Global Scientific JOURNALS

GSJ: Volume 9, Issue 3, March 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

An Integrated Approach for Municipal Solid Waste Management Deemed to Reducing Dependency on Landfill

[1] Md. Zahid Hossain, [2] Masaharu Takasugi, Rehnuma Siddiqua[3]

[1] Consultant-WASH, UNICEF, Dhaka, Bangladesh. E-mail: zahidho@yahoo.com
[2] Solid Waste Management Specialist (CGP-Bangladesh), 2 NJS Consultants Co. Ltd, 6-8 Tomihisa-Cho Shinjuku-ku, Tokyo, Japan.
[3] Junior urban planner, City Goverance project, LGED

Abstract— Solid waste management (SWM) is one of the most challenging issues for Narayangonj City Corporation (NCC) in Bangladesh, which is facing a serious pollution problem due to the generation of huge quantities of solid waste and therefore facing the land crisis for dumping those giant volume of municipal solid waste. Various studies, Focus Group Discussion (FGD), Key Informant Interview (KII) and physical survey reveal that about 40% to 50% solid waste of its generation has been collecting and transporting in open dumps in low land and roadside in NCC.

This paper analyses the municipal waste fraction and per capita waste generation from primary and secondary data and explore future trends of solid waste generation up to 2036. Calculating the required land for dumping and evaluating financial assistant. The study has developed the flow diagrams, one is exiting, and another is for future for analysing how the challenges would be addresses effectively

Keywords: Land crises, 3R (reduce, reuse and recycle) approach, reducing the dependency on land, sustainability of SWM

1 INTRODUCTION

Sustainable Development Goals set the target 11.6 is that by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to waste management. There are two indicators against this target, and one is 11.6.1 being citing as proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated by cities. Municipal solid waste generation is an issue of worldwide concern. The generators of municipal waste are broadly classified as residential, industrial, commercial, institutional, construction, municipal and agricultural types (Sheker and Beukering, 1998). Municipal solid waste is also generated by human and animal activities that are discarded as useless and unwanted waste. Economic development, urbanization and improving living standard in cities of developing countries have led to increase in the quantity and complex composition of municipal solid waste. Management of municipal solid waste resulting from rapid urbanization has become a serious concern for government departments, pollution control agencies, regulatory bodies and public in most of the developing countries (Glawe et al., 2005; Erdogan et al., 2008)

In Bangladesh, solid waste management is one of the most challenging issues in urban cities, which are facing a serious pollution problem due to the generation of huge quantities of solid waste and thereby facing the land crisis for dumping those giant volume of municipal solid waste.

The 7th Five Year Plan of Bangladesh identified the problems regarding solid waste management and states in Chapter-8 under Environment management (page 420), "Solid waste comes from households, commercial and industrial establishments. In cities, the municipal authorities are unable to collect and dispose 100% of solid waste. Disposal of solid waste causes serious environmental hazards – uncontrolled open dumping clogs the urban drainage system-causing frequent congestion and contamination of water". Seventh 5 Year Plan also overviewed the solid and liquid waste problems and way out the solution as the volume of solid wastes is increasing in the cities, adoption of measures including discarding polythene, producing energy from wastes will be helpful. Programme regarding this issue as follows: (7th Five Year Plan -Chapter-8, Issue-4, page 428) Design and implement plans on solid waste management in accordance with the internationally recognized 4R strategy (reduce, reuse, recycle, recovery). Removal of neighborhood dumping sites and introducing of private/community waste collectors to carry the segregated waste to central dumping sites or transfer stations. Exploring possibilities for producing bio-fertilizer and energy from waste. Exploring and using new ideas or technologies, like bio-remediation, innovative and eco-friendly strategy, involving microbial agent (i.e., bacteria, protozoa, algae, fungi etc.) as successful alternative of traditional (physical and chemical) treatment to clean up waste. Judicious selection of alternative SWM treatment options (composting, incineration, landfill etc.) through undertaking of EIA. Continue to

enforce the ban on polythene, encourage the use of cotton and jute bags through economic investment

2 Study Location

Narayanganj City Corporation (NCC) has been formed on 5 May 2011 unifying three former municipalities: Narayanganj municipality, Siddhirganj municipality and Kadam Rasul municipality, and located at the central of the country, very closed to Dhaka. The area of the City Corporation is 72.43 sq km and is divided into 3 zones and these zones consists of 27 wards. According to The BBS population census 2011 the total population is 709,368 within the wards and 1,683,430 including surrounding influential area.

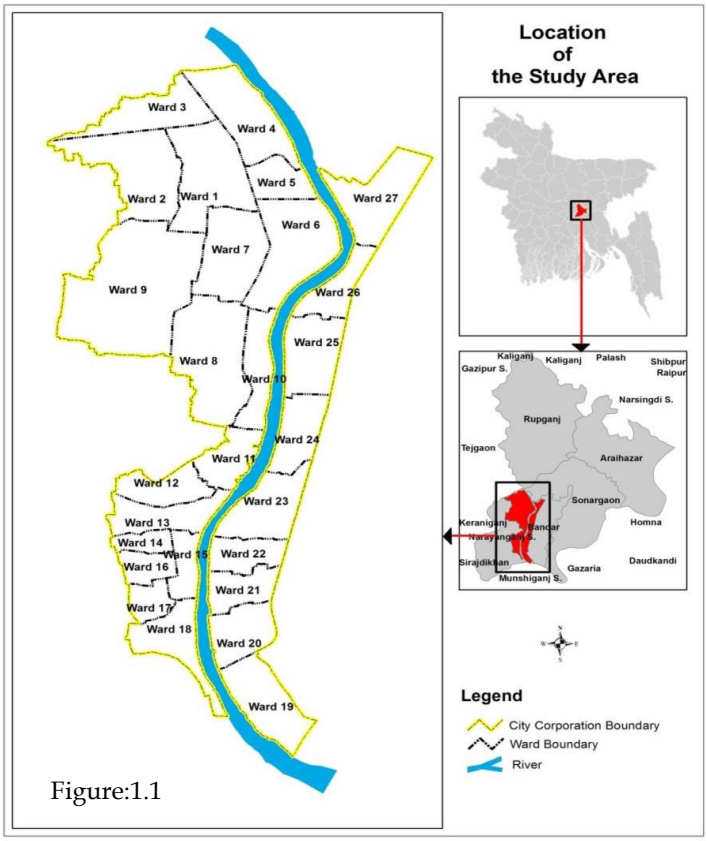


Figure:1.1

3 Solid Waste Streams in NCC

Flow of solid waste for NCC is shown in the figure 1.2. Generated 40% to 50% solid waste has been transported to dumping places by two-fold supported services, one is from generating source to secondary storage station by NGOs, Community Based Organizations (CBOs) and another is from secondary storage station to final dumping place by City Corporation's initiatives like using truck. First step is called as primary collection and second step is called as secondary collection.

Primary Collection:
The main actors at primary collection where the generator such as households discharges their waste are NGOs (Non-Government Organizations), CBO (Community Based Organizations) and households themselves.
Secondary Collection:
Most of the secondary stations have no containers just the open dumping in the ground

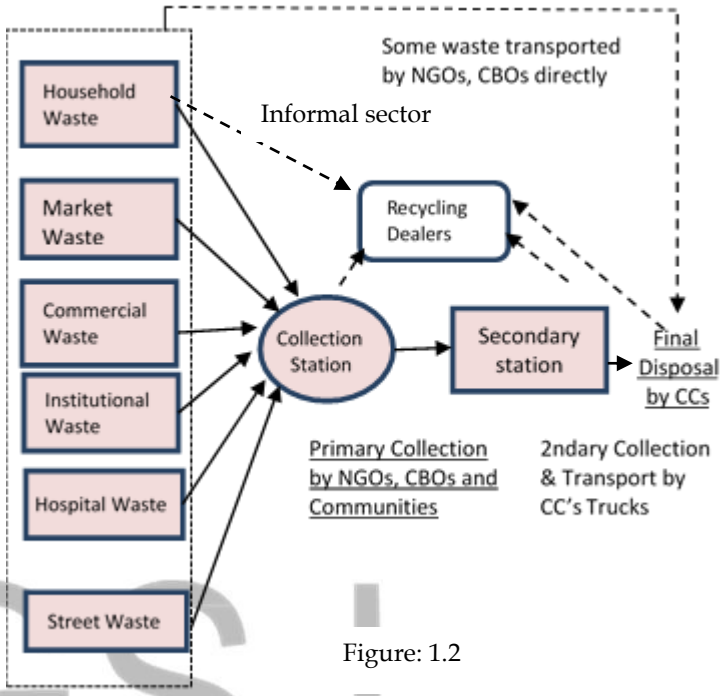


Figure: 1.2

At its primary stage, wastes are collected by rickshaw vans and transported to secondary storage station where CC's collection tracks transport the collected waste from there to final disposal sites. Some in places, primary collections are directly dumping into final disposal sites. In general, each household pay collection fee of 50 to 70 TK per month to rickshaw vans.

4 Methodology

This study focuses on municipality solid waste management under the jurisdiction of NCC. The data used in this study were derived from secondary and primary sources, where primary source means Focus Group discussion, Key Informant Interview and field observation with structural questionaries. The collected information was analyzed to develop an understanding of the existing solid waste management system and its future trend with considering different approaches including 3R.

5 Literature Review

Many literatures in Asia especially in South Asia have been taken to review with a view to gathering the information about on municipal solid waste management helping to study and research on the above subject. During literature review we have gathered the following information that have been considered and analyzed critically. Proper management requires the construction and installation of essential facilities and machinery, based on a suitable management plan

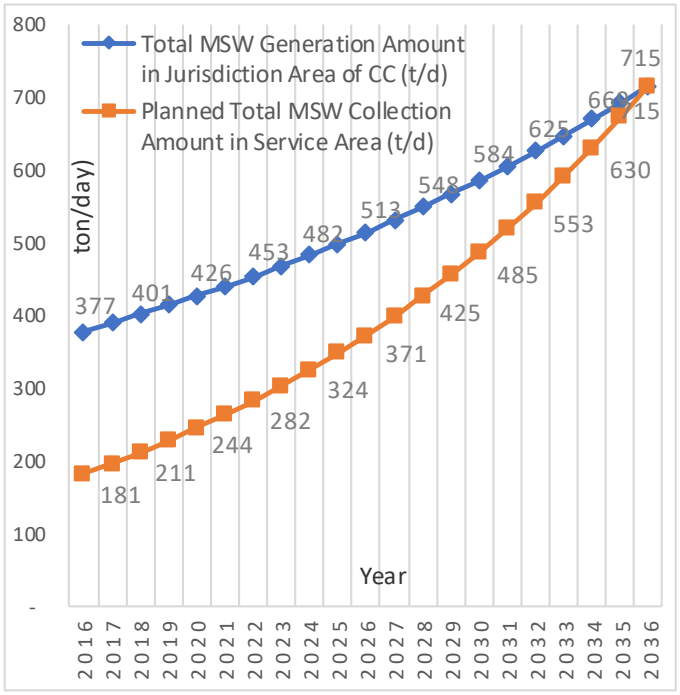
(Shimura et. al. 2001). Incineration would not work with municipal solid waste in developing countries due to high moisture content and low calorific value caused by the predominantly organic nature of the waste (Glawe, et al 2005); (Visvanathan & Trankler, 2003); (Sharholy et.al 2008); (Yedla & Kansal, 2003); (Bandara, 2008). The MSW amount is expected to increase significantly in the near future as the country strives to attain an industrialized nation status by the year 2020 (Sharma and Shah 2005, CPCB 2004, Shekdar et al .1992). Unscientific disposal causes an adverse impact on all components of the environment and human health (Rathi; 2006, Sharholy et al 2005, Ray et al 2005, Kansal 2002, Singh 1998).

6 Discussion and Result

The population was used in prediction of the future waste amount is to apply the estimated future population predicted for this study. Waste collection population is calculated by multiplying the proposed future collection service rate of each ward. The per capita waste generation rate of the municipal solid waste, including domestic and commercial waste, varies to 712g/c/d in 2036 from 500 g/c/d in 2016. (2016 is considered as based value for population which was predicted from census 2011)

Item	2016	2021	2026	2031	2036
City Population	753,800	804,600	862,400	928,500	1,004,900
Domestic Waste Generation Rate (g/c/d)	350	368	387	406	427
Domestic Waste Generation Amount (t/d)	264	296	333	377	429
Rate of Domestic Waste in MSW	70%	67.5%	65%	62.5	60%
Rate of Business Waste in MSW	30%	32.5%	35%	37.5	40%
Business Waste Amount (t/d)	113	143	180	226	286
Total MSW Generation Amount in the CC (t/d)	377	438	513	604	715
Avg. per Capita Waste Generation Rate (g/c/d)	500	545	595	650	712

Waste Collection Population and Planned Waste Collection Amount: The target collection rate is proposed to increase from 48% in 2016 to 100% in 2036. With this condition, the planned waste collection population is estimated to increase up to 1.00 Million persons in 2036 from 0.36 Million persons in 2016, and the waste discharge amount per day as well is also estimated to increase up Waste Collection Population and Planned Waste Collection Amount. The target collection rate is proposed to increase from 48% in 2016 to 100% in 2036. With this condition, the planned waste collection population is estimated to increase up to 1.00 Million persons in 2036 from 0.36 Million persons in 2016, and the waste discharge amount per day as well is also estimated to increase up

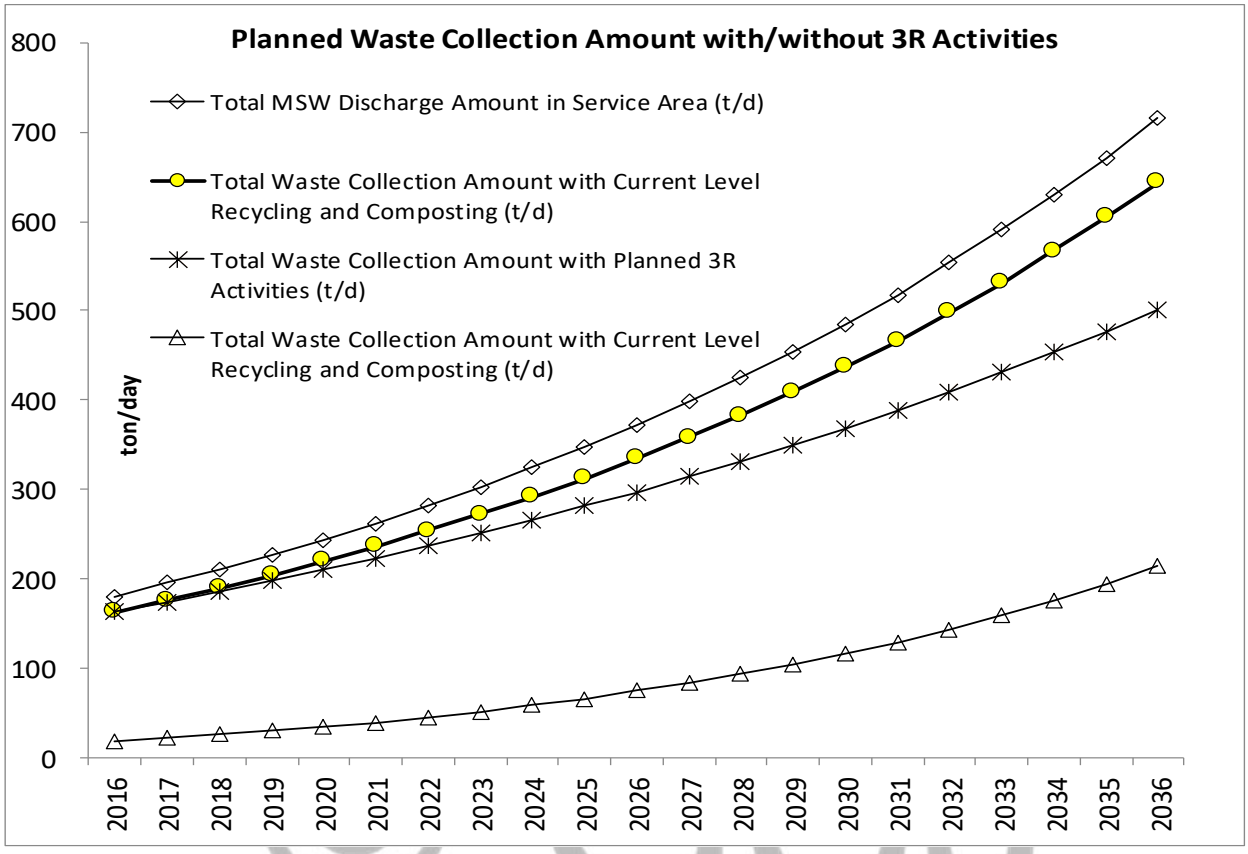


Average Value of Waste Composition of Domestic Waste from Households and Incoming Waste at Landfill Site:

Waste Composition	Domestic Waste			Incoming Waste		
	Min Value	Mean Value	Max Value	Min Value	Mean Value	Max Value
Food	46.3%	59.8%	68.3%	28.0%	42.2%	58.8%
Paper	6.5%	12.6%	20.8%	5.0%	10.8%	18.0%
Plastics	4.1%	10.6%	17.4%	5.1%	10.1%	16.6%
Leather	0.5%	1.0%	1.7%	0.4%	1.6%	2.7%
Textiles	1.4%	3.0%	5.3%	1.9%	5.6%	9.8%
Yard	0.9%	2.2%	5.2%	1.9%	6.0%	10.1%
Other Organic	0.0%	0.9%	1.6%	1.0%	6.7%	16.3%
Glass	1.3%	2.0%	3.2%	0.5%	2.5%	5.2%
Metals	0.3%	1.1%	2.2%	0.2%	0.8%	1.3%
Dirt, Ash, Stone, Sand	1.6%	4.5%	8.5%	3.2%	7.9%	14.1%
Unclassified Residual	0.2%	2.1%	6.4%	0.4%	5.7%	13.8%
Domestic Hazardous	0.0%	0.4%	0.9%	0.0%	0.1%	0.4%
Total	-	100.0%	-	-	100.0%	-
Organic Waste (Food Waste +Yard	48.1%	62.0%	73.5%	31.9%	48.2%	67.0%
Combustible & Food	87.2%	90.0%	92.5%	78.7%	83.0%	87.8%
Combustible	19.0%	30.2%	45.9%	29.0%	40.8%	50.7%

The annual waste disposal amount collection amount (residual waste amount) together with the various elements for implementing the proposed plans of 3R activities and the intermediate treatment facility development. The following graphs indicate the annual trend lines of the cumulative final disposal volume of, 1) final disposal volume with 3R, 2) final disposal volume with 3R and composting, and 3) final disposal volume with 3R, composting and incineration.

Which has been in the following grap:



Landfill Volume with Proposed 3R and Intermediate Treatment Plan

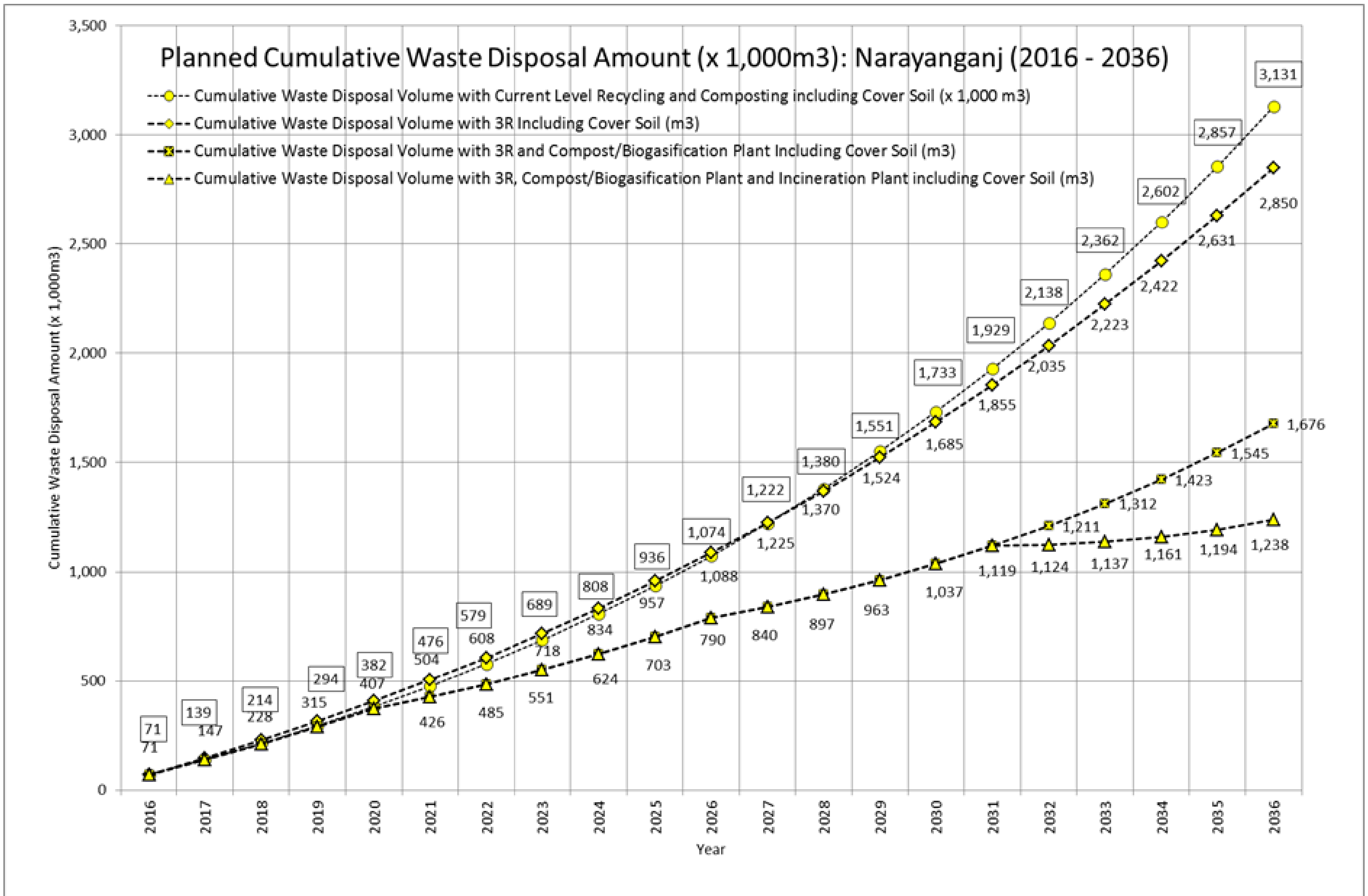
The final waste disposal amount is calculated by subtracting the waste amount of 3R activities (waste generation reduction control amount and recovery amount of recyclable materials) and intermediate treatment amount (composting and incineration treatment amount) from the potential waste discharge amount. The 3R plan and intermediate treatment plan of Narayanganj CC are proposed with the tentative target level of each activities as reiterate in the followings for reference to understand the calculation of waste amount to be diverted from the final disposal.

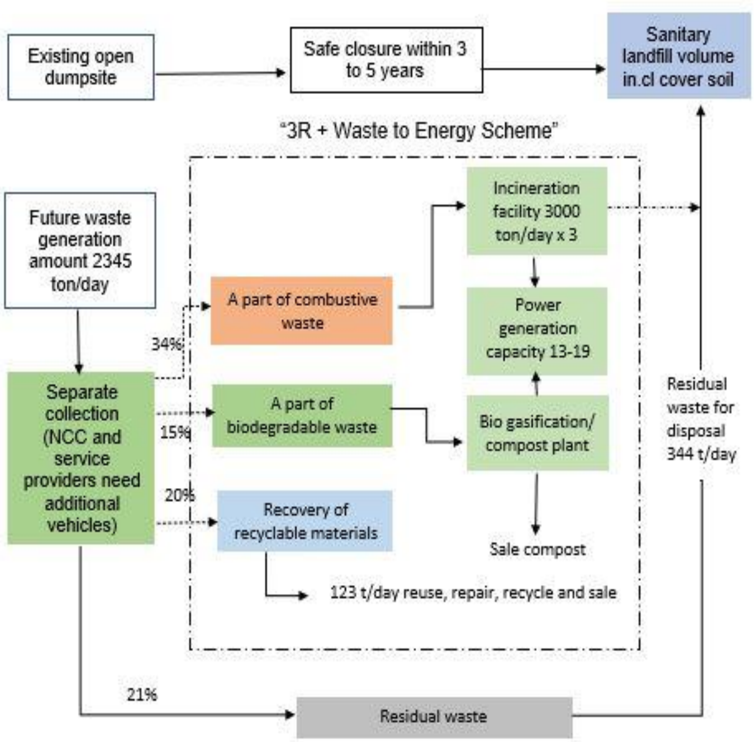
Item	2016	2021	2026	2031	2036
Target Waste Reduction Rate	0%	2.5%	5%	7.5%	10%
Target Recovery Rate of Recyclables	10%	12.5%	15.0%	17.5%	20%
On-going Composting Project: 20t/d, Start operation in	2018				
Composting Stage-1: 100 t/d, Start operation in	2021				
Composting Stage-2: 200 t/d (incl. Stage-1 Plant, Start operation in	2027				
Incineration/Waste-to-Energy Plant: 900 t/d, Start operation in	2032				

summarize the annual waste disposal amount collection amount (residual waste amount) together with the various elements for implementing the proposed plans of 3R activities and the intermediate treatment facility development. The graphs indicate the annual trend lines of the cumulative final disposal volume of, 1) final disposal volume with 3R, 2) final disposal volume with 3R and composting, and 3) final disposal volume with 3R, composting and incineration. The landfill volume in 2036 reach at 2.9 Million m3 with 3R activities, 1.7 Million m3 with 3R and composting and at 1.2 Million m3 with 3R, composting & incineration

Landfill Volume with/without Proposed 3R and Intermediate Treatment Plan

Following figure for indicating the annual increase of cumulative final waste disposal amount with/without 3R and/or intermediate treatment. The reduced landfill volume in 2036 reach about 0.28 Million m3 with 3R, 0.46 Million m3 with 3R and composting, and about 1.89 Million m3 with 3R, composting and incineration.


Planned Cumulative Waste Disposal Amount (x 1,000m3): Narayanganj (2016 - 2036)
Cumulative Waste Disposal Volume with Current Level Recycling and Composting including Cover Soil (x 1,000 m3)
Cumulative Waste Disposal Volume with 3R Including Cover Soil (m3)
Cumulative Waste Disposal Volume with 3R and Compost/Biogasification Plant Including Cover Soil (m3)
Cumulative Waste Disposal Volume with 3R, Compost/Biogasification Plant and Incineration Plant including Cover Soil (m3)
Cumulative Waste Disposal Amount (x 1,000m3)
Year


Existing open dumpsite
Safe closure within 3 to 5 years
Sanitary landfill volume in.cl cover soil
"3R + Waste to Energy Scheme"
Future waste generation amount 2345 ton/day
Incineration facility 3000 ton/day x 3
Power generation capacity 13-19
A part of combustive waste
34%
Separate collection (NCC and service providers need additional vehicles)
15%
A part of biodegradable waste
Bio gasification/ compost plant
Residual waste for disposal 344 t/day
20%
Recovery of recyclable materials
Sale compost
123 t/day reuse, repair, recycle and sale
21%
Residual waste

7 CONCLUSION REMARK:

Mathematical calculation with waste generation per capita including its waste fraction has been showing the projection volume of MSW for NCC would be gigantic and would not be manageable only due to land crises. Whereas the opportunity is there if the waste turn into resources which fully depended on 3R. Thin polythene, especially less than 58 millimicron thick need to control as these not being collected by waste picker at primary, secondary and final dumping point. In conclusion, if polythene is controlled, organic waste could be compost and bio-gasification which will have contribution to development and little incinerator would be needed for rest combustible waste, eventually NCC's waste would be managed properly without required a huge land.

8 REFFERENCES

- Shimura, S. Yokota, I, Nitta, Y, 2001, Research for MSW flow analysis in developing nations. Journal of Material Cycles and Waste management 3, 48-59
- Glawe, U, Visvanathan, C & Alamgir, M, 2005. Solid waste management in least developed Asian countries-A Comparative Analysis s.I, sn, pp 5-7
- Visvanathan, C & Trankler, J, 2003. Municipal Solid Waste Management in Asia-A Comparative Analysis. Sl,sn, pp, 3-15
- Yedla, S. & Kansal, S, 2003. Economic Insight into Municipal Solid Waste Management in Mumbai: A Critical Analysis. Int. J. Environmental and Pollution, Volume 19, pp. 516-527
- Sharholy, M, Ahmed, M, Mahmood, G & Trivedi R, 2008. Municipal solid waste management in India cities-A review, waste management, Volume 28, pp. 459-467
- Bandara, N, 2008. Municipal solid waste management: the Sri Lanka Case: University of Sri Lanka
- Sharma, S, Shah, K.W, 2005 Generation and disposal of solid waste in Hoshangabad
- Shekdar, A.V, krshnawamy, K.N, Tikekar, V.G, Bhide, A.D 1992, Journal of Waste Management, 12,4, pp 379-387
- Rathi, S, 2006, Alternative approaches for better municipal solid waste management in Mumbai, India, Journal of Waste Management, 26, 10, pp 1192-1200
- UN, Cities and Sustainable Development: Lessons and Experiences from Asia and the Pacific, United Nations Economic and Social Commission for Asia and the Pacific, 2003.
- D. Hoornweg and P. Bhada-Tata, "What a waste: a global review of solid waste management," World Bank 15, 2012.
- N. Scarlat, V. Motola, J. F. Dallemand, F. Monforti-Ferrario, and L. Mofor, "Evaluation of energy potential of municipal solid Waste from African urban areas," Renewable and Sustainable Energy Reviews, vol. 50, pp. 1269–1286, 2015.
- H. Cheng and Y. Hu, "Municipal solid waste (MSW) as a renewable source of energy: current and future practices in China," Bioresource Technology, vol. 101, no. 11, pp. 3816–3824, 2010.
- R. P. Singh, V. V. Tyagi, T. Allen, M. H. Ibrahim, and R. Kothari, "An overview for exploring the possibilities of energy generation from municipal solid waste (MSW) in Indian scenario," Renewable and Sustainable Energy Reviews, vol. 15, no. 9, pp. 4797–4808, 2011.
- Johari, S. I. Ahmed, H. Hashim, H. Alkali, and M. Ramli, "Economic and environmental benefits of landfill gas from municipal solid waste in Malaysia," Renewable and Sustainable Energy Reviews, vol. 16, no. 5, pp. 2907–2912, 2012.
- Chiemchaisri and C. Visvanathan, "Greenhouse gas emission potential of the municipal solid waste disposal sites in-Thailand," Journal of the Air and Waste Management Association, vol. 58, no. 5, pp. 629–635, 2008.
- S. H. Bhuiyan, "A crisis in governance: urban solid waste management in Bangladesh," Habitat International, vol. 34, no. 1, pp. 125–133, 2010.
- Ahsan, M. Alamgir, M. M. El-Sergany, S. Shams, M. K. Rowshon, and N. N. Daud, "Assessment of municipal solid waste management system in a developing country," Chinese Journal of Engineering, vol. 2014, Article ID 561935, 11 pages, 2014.
- R. Afroz, K. Hanaki, and R. Tudin, "Factors affecting waste generation: a study in a waste management program in Dhaka City, Bangladesh," Environmental Monitoring and Assessment, vol. 179, no. 1–4, pp. 509–519, 2011.
- N. Desk and bdnews24.com, "6.3 Percent maximum possible GDP growth of Bangladesh in 2015–16: World Bank," bdnews24 .com, http://bdnews24.com/economy/2015/06/13/6.3-percentmaximum-possible-gdp-growth-of-bangladesh-in-2015-16- world-bank.
- "Bangladesh: Economy," Asian Development Bank, 2014, http://www.adb.org/countries/bangladesh/economy.
- R. Harmachi and bdnews24.com, "Year in review: Bangladesh economy in 2015," bdnews24.com, http://bdnews24.com/ economy/2015/12/29/year-in-