

## Environmentally Sound Waste Management in Asia Pacific

# BENGALURU, INDIA

## BACKGROUND

Bengaluru, or Bangalore, as it used to be known, is nearly 500 years old and has grown from a small-time settlement where Kempe Gowda, the architect of Bengaluru, built a mud fort in 1537 and his son marked the city boundaries by erecting four watch towers. Today Bengaluru has grown well beyond those four towers into a sprawling metropolis of nearly 8 million people that is referred to as the Silicon Valley of India – accounting for more than 35 per cent of India's software exports. Bengaluru's temperate climate, high-quality educational, scientific and technology institutions, coupled with

thriving information technology (IT), biotechnology and manufacturing industry, make it one of the most sought-after global destinations.



Topography	Flat except for a ridge in the middle
Climate/rainfall	Average temperature 24° C; Annual rainfall 860mm
Area	800 km <sup>2</sup>
Population:	7.8 million (2009)
Population density	9750 persons/km <sup>2</sup>
Human Development Index	0.70

## WASTE MANAGEMENT SYSTEM

There is strong political commitment to improving and modernizing collection, with high-level performance goals and a mixed system approach. A mix of the municipality and private operators provide a direct, daily door-to-door primary collection system to 70 per cent of Bengaluru citizens in high-income,

middle-income and some low-income and slum areas. Private contractors provide services in the central business district and in the better-off residential areas. The handcarts used by the door-to-door collectors are directly unloaded into large vehicles, including auto-tippers and state-of-the-art compactors,

for transportation to the processing or disposal sites, making most of the city effectively bin free. The exception is a few low-income areas on the city boundaries and in old settlements, where the municipality provides less frequent and less regular waste collection services from community waste collection.



It is estimated that nearly 10 per cent of waste still goes for open dumping. Two designated controlled dumpsites closed in 2007, and the rest of Bengaluru waste now goes to two new modern landfills constructed near processing plants in Mavallipura Hesaragatta Hobli and Mandur BideraHalli Hobli. The expected useful life is at least until 2030, provided that the processing plants function at full capacity. The landfill sites are operated by the private sector based on public-private partnership (PPP) models.

The 2000 Municipal Solid Waste Rules require cities to recover all recyclables and compostable materials and only allow rejects and inerts to be landfilled. Even though this has not been operationalized, in Bengaluru, 25 per cent of the total waste is being valorized by informal and formal activities, and there are plans for more. An active informal sector recovers around 15 per cent of the city waste and feeds the regional industrial recycling supply chain, while supporting livelihoods of more than 30,000 waste-pickers in the city and at the landfill site, who sell to junk dealers, sorters and recycling units, which comprise an additional estimated 10,000 workers. Now that a formal door-to-door collection system has been extended to the majority of the population, the formal-sector waste collectors and transfer station workers also retrieve recyclables and sell to small scrap dealers. Segregated organic waste from hotels and fruit and vegetable markets is directly taken to four composting plants, operated by the formal private sector on PPP models. The compost is sold to the fertilizer agencies who market it mostly to coffee planters and large farmers. There is still not enough demand for compost; hence, the processing plants



produce compost when they have buyers, and the rest goes to the landfill sites. There are plants under construction to make refuse-derived fuel (RDF) from the rejects from compost processing, which contains some organic material and often a high percentage of paper and plastic.

## SPECIAL FEATURE

As Bengaluru has an intensive IT industry, there are NGO initiatives to decrease relatively dangerous informal e-waste recycling and to collect e-waste separately and send it for formal recycling and recovery. The IT industry is also a key player in the Bangalore Agenda Task Force (BATF) initiative, organizing the modernization of waste management and upgrading of collection.

Total municipal solid waste (MSW) generated	2,098,750 tonnes/year
Per capita waste generation	269 kg/year
Percentage coverage	65%
Percentage of waste disposed in environmentally sound landfill or controlled disposal sites	90%
Percentage of MSW incinerated	None
Percentage of MSW diverted and valorized	14%
Percentage valorized by informal sector	1%
Percentage valorized by formal sector	13%
Goals for waste collection coverage	100%
Goals for environmentally sound disposal	20-30%
Goals for valorization of waste through recycling	70%

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# DHAKA, BANGLADESH

## INTRODUCTION

Dhaka the capital of Bangladesh is the most densely populated city in the world with over 7 million residents and day time population of over 12 million. With the population continuing to grow at about 3 percent per year, and the fact that over 3 million people live in slums and over half the population live below poverty line makes, providing basic infrastructure and services, including solid waste management, is a major challenge. The city receives heavy rainfall, particularly during the monsoon, leaving much of the low lying areas flooded.

## WASTE MANAGEMENT SYSTEM

Although the average per capita waste generation rate in Dhaka is fairly low at about 0.5 kg per day, because of the large population, the City of Dhaka generates approximately 3,500 tons of solid waste per day or 1.2 million tons per year. It is estimated that about 80percent of the municipal waste is organic in nature.

Waste collection in Dhaka is mainly based on door-to-door primary collection of waste by micro-enterprises, who



Topography	Flat
Climate/rainfall	Subtropical / 1429-4338 mm /year
Area	365 km <sup>2</sup> (metropolitan area)
Population:	7 million
Population density	9,178 persons/km <sup>2</sup>
Human Development Index	0.543

take the waste to designated points on the roadside or collection/transfer points. The municipal authority, Dhaka City Corporation (DCC), services these secondary collection points. Ward-based waste management schemes are in place in several wards of Dhaka City. Citizens form an active part of the waste management efforts. Primary collectors in the ward are also given training, which facilitates integrating primary collection with the secondary collection by DCC.

Collected waste is disposed of at one of the two disposal sites: Matuail and Aminbazar. Matuail is the first ever sanitary landfill in Bangladesh, upgraded from a dumpsite previously in operation for many years. The resulting engineered disposal facility opened in October 2007 as a part of a long-standing partnership between DCC and Japan International Cooperation Agency (JICA). Matuail now has year-round access, gate controls, a computerized weighbridge, perimeter drainage, cellular emplacement, and leachate and landfill gas control. DCC now faces the more challenging task of operating and maintaining the facility as a sanitary landfill, and to date the facility is being managed well. Matuail is operated 24 hours a day in three shifts. It receives around 1200 tonnes of waste per day, arriving at both day- and night-time. DCC is currently in the process of upgrading the Aminbazar disposal site.

The concept of 'waste' is only a relatively recent phenomenon in Bangladesh, and many of the materials which are generally considered to be waste in other countries are stripped out of the waste stream for extraction of resource value. Newspapers, glass bottles, metal cans, plastic items – practically anything of value – are reused or sold by their owners or informal waste-pickers. Resource recovery in Dhaka is carried out and managed by multiple and complex chains of informal and formal, public, private and multinational actors. About 120,000 people are involved in the informal recycling trade chain in Dhaka City. None of these activities receive any public funding support.

A new 130 ton per day capacity compost plant located in Bulta just outside Dhaka started operation in 2008 by WWR Bio Fertilizer Bangladesh Ltd (a joint venture company of Waste Concern, Bangladesh, World Wide Recycling BV, FMO and Triodos Bank, The Netherlands). This activity is accompanied by collection services of market (organic) waste for this composting plant. The project is registered and approved by the executive board of the Clean Development



Mechanism under the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) and is gradually scaling up.

## SPECIAL FEATURE

Dhaka offers an excellent example of a waste management plan being prepared to a high standard, and then being implemented in management cycles with the support of development partners. Some of the achievements are the establishment of a waste management department; implementation of a ward-based approach to waste management; and construction of the first ever sanitary landfill in Bangladesh. In 2008 a new Waste Management Department was inaugurated at DCC, combining the conservancy and mechanical engineering departments into a single department, putting Dhaka City Corporation at the forefront of modernized institutional arrangements for solid waste management in South Asia.

Another special feature of the waste management system in Dhaka is the utilization of Clean Development Mechanism (CDM) for converting waste

Total municipal solid waste (MSW) generated	1,168,000 tonnes/year
Per capita waste generation	167 kg/year
Percentage coverage	43%
Percentage of waste disposed in environmentally sound landfill or controlled disposal sites	44%
Percentage of MSW incinerated	None
Percentage of MSW diverted and valorized	18%
Percentage valorized by informal sector	18%
Percentage valorized by formal sector	None
Goals for waste collection coverage	None
Goals for environmentally sound disposal	Second landfill under construction
Goals for valorization of waste through recycling	None

to compost in partnership with private sector. This is the first CDM project related to waste composting. The project collects 700 tons of waste per day free of charge and processes it to produce about 50,000 tons of compost per year and saves 89,000 tonnes of CO<sub>2</sub>eq per year, while providing 800

jobs to urban poor. The total investment cost for the project is 12 million Euros. Over a period of 10 years, the project expects to earn 27.24 million Euros from sale of compost and 9.76 million Euros from sale of carbon credits at 13 Euros per tonne.

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# GHORAH, NEPAL

## INTRODUCTION

Ghorahi, the headquarters of Dang District, is a small town located in Dang Valley in mid-western region of Nepal. The Dang Valley, which is drained by the Babai River is at an elevation of 600 to 700 meters above sea level. The town is the administrative and economic centre of the district and is 25 km north of the East-West Highway. Although traditionally, the Dang Valley along with Deuhuri Valley located immediately to the south was inhabited by the Tharu ethnic group now the population is more diverse as the city continues to expand and attract many migrants from the surrounding hills, who come in search for economic opportunities and facilities. The city is growing at over 4.6% per year.

## WASTE MANAGEMENT SYSTEM

Waste collection system in Ghorahi includes on-time-collection and roadside collection using both mechanized and non-mechanized systems. On-time collection using a tipper and compactor in some parts of the city collects about



Topography	Valley
Climate/rainfall	Average temperature: 23.1° C; Annual rainfall: 1277 mm
Area	74.45 km <sup>2</sup> ;
Population (2011)	62,928
Population density	845 persons/km <sup>2</sup>
Human Development Index	0.409

50 per cent of the waste, while the other half is collected through roadside collection using sweeping, manual loading of rickshaws, and manual transfer to a larger mechanized vehicle. The on-time collection system is fairly efficient because the waste is directly placed in the vehicles by the waste generators. However, dumping of waste on the streets by the waste generators and then collecting it in small collection vehicles followed by manual transfer into larger haulage vehicles involves handling the waste several times, which makes the system as a whole inefficient and increases public health risks.

While Ghorahi's waste collection still has a long way to go in the modernization process, the city has done an impressive job in addressing the environmental issues related to waste disposal. The municipality's own Karauti Danda Sanitary Landfill is one of only six landfill sites in the country. Environmental protection is achieved through selection of a site with thick deposits of natural clay, a leachate collection and treatment system, as well as a buffer zone that includes a small forest, a flower garden and bee farming.

The resource management system is a mixture of formal, informal, public and private. The municipality has a plastic sorting facility at the landfill site, where about 20 tonnes of plastics are recovered annually and marketed to a recycling industry about 350km away in Chitwan district. Compost pits are also present on the site of the landfill; but efforts to sell the compost have proved disappointing and demand for the compost remains weak, probably due to glass contamination. Collection of recyclables is done by about 35 informal sector itinerant waste buyers (IWBs) who sell plastics, metal, bottles and paper to four (formal) private recycling businesses. The total amount of recyclable materials recovered is estimated to be between 100 and 500 tonnes per year. Most of the waste from rural areas is reported to be recycled within the households; but there is little information about either recycling or composting outside of the city.



## SPECIAL FEATURE

The main special feature of Ghorahi's waste management system is the sanitary landfill site and its governance. The City has demonstrated that an environment friendly sanitary landfill can be built and operated successfully through a partnership between local community and the municipality. The landfill management system includes a committee involving local community leaders and members of the business community.

The landfill, which is spread over 20 ha of land at Karauti Danda in ward 9, five km away from the town centre, was established in 2005. About five tons of waste is collected daily by the municipality and brought to the landfill in covered vehicles. At the landfill the waste is first sorted to remove plastics and other recyclable materials. The organic waste is composted in pits and the remaining waste is landfilled and covered with soil. The landfill has drains for collecting storm water runoff

and leachate along with a facility for treating leachate. The area designated for waste disposal is surrounded by a buffer zone with forest as well as a garden. The landfill also has many bee hives and a sunflower garden for the bees, which adds to the aesthetics of the area.

Total municipal solid waste (MSW) generated	7,285 tonnes/year
Per capita waste generation	167 kg/year
Percentage coverage	46%
Percentage of waste disposed in environmentally sound landfill or controlled disposal sites	67%
Percentage of MSW incinerated	None
Percentage of MSW diverted and valorized	11%
Percentage valorized by informal sector	9%
Percentage valorized by formal sector	2%
Goals for waste collection coverage	None
Goals for environmentally sound disposal	None
Goals for valorization of waste through recycling	None

# Environmentally Sound Waste Management in Asia Pacific

## KUNMING, PEOPLE'S REPUBLIC OF CHINA

### BACKGROUND

Kunming, the capital and largest city of Yunnan Province, is a typical medium sized Chinese City with a population of 6.8 million. Kunming is the political, economic and cultural centre of Yunnan Province, and is the seat of the provincial government. It is also home to several universities, museums, galleries and headquarters of many of Yunnan's large businesses. The rich history of Kunming dates more than 2000 years, back to the year 279 BC when a general of the Chu Kingdom formed a settlement near Dian Lake. Today, the city is undergoing rapid development, following the central government's Western Region Development Strategy, 2000–2010.



Topography	Flat, on a high plateau (1890m above sea level)
Climate/rainfall	1031mm; rainy season is May to October
Area	21,473km <sup>2</sup> ; 220km <sup>2</sup> in the main urban area.
Population :	6.8 million
Population density	1590 persons/km <sup>2</sup> in four major districts
Human Development Index	0.772

### WASTE MANAGEMENT SYSTEM

Solid waste management in Kunming City is well on the way to modernization. Environment is the main driver, symbolized and driven by concerns about the city's international image



in the context of preparing the World Horticulture Exhibition in 1999, with a focus on improving the situation with regards to pollution in Dian Lake. These preparations prompted development of the first sanitary landfill in 1997, funded by the World Bank. The Western Region Development Strategy of 2000, which promotes the development of Yunnan and other less developed western provinces of China, contributes to the 248 ongoing projects for construction of waste landfills and sewage treatment plants in Yunnan Province. These installations are funded by state and provincial governments, a large public utility company, Water Investment, and some private investors. Of those 248 projects, 31 are in the larger Kunming area, 10 of which are waste landfills.

Consistent with the priorities of socialist states elsewhere, Kunming has long had virtually 100 per cent collection coverage and city streets are clean. Collection occurs daily in the central business district and less frequently elsewhere. Collection and sweeping are operated by two levels of

government under the city administrative level – the district level and the 'street neighbourhood' or ward level. Kunming has an excellent waste collection system based on over 120 small transfer stations throughout the city and a combination of low-tech tricycles and high-tech compaction vehicles; all are operated by public employees. Since 2006, street sweeping has been progressively privatized in the city's districts and the trend towards privatization is likely to continue in solid waste services in general. With economic development and changes in lifestyles, waste composition has changed markedly, and the percentage of ash in municipal solid waste has decreased from over 50 per cent in 1997 to less than 25 per cent in 2004. Final waste disposal is controlled – municipal waste ends either in the incinerator or at one of the two landfills. The technology of choice for the near future is incineration once the existing landfills are closed, something which is expected soon. One of the landfills, Guandu, has an ongoing carbon credit project in cooperation with a European partner, by chance the same partner as in Belo Horizonte, Brazil.

The existing – and thriving – recycling business, with the focus on metals, functions as commodity trading and is separate



from the solid waste management system, as was the case in the US and Europe prior to the 1970s, the Philippines during the 1990s, and Lusaka, Moshi, Bamako and Nairobi up to the present. In contrast, the opportunities to develop valorization of organic waste have not yet been seized.

## SPECIAL FEATURE

The more than 120 small transfer stations represent a global good practice and have provided a model for other cities worldwide for connecting non-motorized community collection with high-technology compacted motorized transport, for an effective waste collection service. Another special feature in Kunming is the city's successful involvement of the private sector in financing the development of new disposal capacity, including incineration.

Total municipal solid waste (MSW) generated	1 million tonnes/year
Per capita waste generation	258 kg/year
Percentage coverage	100% in urban areas
Percentage of waste disposed in environmentally sound landfill or controlled disposal sites	Almost 100%
Percentage of MSW incinerated	37%
Percentage of MSW diverted and valorized	NA
Percentage valorized by informal sector	NA
Percentage valorized by formal sector	NA
Goals for waste collection coverage	100%
Goals for environmentally sound disposal	100%
Goals for valorization of waste through recycling	None



## Environmentally Sound Waste Management in Asia Pacific

# QUEZON CITY, PHILIPPINES

## INTRODUCTION

Quezon City, located in the island of Luzon, is the largest of the 15 cities and 2 municipalities that make up the National Capital region or Metro Manila. The city is spread over an area of 161.12 sq. km and is home to 3.18 million people in 706,564 households. The city has a largely rolling landscape and a tropical climate. As the city was a former capital of Philippines, it houses many government offices and commercial centres.



## WASTE MANAGEMENT SYSTEM

It is estimated that Quezon city generates 7,150 cubic meters or 1429 metric tons of solid waste every day. Of this, organic or biodegradable waste makes up the largest portion (48%). This is followed by recyclable waste (39%) such as paper and plastics, and residual waste (13%). Among the recyclables, paper and plastics are the most highly generated, with 17 and 16 per cent, respectively (SWAPP, 2006).

The city has formal as well as informal waste collection systems. The formal waste collection is done by five



Topography	Flat
Climate/rainfall	2532 mm/year
Area	161.12 km <sup>2</sup>
Population :	2,861,091
Population density	166 persons/km <sup>2</sup>
Human Development Index	0.771

contractors, 13 barangays with their own collection trucks, and private hauliers for commercial establishments. The city has adopted a 'package clean up' system whereby the contractor is fully responsible for waste management from collection to final disposal, including the provision of street sweepers; information, education and communication (IEC) campaigners; riverways cleaning; bulky waste collection and a subsystem of garbage collection for inaccessible areas. The city collection gets about 365,390 tonnes; barangay collection is about 29,628 tonnes and private commercial collection is 75,880 tonnes. Informal collection, by itinerant waste buyers (IWBs) focuses only on recyclables.

The Quezon City Controlled Disposal Facility is the oldest dumpsite in Metro Manila, operating for more than three decades. Once a symbol of everything that was wrong with waste disposal systems, the dumpsite has been transformed into a model and pioneering disposal facility. Through the Biogas Emission Reduction Project, initiated in 2007, accumulating biogas from the soil-covered garbage mound is now being extracted,

flared and converted into usable electricity. The project is registered under the Clean Development Mechanism (CDM) and is projected to cut down greenhouse gas emissions by 1,162,000 tonnes of CO<sub>2</sub> throughout its operating life.

Collection of recyclables is done by both the formal and informal waste sector. For the formal sector, it is undertaken by the city collectors and barangay collectors. For the informal sector, it is done by itinerant waste buyers at the household level, garbage crews on the trucks, and waste-pickers at the dumpsite and the junk shops; in combination they get 241,195 tonnes. While itinerant waste buyers recover 73 per cent of the stated amount, the junk shops are the main system players that pool recyclables from the different sources for final recovery by the recycling industries and/or exporters. While some barangays have materials recovery facilities (MRFs), others have junk shops which have been registered and designated as fulfilling the MRF function. Biodegradable wastes that consist mostly of food wastes are collected from households and establishments by city collectors, barangay collectors, accredited kitchen waste collectors or private commercial hauliers. These are processed



into composts, soil conditioners or feeds for animals. The total organics being generated at source is 383,499 tonnes per year. The buyers of the organics are livestock growers who get 12,723 tonnes and the compost producers and traders who get 1592 tonnes.

## SPECIAL FEATURE

Quezon City has the highest recovery rate of any of the low- and middle-income reference cities, and the Philippines is active in the 3R Asia Regional Forum. The Philippines National Strategy for the integration of the informal sector, written in 2008 and supported by the United Nations Development Programme (UNDP), represents global best practice. In 2012, the Quezon City Government was awarded with a Certificate of Recognition by the Department of Environment and Natural Resources (DENR) for sustained good performance in the implementation of the Republic Act 9003 through segregation at source, deployment of dedicated units as well as the establishment and operationalization of Materials Recovery Facilities.

Total municipal solid waste (MSW) generated	636,083 tonnes/year
Per capita waste generation	257 kg/year
Percentage coverage	99%
Percentage of waste disposed in environmentally sound landfill or controlled disposal sites	66%
Percentage of MSW incinerated	None
Percentage of MSW diverted and valorized	39%
Percentage valorized by informal sector	31%
Percentage valorized by formal sector	8%
Goals for waste collection coverage	100%
Goals for environmentally sound disposal	None
Goals for valorization of waste through recycling	25%