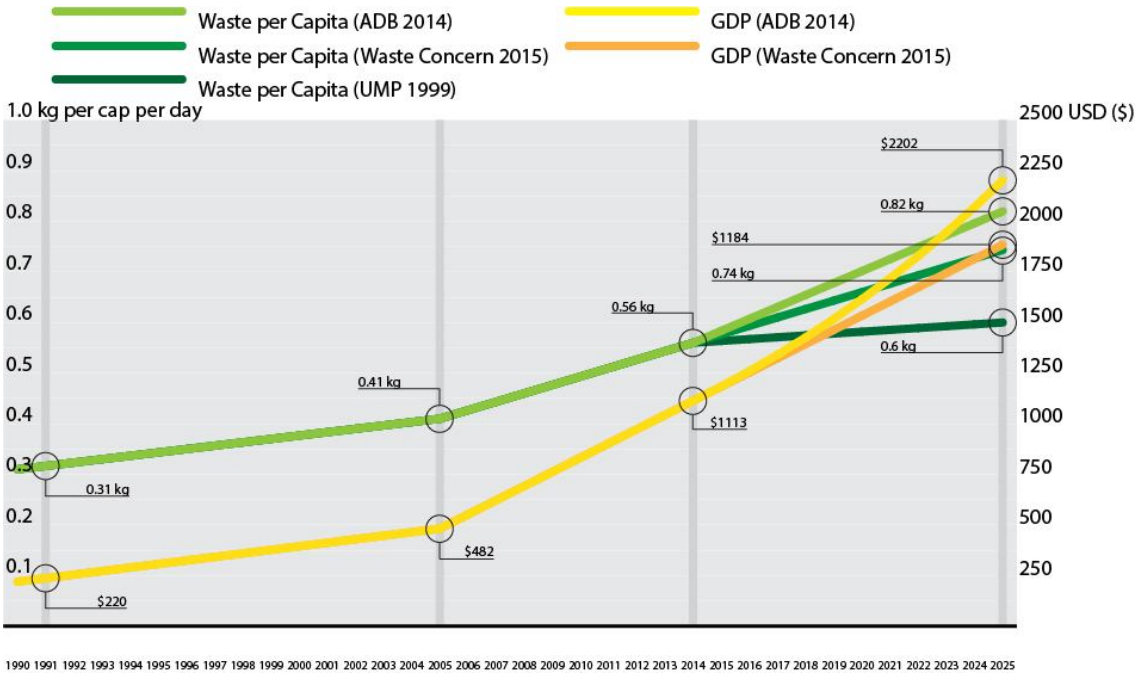


Figure 7: Per Capita Waste Generation Rate vs. GDP

In a business-as-usual scenario, with both the GDP and the per capita waste generation rate increasing at current rates, Bangladesh would expect its GDP to reach $1,884 by 2025 and its waste generation rate to reach 0.74kg per capita per day by the same year. GDP growth projections by the Asian Development Bank (ADB, 2014) for the fiscal year 2015 expect the GDP of Bangladesh to grow by +6.4%. If the same rate of growth is maintained annually from 2014 to 2025, Bangladesh can expect it's GDP to reach $2,202 by 2025. A corresponding rate of growth annually for per capita waste generation would see Bangladesh generate 0.82kg per capita per day by 2025, which is a significant increase in the waste generation from the rate of 0.60kg per capita per day as projected for 2025 by UMP in 1999. This is also higher than the World Bank projection for 2025 of 0.75kg per capita per day (Hoornweg & Bhada-Tata, 2012).

Waste Composition

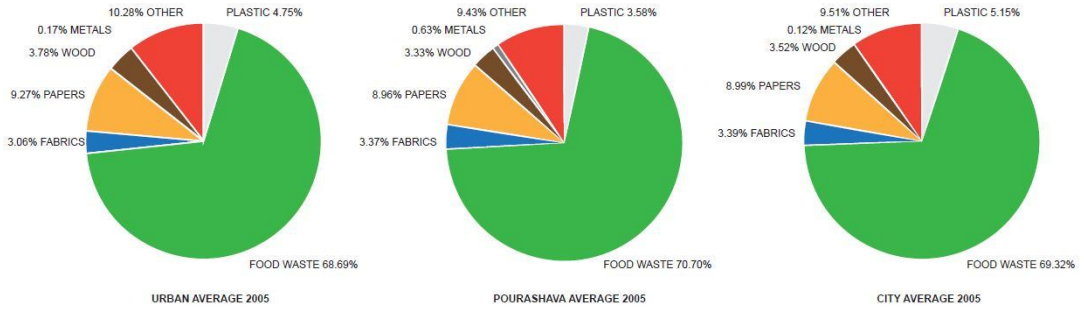


Figure 8: Average Composition of Waste 2005

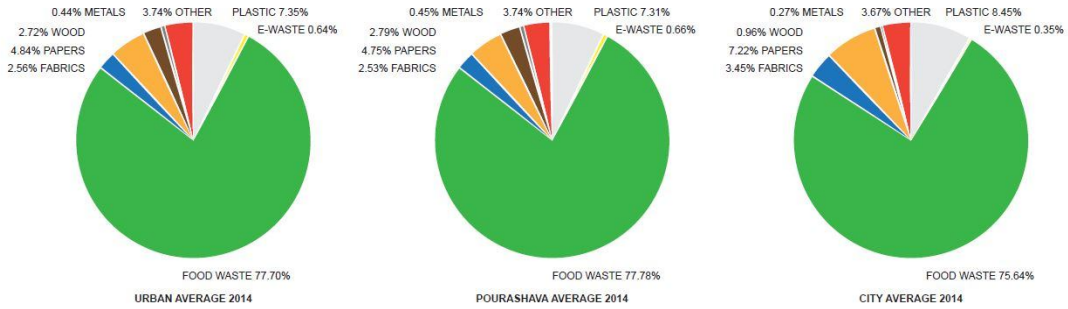


Figure 9: Average Composition of Waste 2014

The composition of municipal solid waste in Bangladesh, as per different waste types, and how the composition of waste has changed between 2005 and 2014 is discussed below. The study distinguishes the waste composition in cities as being different to the waste composition in pourashavas (including Category A, Category B and Category C pourashavas). The umbrella term “urban areas” is used to refer to all urban areas of Bangladesh, including all cities, all categories of pourashava, and other smaller urban localities.

On average in urban areas of Bangladesh, food waste still makes up the majority of waste ending up at the landfill at 77.70% of total waste generated in 2014. This is an increase of +9.01% from the 2005 urban average of 68.69%. The percentage of food waste in pourashavas experiences a similar increase from 2005 and 2014, with data recording an increase of +7.08% from 70.70% to 77.78%. Similarly, the percentage of food waste in cities increased +6.32% from 69.32% in 2005 to 75.64% in 2014.

Overall in urban areas of Bangladesh, the percentage of plastics in waste ending up at the landfill has gone up by +2.60% from 4.75% to 7.35% between 2005 and 2014. This is predominant in cities of Bangladesh where the amount of plastic waste has increased by +3.30% from 5.15% to 8.45% over the same time period. Pourashavas have also experienced an increase in quantities of plastic waste, with a change of +3.73% from 3.58% to 7.31%.

On the other hand, the percentage of paper waste has gone down in urban areas of Bangladesh from 2005 to 2014, with a reduction of -4.43% from 9.27% to 4.48%. A similar reduction in paper waste is witnessed in the cities, with a decrease of -1.77% from 8.99% to 7.22%. The percentage of paper waste in pourashavas has also gone down by a corresponding -4.21% from 8.96% in 2005 to

4.75% in 2014.

The increase in plastic and decrease in paper waste is, perhaps, indicative of changes to the selection of packaging materials in Bangladesh, with plastic packaging becoming preferred over paper packaging.

Electric and Electronic waste, also referred to as e-waste, was not recorded in its own distinct category in 2005, coming under the more generic "Other" category at the time of the 2005 publication. The latest study categorises electric and electronic waste as its own distinct waste type, making up 0.64% of the urban total, 0.66% of pourashava total and 0.35% of city total in 2014.

While in cities the percentage of wood in total waste generated has decreased from 3.52% to only 0.96%, meaning a decrease of -2.57% from 2005 to 2014, on average in urban areas the percentage of wood has decreased by -1.06% from 3.78% to 2.72% over the same time period. Similarly, in pourashavas the percentage of wood in landfill waste has decreased by -0.54% from 3.33% to 2.79%. This can be interpreted to be a sign of urban dwellers in Bangladesh having improved access to alternative fuel sources, reducing reliance on wood for energy and heating.

On average in pourashavas and in urban areas in general, the percentage of fabrics and textiles in total waste generated has gone down. From 2005 to 2014, the percentage of fabrics went down from 3.37% to 2.53% in pourashavas, meaning a decrease of -0.84%, and from 3.06% to 2.55% in urban areas, meaning a decrease of -0.50%. At the same time, however, the percentage of fabrics in the total waste generated in cities increased by +0.06% from 3.39% to 3.45%. This is perhaps indicative of an increasingly prominent consumer culture in the cities of Bangladesh as a result of a higher GDP and greater purchasing power.

The percentage of metals in municipal solid waste in the pourashavas and cities, and thus in urban areas in general, has remained at a near constant, with only small variations between 2005 and 2014. In urban areas as a whole, the percentage of metals has increased by +0.27% from 0.17% to 0.44%, and similarly in the cities of Bangladesh the percentage of metals has increased by +0.15% from 0.12% to 0.27%. In pourashavas, a decrease of -0.18% has seen the percentage of metals in mixed waste change from 0.63% to 0.45% over the same time period.

Waste classified under the "Other" category has decreased in Bangladesh. Decreases of -6.54% from 10.28% to 3.74% in urban areas, of -5.69% from 9.43% to 3.74% in pourashavas, and of -5.84% from 9.51% to 3.67% in cities between 2005 and 2014, can be interpreted in a number of different ways. The "Other" category is, in this case, defined to include various waste types, including clinical and hazardous waste, construction waste, ash, sand and rocks, as well as other items not coming under the existing categories.

Notably, the increases in food waste and plastics, as well as the rise of various e-wastes, are symptomatic of an increase in the GDP of Bangladesh. With more purchase power and an increasingly consumerist society, the advent of plastic packaging materials, and greater and more equitable access to electric and electronic goods, the composition of municipal solid waste in Bangladesh is changing. While the differences in waste composition between pourashavas and bigger cities are of interest, it is also important to look at the differences in waste composition between different income levels, particularly due to the increasing GDP.

Waste Composition by Income Level

The 2013 study by the Center for Environmental and Geographic Information Services has been used as a platform from which to analyse the composition of waste by income level (CEGIS 2013, p.62-66). To determine the average waste composition percentages for waste from domestic sources for each of the categories of pourashava , the averages of 12 Category A pourashavas , the averages of 5 Category B pourashavas, and the averages of 2 Category C pourashavas, were used respectively. Averages by each category pourashava were calculated for four different income level groups; low income, lower middle income, middle income and high income.

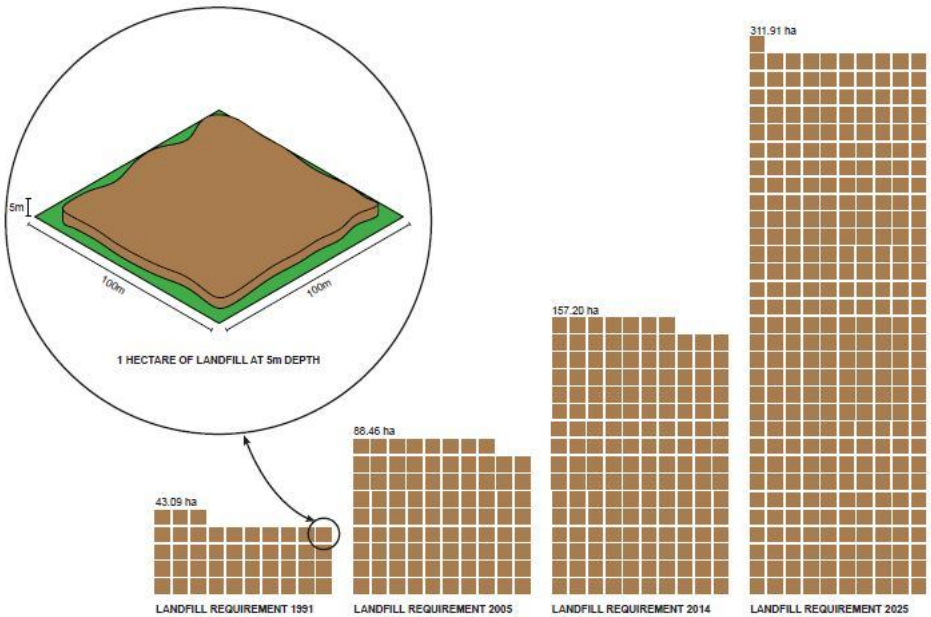
For Category A pourashavas, an increase in the amount of food waste is recorded as the income level increases from low income to high income, while a decrease in the amount of wood waste is recorded as one moves down the income levels from high to low. No noticeable difference exists between the percentages of plastics, papers, fabrics, metals, e-waste or other wastes, while reviewing the different income levels for their average waste composition.

For Category B pourashavas, a more significant increase in the percentage of food waste is witnessed as the income level increases from low to high. A particularly definite increase in food

Landfilling Requirement

With the amount of waste generated increasing by the year, the demand for land available for landfilling is also increasing in Bangladesh. With the effects of climate change, an increasing population and a prevailing scarcity of available land, the issue of landfilling and land available for landfilling will be exacerbated in Bangladesh in the future years.

For the purpose of this study, area required for landfilling is given in hectares, assuming a shallow 5m depth of landfill. Where otherwise specified, the amounts for area required also assume that 100% of generated waste is collected and that 100% of this collected waste reaches the landfill.



In 1991, 43.09 hectares of landfill area was required to accommodate the 2,369,945 tons of waste generated in the urban areas of Bangladesh that year, equivalent to 6,493 tons per day. By 2005, 88.46 hectares of landfill area was required, with waste generation reaching 4,865,450 tons per annum, or 13,330 tons per day. Nine years later, 157.20 hectares of landfill area were required to accommodate the 8,646,120 tons per annum, or 23,688 tons per day, of waste generated in 2014. With 17,155,000 tons of waste projected to be generated in the year 2025 in the urban areas of Bangladesh, amounting to 47,000 tons per day, 311.91 hectares of landfill area is required to accommodate the waste generated in that given year.

Increased waste generation and increased dependence on landfilling are having a significant impact on the greenhouse gas emissions of Bangladesh, contributing to climate change.

City	Total Waste Generation (tons per day)	Total Waste Generation (tons per annum)	Landfill required annually	Landfill required annually (unmanaged 5m depth)			Landfill required annually (unmanaged 5m depth)			Landfill required annually (unmanaged 5m depth)		
Composting Rate			No Composting	100% composting			75% composting			50% composting		
Collection Rate			100%	100%	75%	50%	100%	75%	50%	100%	75%	50%
Barisal	59.53	21,727.36	0.40	0.10	0.07	0.05	0.17	0.13	0.09	0.25	0.18	0.12
Chittagong	1,008.81	368,215.65	6.69	1.63	1.22	0.82	2.90	2.17	1.45	4.16	3.12	2.08
Comilla	86.00	31,390.00	0.57	0.14	0.10	0.07	0.25	0.19	0.12	0.35	0.27	0.18
Dhaka	3,347.74	1,221,925.10	22.22	5.41	4.06	2.71	9.61	7.21	4.81	13.81	10.36	6.91
Gazipur	48.29	17,625.85	0.32	0.08	0.06	0.04	0.14	0.10	0.07	0.20	0.15	0.10
Khulna	174.79	63,798.35	1.16	0.28	0.21	0.14	0.50	0.38	0.25	0.72	0.54	0.36
Narayanganj	178.50	65,152.50	1.18	0.29	0.22	0.14	0.51	0.38	0.26	0.74	0.55	0.37
Rajshahi	124.88	45,581.20	0.83	0.20	0.15	0.10	0.36	0.27	0.18	0.52	0.39	0.26
Rangpur	105.08	38,354.20	0.70	0.17	0.13	0.08	0.30	0.23	0.15	0.43	0.33	0.22
Sylhet	152.27	55,578.55	1.01	0.25	0.18	0.12	0.44	0.33	0.22	0.63	0.47	0.31
Cities Total			35.08	8.55	6.41	4.27	15.18	11.38	7.59	21.81	16.36	10.91

Greenhouse Gas Emissions

Figure 10: Greenhouse Gas emissions from urban waste per capita (2005 vs. 2014)

On average, an estimated total of 23,687.78 tons of waste was generated every day in urban areas

of Bangladesh in 2014. This amounts to 710,633.34 tons per month, or 8,527,598.88 tons per annum. If all of this waste was landfilled, approximately 301,875.01 tons of CO2e would be produced per month, or 3,622,500.12 tons of CO2e per annum. This is equivalent to 418.98kg of CO2e per ton of mixed waste produced.

In 2005, less waste was being generated in the urban areas of Bangladesh, and hence less greenhouse gases were emitted. On average 13,330 tons of waste was being generated every day, totalling 399,900 per month, or 4,798,800 tons per year. Had all that waste being landfilled in 2005, 175,988.68 tons of CO2e would have been produced per month, or 2,111,864.16 tons of CO2e per annum. The amount signifies that 434.05kg of CO2e would have been produced per ton of mixed waste.

While in 2005 Bangladesh was emitting 64.46kg of CO2e per capita per year from the waste it generated, by 2014 that figure had increased to 86.38kg of CO2e per capita per year. This means that in 2005 the average urban household in Bangladesh was emitting 304.25kg of CO2e per year, with an average household size of 4.72 persons, whereas in 2014 the average household in Bangladesh was emitting 380.07kg of CO2e per year, with an average household size of 4.40 persons. Currently generating more waste than in the past, the people of Bangladesh are also currently emitting more CO2e than in the past through existing waste management practices.

Figure 11: Greenhouse Gas emissions from urban waste per household (2005 vs. 2014)

The difference in the amounts kg of CO2e produced per ton of mixed waste between 2005 and 2014 is explained by the change in the average composition of urban waste, with percentages of fabrics, paper and other waste decreasing, while plastics, food waste, wood and metal waste increased.

The composition of waste is also significant in its potential to address the issue of greenhouse gas emissions from urban waste. The high portion of organic waste in the urban waste of Bangladesh has the potential to be recycled, considerably reducing greenhouse gas emissions, as well as having other co-benefits in job creation, compost production, landfill savings, crop yield and fertiliser use.

Co-Benefits

Numerically, if all generated waste was collected and if out of this all organic waste was recycled into compost, Bangladesh could potentially create an additional 24,981 jobs, produce 911,816 tons of organic compost per year, reduce 2,279,541 tons of CO2e per year, and reduce its landfill area requirement by 5,014,991m^3 every year.

Conclusion

The generation of waste in the urban areas of Bangladesh is increasing year by year. Not only is Bangladesh generating more waste due to a growing population, but the per capita rate of waste generation is also increasing alongside an increasing GDP. At current rates, earlier projections will be surpassed by 2025 and Bangladesh will be generating more waste than was previously envisaged. Under the light of these facts, increasingly great pressure will be put on existing waste management systems and practices in Bangladesh, with an accumulative reliance on landfilling proving to be a disastrous outcome for a country already restricted by the amount of available land.

While the findings in this study can be interpreted as painting an undesirable scenario for the development of Bangladesh, great potential also lies in the changing practices and patterns of municipal solid waste management and resource recovery in the urban areas of Bangladesh, as the country continues its journey toward becoming a middle income nation.

The findings of this study have implications on the selection of waste management technologies, as Bangladesh prepares to move forward to more sustainable models of waste management in its urban areas.

The high percentage of organic waste, both food waste from domestic sources and other organics from non-domestic sources, means that great potential lies in recycling this organic waste into organic fertiliser through aerobic composting or into biogas through anaerobic digestion and then to electricity. Particularly, a decentralised model of integrated resource recovery, with a capacity to recycle up to 20,000 tons of waste per day, is appropriate to 81% of the pourashavas identified in this report.

The growing consumption of plastics in Bangladesh, epitomized by the higher percentage of plastics appearing in urban waste, is symptomatic of an increasing GDP. While the increase in plastics can be viewed as a challenge for Bangladesh, it also carries with it opportunity. Through best practice source separation and resource recovery, plastic waste can be recycled into a fuel source in the form of refuse derived fuel pellets. Currently at an experimental research phase in Bangladesh, the development and production of refuse derived fuel combines plastic, paper, cardboard, fabric and textile wastes along with other waste types to produce a new material that can be used as a source of fuel.

Up to now, the potential for implementation and wide-spread use of refuse derived fuel in Bangladesh has been deliberated with the country's brick industry, where refuse derived fuel pellets can complement and thus reduce reliance on coal and timber used to fire brick kilns. Further discussions with all relevant stakeholders are required to draft a holistic picture of the potential in resource recovery of plastics.

Moreover, the findings in this study underline the need for a low carbon development path for the waste sector in Bangladesh. With climate change having adverse effects on Bangladesh, there is a growing need for stronger mitigation actions from the waste sector through reductions in carbon emissions traced to waste management and resource recovery.

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