| Chapter 6 |

Urban Organic Waste – From Hazard to Resource

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1. Introduction

Uncollected and improperly treated organic wastes are sanitary hazards and sources of public nuisance in developing countries, especially in densely populated cities. However, organic waste contains plant nutrients and energy, so it is also a potential resource. Local governments typically try to reduce the hazards posed by organising a collection system and depositing the waste in open dumpsites, usually in wasteland on the city outskirts. The people living there, who are usually low-income groups, are exposed to health and environmental impacts, and some of them who make a living by scavenging on the waste dumps, face even greater hazards. In response to these problems, many municipalities try to upgrade their dump sites to landfills, which can mean anything from a marginally improved fenced-off dump to a fully engineered site with gas and liquid effluent (leachate) recovery systems. Upgrading existing dumpsites is a relatively affordable option, which can solve the immediate sanitary hazards and reduce leakage of environmental pollutants. In the long term, however, delivering untreated household waste to landfills is not a sustainable solution. The availability of suitable landfill sites is highly limited in most regions and land is needed for other purposes. Potentially valuable resources are lost when buried in landfills; surrounding soil, plants, surface and underground waters may be contaminated by substances leaching from the site and the degradation of organic materials generates methane, a powerful greenhouse gas (GHG). At the international level, the significance of the waste sector for climate protection is being increasingly recognised (IPCC 2007).

This chapter deals with the linkages between organic waste treatment and climate change in cities in developing countries in the Asia-Pacific region, and it attempts to identify policies that can satisfy both sustainable development and climate protection objectives. It focuses on biodegradable waste, mainly food and yard waste, from households, institutions and small businesses, and how methane emissions from the treatment of this waste can be avoided (or captured and used). It concludes that composting is one method that can reduce GHG emissions from waste treatment and seems to have potential in the region. Therefore, the chapter examines the record of introducing and promoting composting in cities in developing countries in Asia-Pacific. Special attention is given to how policymakers at national and local levels can facilitate composting initiatives. This analysis is based on a literature review of policies relevant to organic waste management in the major developing countries in the region and six local case studies based on literature sources, site visits and interviews.

2. Greenhouse gas emissions from waste treatment

Decomposition of organic waste under anaerobic conditions in solid waste disposal sites (SWDS) leads to the formation of biogas consisting of approximately 50% methane (IPCC 2006). Methane is a potent GHG with a radiative forcing 25 times higher than CO_2, and among the anthropogenic emissions it is the second largest contributor to global warming after CO_2 (IPCC 2007). The CO_2 emitted from the treatment of organic waste is regarded as part of the biological carbon cycle and is therefore normally not included in calculations of anthropogenic GHG emissions.

Methane produced at SWDS contributes approximately 3-4% to the global anthropogenic GHG emissions (IPCC 2006). Although there are other sectors generating more GHG emissions, the emissions from waste are already significant and expected to increase further due to economic growth and changing consumption patterns in developing countries. This section includes a calculation of GHG emissions from waste management in developing countries in Asia-Pacific based on World Bank estimates of waste generation between 1995 and 2025. A calculation based on more recent data for 2000 is also presented.

2.1. Methane emissions between 1995 and 2025

Methane generation in SWDS depends on (i) the total amount of solid waste, which is determined by population size and affluence; (ii) composition of the waste; and (iii) the characteristics of the SWDS (e.g. climate, size/depth, pH level, and moisture). Growing populations, increased incomes, and expanding industrialisation are expected to lead to increasing amounts of solid waste and potentially escalate methane emissions from SWDS (Bogner et al. 2007; USEPA 2006).

A World Bank study (Hoornweg et al. 1999) estimated that urban per capita waste generation rates will increase by 1.14 to 1.73 times in the selected countries between 1995 and 2025. The same report also predicted significant changes in waste composition patterns by 2025. Sharp increases in waste generation and changes in waste composition will place enormous stress on limited financial resources and inadequate waste management systems. Increased waste volumes will also result in increased methane emissions if current trends in waste treatment technologies continue.

Table 6.1. Waste generation rates and methane emissions from solid waste disposal sites (1995-2025)

Country	1995 data			2025 projection		
	Urban MSW generation rate (kg/cap/ day)*	Methane emissions (kt/year)	Methane emissions (kg/cap/ year)	Urban MSW generation rate (kg/cap/ day)*	Estimated methane emissions (kt/year)	Estimated methane emissions (kg/cap/ year)
China	0.79	898.52	2.35	0.90	4,075.12	4.93
India	0.46	474.55	1.92	0.70	2,774.92	5.37
Indonesia	0.76	457.49	6.52	1.00	1,581.74	9.05
Thailand	1.10	165.33	9.44	1.50	424.39	13.58
The Philippines	0.52	127.83	3.46	0.80	451.11	5.61
Malaysia	0.81	68.91	6.08	1.40	281.11	11.09
Bangladesh	0.49	38.66	1.46	0.60	243.69	3.29
Vietnam	0.55	31.76	1.96	0.70	189.87	4.60
Myanmar	0.45	18.46	1.61	0.60	106.41	3.94
Cambodia	0.69	2.67	1.64	0.80	25.50	3.50
Lao PDR	0.69	1.33	1.64	0.80	10.41	3.50

* Data on urban MSW generation rate are cited from Hoornweg et al. 1999; MSW=municipal solid waste

Emissions of methane between 1995 and 2025 were calculated using the mass-balance methodology from the Intergovernmental Panel on Climate Change (IPCC) guidelines (IPCC 1997). Methane emissions from the selected countries are projected to increase sharply (2.6 to 9.6 times) until 2025 (table 6.1).

The projected per-capita methane emissions would increase 1.4 to 2.8 times the 1995 levels. On average, a doubling of these emissions was estimated. In addition, according to projections from the United Nations (UN) Population Division, the urban populations of the countries studied are expected to increase 1.8 to 4.5 times. From these projections, it is clear that GHG emissions from waste disposal are growing rapidly and will become increasingly important.

In 1995, methane emissions per capita were higher in Thailand, Indonesia and Malaysia than in other countries: 9.4, 6.5, and 6.1 kg per capita per day, respectively. In 2025, due to economic growth and expanding urbanisation, Malaysia would become the second highest methane emitter per capita among the selected countries.

2.2. Methane emissions in 2000

Considering the rapid economic growth of most of the target countries, and the uncertainty of the basic waste data, emissions were recalculated using more recent data. To calculate each country's amount of solid waste generated, country specific per-capita waste generation rates were compiled from various literature sources. The amount of municipal solid waste in each country was then calculated based on country specific per-capita waste generation rates and urban population data for the year 2000 (from UN statistics). For other parameters, default values from the 2006 IPCC guidelines were used (IPCC 2006).

Table 6.2. Methane emissions from MSW in selected countries in 2000

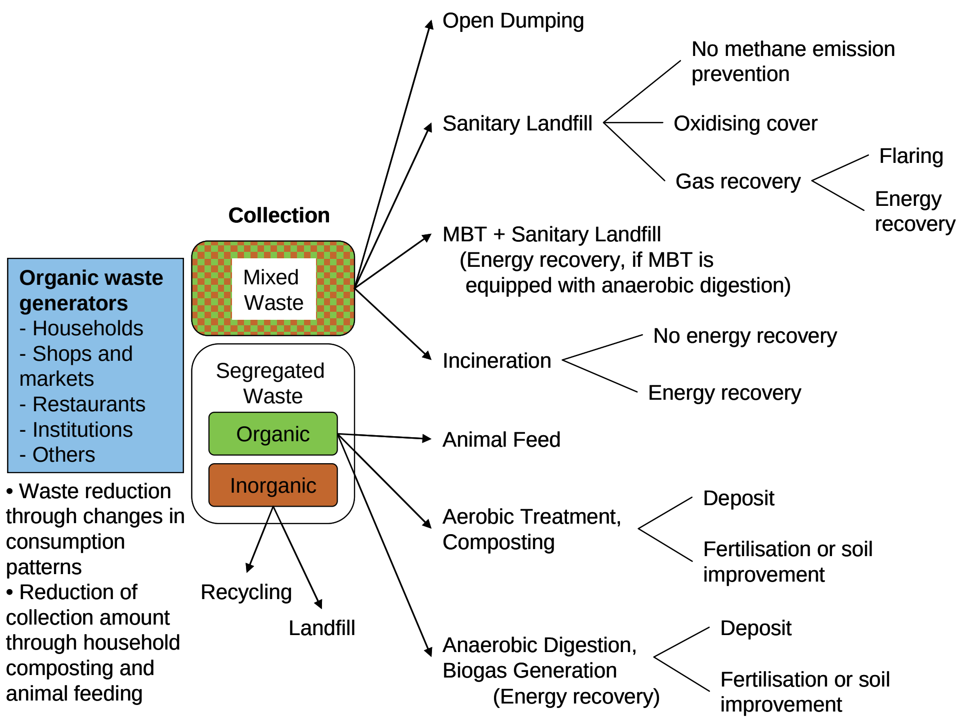
Country	MSW generation rate (kg/cap/day)	Urban population (thousands)	Fraction disposed to SWDSs	Estimated Methane emissions (kt/year)	Methane emissions (kg/cap/year)
China	1.00	456,247	0.50	2,281	5.00
India	0.47	281,255	0.70	1,121	3.98
Indonesia	0.77	88,863	0.80	663	7.46
Thailand	1.10	18,974	0.80	176	9.26
The Philippines	0.52	44,327	0.62	173	3.90
Malaysia	0.82	14,212	0.70	98.8	6.95
Bangladesh	0.49	31,996	0.50	94.9	2.97
Vietnam	0.70	19,006	0.60	96.7	5.09
Myanmar	0.44	13,290	0.60	42.5	3.20
Cambodia	0.76	2,223	0.40	8.18	3.68
Lao PDR	0.75	1,018	0.40	3.70	3.63

Total emissions in the waste sector are driven primarily by urban population size. As expected, the highest emissions occur in the most populous countries, China and India (table 6.2). These countries are also among the top five global emitters of total GHGs (Baumert et al. 2005). In 2000, emissions from the waste sector in selected countries were already 1.1 to 3.1 times higher than estimated for 1995. According to this calculation, methane emissions per capita in 2000 in China, Vietnam, Cambodia and Lao PDR already exceeded projected values for 2025. If current trends continue, a drastic increase in emissions can be expected.

3. Organic waste treatment

Open dumping and simple landfills are the most common treatment methods for municipal solid waste in developing countries. The main reason is the low investment and operation costs. However, the environmental problems related to these treatment techniques are well known and, as mentioned in the introduction, many municipalities and communities are trying to introduce improved methods. Paradoxically, upgrading open dumps to landfills may contribute to increased emissions of GHG. Methane generation is higher in deep, compacted landfills than in shallow, loosely packed open dumps because of the anaerobic conditions prevailing in the former. Hence, by introducing measures aimed at improving waste management, local authorities run the risk of shifting local problems related to health impacts, water pollution, odour and land shortage to the global problem of climate change. However, a number of alternative treatment methods exist (fig. 6.1) and more experience in using these methods is gradually being gained. This section briefly presents the main treatment methods and discusses their pros and cons from a sustainability perspective with special attention given to emissions of GHGs.

Figure 6.1. Treatment methods for municipal organic waste



Note: MBT stands for mechanical-biological treatment.

3.1. Waste reduction

Waste reduction is the most fundamental strategy for sustainable waste management, and all waste management plans should include efforts to reduce the amount of waste generated. Waste reduction has the double benefit of saving resources and reducing costs for waste collection and treatment. In developed countries, the significance of waste reduction is now well recognised (e.g. OECD 2000). In most developing countries, where per-capita waste generation is still at relatively low levels, there is less scope for reduction, but also in these countries – especially in urban areas – there are growing numbers of people who generate as much waste as people in industrialised countries. Significant waste reduction takes time to achieve and requires large numbers of households to change their consumption patterns and daily habits.

From the perspective of a municipality responsible for waste collection and treatment, households composting for their own use and feeding of domestic animals can be considered as waste reduction methods. However, in this overview, they are discussed together with other biological treatment methods.

3.2. Improved landfill-based methods

3.2.1. Landfill gas treatment

Recovery of landfill gas has been practiced since the 1970s and globally there are more than 1,100 systems installed (Willumsen 2003). Typically a closed landfill cell (section of a landfill site) is covered and the gas produced in the cell is collected through a system of pipes. The gas collected can either be flared or used as fuel. If the gas replaces fossil fuels, then gas recovery has an additional climate benefit.

In well-designed systems in developed countries, recovery rates of around 90% have been achieved. However, high recovery rates are only expected for landfills designed for gas recovery, equipped with proper cover layers and where tight pipe grids are used for gas collection. In developing countries recovery rates are typically much lower, with up to 60% leakage expected (Hoornweg et al. 1999). The guidelines for clean development mechanism (CDM) projects recommend that a recovery rate of 50% be used in project proposals. Hence, from a climate protection perspective, landfills with gas recovery systems are not entirely suitable for treating organic waste.

Methane emissions from landfills can also be reduced by using oxidising cover layers. Such layers need to be kept well-aerated so that methanotrophic bacteria, which can only be active under aerobic conditions, can decompose the methane. The efficiency of oxidising layers is sensitive to layer thickness, layer substrate, temperature and humidity, but removal efficiencies up to 75% have been reported (Chiemchaisri 2008).

An alternative approach is to reduce methane generation through aeration of the whole landfill. By installing a piping system and pumping air into the landfill cells, it is possible to reduce the prevalence of anaerobic conditions and thereby also methane generation.

3.2.2. Mechanical biological treatment

Mechanical-biological treatment (MBT) is a group of hybrid methods where unsorted waste undergoes pre-treatment before disposal in landfills. There are many possible designs, but a common MBT pre-treatment system includes (i) mechanical separation where recyclable materials such as ferrous metals and plastics are removed; and (ii) biological treatment where the organic fraction is partly degraded. The biological step can include both anaerobic and aerobic treatment, generating biogas which can be recovered. MBT can reduce the volume of the waste by up to 40% and lower the leakage and gas emissions from landfills significantly (Visvanathan et al. 2005). If the treated waste contains low levels of pollutants, it can be used for landscaping instead of being deposited in a landfill, but not for food production.

Several MBT systems are in operation, mainly in Europe. In China and Thailand; some MBT systems have been installed through financial and technical assistance from Germany. In most of these cases, the technology is simplified with more manual separation and only aerobic treatment. At present it is difficult to assess the potential of this method for developing countries.

3.3. Thermal and biological treatment methods

3.3.1. Incineration

Incineration of municipal solid waste is widespread in industrialised countries and currently more than 600 facilities are in operation worldwide. Incineration has a number of advantages, which can explain its widespread use (Bogner et al. 2007). It effectively eliminates the hygienic hazards of organic waste and decreases the waste volumes drastically. Methane generation is completely avoided and the process can also generate electricity and heat which can replace energy from fossil fuels.

However, few developing countries are successfully incinerating municipal waste. Waste in developing countries typically has a low calorific content compared to developed countries. The waste is often relatively wet, especially in the tropics, and extra fuel, typically coal, may have to be added (Solenthaler and Bunge 2005). As a consequence, the recoverable energy is low and the cost high. The investment costs for incineration plants are high compared to other options, and the technology used is advanced. In many cities, incineration has met strong opposition because of emission of highly toxic dioxins and other pollutants. It is possible to reduce these emissions to very low levels by advanced flue gas treatment, but this makes the investment costs for incineration plants significantly higher.

3.3.2. Composting

Composting is an aerobic process where micro-organisms decompose organic materials under controlled conditions. The process reduces the waste volume to about one third. Composting can be applied at various scales, from individual households up to large centralised facilities with capacity for several hundred tonnes of waste per day. A number of composting techniques exist; some are manually operated while others aerate the decomposing waste mechanically; some rely on micro-organisms that exist naturally, while others add worms (vermicomposting) or specialised microbes to speed up the process. The residual product is pathogen free and it can be used for improving soil structure and for adding nutrients to soil. Almost all types of soil can benefit from adding compost, especially sandy and clayey soils, which contain little organic matter. In arid regions, compost helps to improve the water holding capacity of the soil. Composting can be a resource for urban and peri-urban agriculture and generate income for urban households (or municipal governments) if farmers are prepared to pay for the compost. Composting has been practiced for a long time in rural areas, and it is therefore not a new and untried method. However, there are some risks and disadvantages of composting; bad smells can occur and vector-borne diseases can spread if the composting process is poorly managed. In general, composting is technically uncomplicated and may be an economically realistic alternative to using landfills for many municipalities in developing Asia.

Under ideal conditions, composting does not generate methane, but under real conditions there is a risk of some emissions caused by anaerobic decomposition. This risk is high if the composting process is poorly managed, especially if the substrate is not sufficiently aerated or becomes too wet. Small emissions of nitrous oxide (N_2O) may occur, but studies have shown that the amounts are small and negligible compared to the emissions saved through avoided landfill gas generation. Recent research has shown that certain types of vermicomposting can generate significant amounts of N_2O (Hobson et al. 2005). These initial findings indicate a need for more research to be conducted before any sound recommendations on vermicomposting can be given. Since the amount of emissions from composting depends on the specific composting method used and on how well the process is managed, it is not possible to give a definitive answer to the question of how much composting contributes to climate change. Most studies on emissions from composting have been carried out in developed countries where conditions differ from the target countries of this study. Nevertheless several environmental agencies have concluded that when composting is done properly, it generates very small amounts of GHGs (e.g. MFE 2002).

3.3.3. Anaerobic digestion

Anaerobic digestion has been used for many years for the treatment of agricultural waste, organic industrial waste and sewage sludge, but only in recent years has it been used for municipal waste. The process used is basically the same as in a compacted landfill—micro-organisms decompose the organic matter in an oxygen-free environment and generate gas with a high proportion of methane. The process takes place in a closed tank and the gas is collected. Anaerobic digestion generates fewer odours than composting and a digester requires less space than a composting facility with similar capacity. The gas can be used for energy generation, replace fossil fuels, and the residue can be treated in an aerobic process and used as fertiliser. In theory, anaerobic digestion has many advantages and there are several systems in operation, although mainly in industrialised countries.

Under real conditions some leakage of methane from digestion tanks and gas powered combustion engines cannot be avoided. A study in the United Kingdom found emissions from digesters at farms in the range of 3.4 to 8.4%, and a Danish study estimated fugitive losses in gas powered engines at 3.5% on average (Reeh and Møller no date). However, it is reasonable to assume that in developing countries average losses will be higher and in individual cases may be considerably higher.

3.3.4. Animal feed

The use of food waste as animal feed has been practised for as long as humans have kept domestic animals. In rural areas this is still common, but in large cities the demand is usually very limited. There are examples in China, Cambodia and Thailand where food waste is collected for animal feed on a relatively large scale, but in general this option can only be expected to play a minor role in organic waste management.

3.4. Evaluation of organic waste treatment options

Generally disposal of organic waste in landfills without pre-treatment or gas control is undesirable from a sustainability perspective and therefore should be avoided. Landfill gas recovery and the use of oxidising landfill covers have important roles to play for reducing future GHG emissions from old landfills and landfills that are currently in operation. However, municipalities considering constructing new landfills for untreated organic waste, even if equipped with gas recovery systems, should consider that (i) GHG emissions will still be relatively high; (ii) valuable nutrients will be lost or mixed with pollutants; (iii) the land could be used more productively for other purposes; and (iv) the risk of water contamination cannot be eliminated.

Incineration is too costly or unfeasible for many cities in developing countries, and cannot be regarded as the main option for waste treatment in the region. However, in some of the newly industrialised countries, if there is public support for the method, incineration is expected to play an important role. MBT should mainly be regarded as a pre-treatment method, which can reduce some of the problems related with landfills.

From a sustainability perspective, the biological treatment methods (composting and anaerobic digestion) have considerable advantages. They can drastically reduce the emissions of GHGs, recycle nutrients and be introduced on a small scale at low cost. Studies reported in the literature do not agree on which of these methods is the least costly, but they are both much less expensive than incineration. Anaerobic digestion is technically more complicated than composting and to function well the process needs to be operated by professional staff. Composting can be labour intensive and therefore generate more jobs. Low investment requirements make composting especially suitable for projects with limited funding. Together with its low-tech nature and the possibility to introduce it at a very small scale, composting is a highly suitable option for community-driven waste management initiatives. A recent study by Barton et al. (2008) came to the same conclusion and identified composting as the first option to consider when replacing open dumping in developing countries.

For these reasons, the rest of this chapter concentrates on composting, and how national and local policies can support composting initiatives for improved waste management with climate protection benefits. However, this does not imply that composting is regarded as the best treatment option for all kinds of organic waste in all cities. Usage of generated compost in food production requires effective prevention of contamination and this is not possible for all waste streams. Even so, composting can play an important role in many cities—especially cities with large slum areas where living conditions are blighted by uncollected rotting waste and where the municipality has limited capacity to collect and treat the waste properly.

The treatment methods described above are not necessarily competing options. Based on local conditions, municipalities and other local actors need to combine options into an integrated system that can realise the synergies of different methods. Factors such as the amount and composition of waste, the economic conditions, past experience with various treatment methods, households' willingness to segregate their waste at source, the availability of nongovernmental organisations (NGO) or community groups with waste issues on their agendas, land availability, and the demand for organic fertilisers influence which methods can be successful. Typically the best system will be based on a mix of treatment methods, and all systems have to be adapted over time in response to changing conditions.

4. Composting of municipal solid waste

This section investigates urban composting in developing Asian countries and looks at policies to promote composting in the region. First, it describes the current situation regarding carbon financing of projects in the waste sector in Asia. Second, it presents an overview of national policies related to organic waste management and briefly describes the current composting situation in five developing Asian countries. The countries included are those with the largest calculated GHG emissions from the waste sector (table 6.2). Next, six local cases where composting is playing an important role are described and analysed. Finally, based on the national overviews and the analysis of local experience, improvements in national and municipal policies to support urban composting are suggested.

4.1. Climate policies and the waste sector

At present, climate change concerns do not have a major influence on decisions concerning municipal waste management in the cities of developing Asian countries. Other factors such as public health and costs are given priority. However, within the next few years developing countries in Asia, like all other countries, will have to face the dangers of climate change and take action to limit their emissions. This will require action by all relevant sectors of society, including waste treatment. Thus, there are good reasons to investigate how national policymakers can stimulate municipalities, communities and other local actors to develop more sustainable waste management systems with a low impact on the climate.

One of the linkages between climate policies and the waste sector is CDM under the Kyoto Protocol. CDM projects make it possible for developed countries to fulfil some of the emission reductions mandated by the Kyoto Protocol through climate protection projects in developing countries. CDM projects are awarded certified emission reductions (CER) in proportion to the amount of GHG emissions they can reduce. The CERs can be sold and generate income for further modernisation of the waste disposal systems. In 2007, the average price of CERs was reported to be $10.90 per tonne of carbon dioxide equivalent (tCO_2e) (Cooper and Ambrosi 2007).

As of the end of February 2008, 948 CDM projects were registered globally and 558 of these were located in Asia. For the waste sector, 256 projects were registered globally, but only 63 projects in Asia; or 24.6%. The most active Asian countries are Malaysia (18 projects), India (13), the Philippines (12) and China (10) (CDM Project Activities Database 2008).

The most common kind of CDM project related with municipal solid waste is landfill gas recovery, but recently a methodology for calculating CERs for composting projects has been developed and the first CDM project on urban composting was registered in Dhaka, Bangladesh, in 2006. The composting experience in Dhaka is described in section 4.3.2 below. Since then, CDM composting projects in China and India have also been registered. In principle, any composting facility above a certain size could qualify for CDM provided that the project can present credible baseline data. However, it can be concluded that CDM financing is a relatively new opportunity which seems to be underutilised at present.

To provide a rough estimate of the economic value of the GHG emissions from the waste sector in each country, the average value of the CERs was applied to estimated methane emissions (table 6.3). The results show that if it were possible for all methane emissions to be avoided and converted into CERs, the annual revenue would be over $400 million. To put these potential revenues into perspective, compared to the estimated total annual expenditure for waste management in each country[1], the range is 13-60%. This is likely to be an overestimation, however, since per capita spending on waste management is lower in smaller cities and towns. Although the results should be viewed with great caution, they indicate that the potential revenues from carbon financing are significant when compared with the current expenditures.

Table 6.3. Economic value of GHG emissions from landfills compared with municipal solid waste expenditure in selected countries

Countries	Methane emission (thousand tonnes/ year)	CO_2 emission equivalent (thousand tonnes/year)	Potential revenue ($'million)	MSW expenditure ($'million /year)	Potential revenue divided by MSW expenditure (%)
India	1,121	28,025	305	506	60
Bangladesh	949	2,373	25.8	46.7	55
The Philippines	173	4,325	47.1	177	27
Malaysia	98.8	2,470	26.9	213	13
Vietnam	96.7	2,417	26.3	66.5	40

4.2. National waste policies and composting

4.2.1. China

MSW management in China is mainly regulated by the Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste. This law sets a target to fully and rationally utilise solid wastes (FAOLEX 2004). The Technical Policies for Municipal Refuse Disposal and the Prevention and Control of Pollution of 2000 identifies landfills as the first MSW treatment option, to be used where land is available, and incineration as the main alternative. However, the Technical Policies also state that "[a]ppropriate biological disposal technology shall be actively developed…" and it contains a separate section on how composting should be carried out (SEPA 2000). The current ratio of landfills is more than 85% of the total, and only a few landfills are equipped with gas recovery systems (Wiaofei 2008). It appears that biological treatment is primarily regarded as a supplement to the two main methods of landfill and incineration. In China, there are also a number of other laws relevant to waste management. A World Bank study (2005) concluded that the legal system on solid waste is complicated and it includes both overlaps and areas where no agency is responsible.

According to Huang et al. (2006), approximately 7% of the MSW generated in 2002 was composted but this figure is considerably higher than the 4.8% officially reported to the UN in 2003 (UN Statistics 2007). Xiaofei (2008) reported that composting is on a downward trend and that the treatment capacity decreased from 8.8% in 2001 to 4.3% in 2005 mainly due to inferior quality of compost and unfavourable market conditions. A number of cities operate relatively low technology in-vessel composting systems with some success, but many facilities using large-scale technology have faced technical problems and have been shut down. The compost quality of such facilities has typically been low because mixed wastes containing metals, ash, plastics and glass have been composted. Such inferior quality compost can be used only for limited applications (World Bank 2005) and the production cost of compost has been reported to often exceed the market value (Rissanen and Naarajärvi 2004). Initiatives on composting seem to come mostly from the local governments. Compared with other countries, community groups and NGOs seem to play a minor role in waste management, perhaps with the exception of waste pickers (World Bank 2005).

4.2.2. India

India's MSW (Management and Handling) Rules of 2000 clearly stipulate that the amount of waste disposed to landfills must be minimised. The rules further state that: "[t]he biodegradable wastes shall be processed by composting, vermicomposting, anaerobic digestion or any other appropriate biological processing…" (MOEF 2000) Specific instructions on composting and quality standards for compost are also included. However, by 2004, few municipalities had started to follow the new rules (Gupta 2004). To expand composting activity, an Inter-Ministerial Task Force on Integrated Plant Nutrient Management has recommended building 1,000 composting plants all over the country and has allocated over $200 million for this purpose (Gopal 2006). However, it is difficult to make composting financially viable since the Government also provides subsidies for chemical fertilisers (Zürbrugg et al. 2004).

In 1997, it was estimated that around 10% of India's MSW was treated by composting (SOE Asia 2000). However, since this estimate is over 10 years old, it may not be relevant to the current situation. In Delhi, the most densely populated city, it has recently been reported that 9% of the collected municipal solid waste is composted (Talyan et al 2007). There are a large number of centralised composting facilities all over India, typically with capacities of 100-700 tonnes per day (t/d). Most of these facilities are operated by private companies on contracts from the municipal authorities and treat only waste from food markets. However, there are also many cases where centralised composting projects have failed and the facilities have been shut down. A common problem for such facilities has been difficulties in marketing the products.

Since the 1990s, small manually operated composting plants at the community level have been initiated by citizens' initiatives and NGOs. This practice has spread to many major cities including Bangalore, Chennai, Pune and Mumbai (Zürbrugg et al. 2004). For Mumbai, it has been reported that community composting has reduced the municipality's costs for waste treatment (Sarika 2005).

The high price of land is a problem for most urban composting initiatives, but in many cases municipalities provide land for free or at a moderate rent. This is common both for initiatives run by community groups and by private entrepreneurs (Ali 2004). Another common obstacle is the difficulty in borrowing money for investments in composting plants. Banks regard waste treatment initiatives as high-risk projects and demand high interest rates or are unwilling to provide loans (ibid.).

4.2.3. Indonesia

In 1999, Indonesia decentralised responsibility for many urban services to the local authorities. The role of the central government became mainly to provide guidance and technical assistance to the local level. However, local governments have limited financial capacity and do not have sufficient technical and managerial skills to plan, develop and operate effective MSW collection and treatment systems (Sanitation Country Profile 2004). Since 2004 the Government has been preparing an umbrella law to improve its regulation of local MSW management, but this is still only at the drafting stage (WALHI 2007).

Waste management is recognised as a major problem in cities in Indonesia and it has caused several conflicts. Some NGOs are very active on waste issues and attempts to construct new dump sites or incinerators have often been met with strong resistance.

In 2000, it was reported that 1.6% of the solid waste generated in urban areas was composted (Sanitation Country Profile 2004). Decentralised composting is promoted by several NGOs in a number of cities, including the capital, Jakarta (Pasang et al. 2007).

4.2.4. Thailand

In Thailand, four major laws on MSW management have been passed since 1992, but composting is not specifically mentioned in any of them. In 1998, however, the Ministry of Industry identified composting as an alternative waste disposal method for industrial waste (MOI 1998) and in 2005 the Ministry of Agriculture and Cooperatives strengthened its quality standards for compost and bio-fertilisers.

One factor motivating composting in Thailand is the national strategy to develop an export-oriented agro-food industry with a healthy image. Therefore, a number of composting projects are driven by the Ministry of Natural Resources and Environment and additional projects are currently being proposed by authorities at provincial, district and sub-district levels. Furthermore, research on improved household composting methods is currently being undertaken at several Thai universities (Thaipost 2004; Tripetchkul and Chaiprasert 2003).

To save energy and promote alternative energy production, in 2007 the Ministry of Energy and the Ministry of Interior signed a memorandum of understanding to cooperate on energy and MSW management. The two ministries have set a target that generated organic waste shall be used beneficially through the promotion of fuel production, composting for fertiliser, and production of fish feed (OPT 2007).

4.2.5. The Philippines

In 2000, the Philippines passed its Ecological Solid Waste Management Act, which stresses the need for waste reduction, segregation at source and recycling. Incineration of MSW is explicitly prohibited according to the Clean Air Act of 1999. The Ecological Solid Waste Management Act emphasises the role of composting and requires the barangays, which are the smallest local government units in the Philippines, to develop ecological solid waste management programs, and to establish Materials Recovery Facilities (NSWMC 2000).

However, implementation of the Act has been difficult and in 2007 only 1,714 facilities had been established by about 4% of the barangays (Ecowaste Coalition 2007). Disregard for regulations and laws, lack of political will, insufficient funds, lengthy and bureaucratic procedures, inadequate technical capacity, insufficient number or inappropriate collection vehicles, and an inability to reach out to households have been identified as some of the main implementation problems (Globe-Net 2007). Sapuay (2006) pointed out that the Act is more focused on technical details than on how to create incentives for change and that the penalties for violating the law are so low that many local actors choose to risk the penalty rather than improve the MSW system. In addition, Chiu (no date) noted that the Solid Waste Management Fund required by the Act has not been established.

In 1997, it was estimated that 10% of the MSW was composted (SOE Asia 2000), but there are no recent estimates available. Where composting has been successful it seems mostly to have been activities initiated by NGOs or community groups, or in some cases by the local governments or barangays. There is a growing market for organic food in the Philippines, and the Department of Agriculture is promoting the use of organic fertilisers. Even so, it has been reported that many composting initiatives have difficulties finding a market for their product (Chiu no date).

4.2.6. Analysis and policy recommendations

The most striking observation is that the two largest countries in the region have set very different priorities in their national waste policies. China regards landfills as the main treatment option, while India strongly avoids them. The Chinese policies also support incineration, an option that is prohibited by law in the Philippines.

All countries have composting systems in operation in several cities, but currently only a minor share (10% or less) of the MSW is composted. However, reliable statistics are lacking and the reported figures are uncertain. Compared with some European countries, the composting share of waste treatment is low, even though the MSW in developing Asia contains more organic matter, and therefore is more suitable for composting.

Both India and the Philippines have advanced legislation on MSW treatment that emphasises the need for waste reduction, segregation at source and biological treatment. The national policies and strategies of China and Thailand also stress these elements of waste management, although not to the same degree. However, all of the countries seem to share a lack of capacity to enforce the laws in order to meet the objectives. The laws require local actors to reform their solid waste management systems to meet high environmental standards, but local governments generally lack the necessary financial capacity and technical knowledge. There are few initiatives from central governments to help local actors meet the requirements stated in the laws.

Composting concerns several governmental departments and there is a clear need for effective coordination. Waste regulation is typically handled by the Ministry of Environment, but sustainable composting, where the product is used for soil improvement, needs support also from other government bodies such as the Ministry of Agriculture. To expand composting it is important not only to stimulate the production of compost but also to promote increased use among farmers. An inter-ministerial body may be needed to coordinate supply oriented and demand oriented policies.

Subsidies to mineral fertilisers are a particular obstacle to increased use of compost and other organic fertilisers. If governments want to promote the beneficial use of compost, these subsidies must be reduced or extended to cover organic fertilisers. Other forms of financial support from national governments could include tax reductions or exemptions for compost and composting equipment.

The demand for organic food is growing, both in the countries studied and in their export markets. This creates an increasing demand for organic fertilisers such as compost. However, despite this trend, many composting initiatives face difficulties in finding markets for their products. The producers of compost and the potential buyers seem to have difficulty in finding each other. Here, national governments can play a role in improving the compost market by reducing transaction costs. Official quality standards for various grades of compost, quality control systems and labelling schemes can be important policy tools. Avoiding contamination of compost is a prerequisite for its sale and safe usage, and experience shows that this requires careful segregation at source. Efforts to develop partnerships between composting initiatives and fertiliser companies can also be effective. Since many composting initiatives are operating on a small-scale, they typically have very limited capacity to search for potential buyers. Likewise, many organic farmers have difficulties in finding reliable suppliers of fertilisers. Especially for such small and medium-sized actors, databases where buyers and sellers can get in contact can be helpful. Farmers' associations and networks of composting initiatives can play an important role as information brokers and governments can encourage them to become more active in this respect.

Composting activities can be initiated by various actors. Although it is usually the local governments that are formally responsible for waste management, in some countries it is more common to find composting schemes run by NGOs or community groups than by the government. To facilitate such initiatives, local governments need to develop their waste management plans in dialogue with citizens. Therefore, stakeholder involvement in local waste management planning should be required in the national waste legislation.

4.3. Composting in municipal waste management – six case studies

The six cases presented below illustrate different approaches to composting, including community-driven activities and projects initiated by the local government, household composting and centralised systems. The cases also represent different types of cities or towns; Bangkok and Dhaka are national capitals and mega-cities, Nonthaburi and Surabaya are large cities, while Phitsanulok and San Fernando are both small towns. The composting initiatives in Dhaka and Surabaya have gained international recognition as good examples, while San Fernando in the Philippines is a less well known case with an interesting model for cooperation between the local government and community groups. The three cases from Thailand – Bangkok, Nonthaburi and Phitsanulok – represent different types of cities and show varying degrees of success in promoting composting. Each case study includes a short background, identifies the main actors and their roles, describes the main characteristics of the composting scheme, and presents some lessons that other cities can learn from. Table 6.4 provides an overview of the six cases.

4.3.1. Bangkok

Bangkok has a permanent population of around 5.5 million and a population density of over 3,600 persons/km^2. Waste generation is about 8,369 t/d, which equates to 1.5 kg/capita/day. Bangkok has tried household composting but currently collective composting carried out by a private company is the main activity.

The Bangkok Metropolitan Administration (BMA) promoted household production of liquid fertiliser from food waste in a campaign from 1999-2002 (BMA 2005). Households were provided with effective micro-organisms to stimulate the waste decomposition. This method is quick and the whole process takes only a few weeks. The liquid product can be applied as organic fertiliser or used as a deodoriser in restrooms for example. BMA is no longer supporting this activity and the current scale of household composting is unknown. Recently, interest in household composting has been revived and a project assisted from Kitakyushu City, Japan, which builds on experience from Surabaya is ongoing (Baitragul 2007).

Table 6.4. Comparison of the local case study composting initiatives

Location	Bangkok, Thailand	Dhaka, Bangladesh	Nonthaburi, Thailand	Surabaya, Indonesia	Phitsanulok, Thailand	San Fernando, The Philippines
Composting initiator	Metropolitan Administration	NGO	Municipality	NGO	Municipality	City/Community Council (Barangay)
Main implementing stakeholder	City government and a contracted private company	NGO	City government	NGO, City government and housewives	City government	City government
International cooperation	Japan	UNDP and UNESCAP	EU: Asia Urbs project	Japan	Germany	None
Waste source	Households and organisations generating large volumes of waste	Households and markets	Markets	Households and markets	Households	Households
Quantity of organic waste composted (ton/day)	1,000	13-14	0.6	>40	No data, small quantity	~ 1
Incentive/subsidy	Basket	Government provided land free of charge	None	Basket distribution based on income	Compost box and marketing support in the early stage	City government provided shredder and purchased the compost produced
Composting scale	- Household - Centralised large scale	Community	Centralised small scale	Household and community	Household	Community
Composting technique	- A newly developed windrow method - In-vessel composting	A newly developed windrow method	Bio-cell	A newly developed windrow method	Windrow: bamboo and cement boxes	- Drum-composting - Vermicomposting
Compost market & use of product	- Household use - Sale to farmers by company	Sale by the NGO to a fertiliser producer	Sale to farmers by the municipality	- Household use - Sale to market - Used by City government	Household use and sale to market	Use for landscaping projects and nurseries by the City government

In addition to household composting, BMA has also developed a system for centralised composting. Since early 2005, the city collects sorted organic waste from selected target sources including education institutions, department stores, hotels, markets, hospital, and housing estates and transports it to a composting facility near one of three transfer stations. The facility, which is operated by a contracted company, has a capacity to treat 1,000 t/d of organic waste, equivalent to a production of 300 t/d of compost (BMA 2006). The facility employs around 100 people. The cost for the municipality is $15 per tonne of waste, which is about the same as the cost for landfill (BMA 2005). The compost is sold to farmers at a price of approximately $60 per tonne.

The Bangkok case illustrates that household composting initiatives are difficult to sustain if there is no continuous support. It is also an example of a city that has chosen to outsource its waste treatment to the private sector.

4.3.2. Dhaka

Dhaka, the capital of Bangladesh, has a population of 7 million, and its waste generation is 3,200-4,000 t/ d. The city currently collects less than half of this waste and the rest remains on roadsides, in open drains and in low-lying areas thus impacting the environment and endangering public health.

In response to these problems, an NGO called Waste Concern started a community-based composting project in Dhaka in 1995. This activity is based on public-private and community partnerships, where the public sector is providing land for composting facilities, the NGO is providing technical support and implementing the project, private companies are marketing the compost product, and households are participating by paying a monthly fee of $0.22 for house to house collection. The original composting facility initiated by Waste Concern was serving 1400 households with a capacity of 3 t/d and produced 0.75 t/d of compost. Two currently operated facilities receive 1.75 and 2 t/d of waste respectively from 1800 households in total. The compost is marketed to farmers through cooperation with a fertiliser company and generates revenue of $37-74 per tonne. In 1998 the national Government recognised the activity of Waste Concern and extended composting practices to other parts of the country with support from the United Nations Development Programme (UNDP). As a result so far, 26 cities and towns are replicating this model. Apart from Bangladesh, the model is being replicated in Viet Nam and Sri Lanka through support from the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP).

The composting activity in Dhaka is unusual as residents are willing to pay a collection fee although the composting activity is fully operated by an NGO, not by the local government. The operation is financially self-sustaining and the only subsidy received is that the Government provides land for the composting facility free of charge. This case shows that source segregation by urban households is possible to achieve and that compost from a mega-city can be of high quality and sold profitably to farmers.

In 2006, a plan for a large scale composting initiative in Dhaka was registered as a CDM project by Waste Concern together with a Dutch partner and in co-operation with the Government. The project marks the first time that a composting project was registered for CDM. The estimated climate benefit of the project is 89,259 tCO_2e/yr (CDM Project Activities Database 2008). From March 2008, this project started its operation of a 10 t/d facility for market waste and by August 2008 this capacity will be increased to 130 t/d and also include household waste. The planned capacity to be reached by 2009 is 700 t/d.

4.3.3. Nonthaburi

Nonthaburi is a suburb of Bangkok with about 270,000 inhabitants and a population density of 6,900 people per square kilometre. Daily waste generation is about 360 tonnes. The main activity is centralised composting of market waste operated by the municipality.

In 2002, the municipality started to promote household composting using effective micro-organisms. This activity is still going on but there is no information on how many households are currently involved. Since 2005, the municipality has run a composting centre, where approximately 4 t/d of waste from food markets is treated. This centre was built with financial and technical assistance from the European Union (EU). The compost quality is high and it is sold to farmers. The income supports part of the operating cost for the composting centre, but the municipality views composting mainly as a waste treatment method and not as a revenue source. The municipality estimates that it saves about 1.5% of its waste management expenses as a result of the composting centre.

Currently, the municipality focuses on the composting centre rather than on promoting household composting. The case of the Nonthaburi compost centre is an example of how a municipality can start composting by treating waste only from a single accessible source. Market waste is highly suitable for composting since it is relatively free from pollutants and inert materials. Furthermore, unlike household waste, market waste is easy to collect and there is no need to convince households to segregate their waste, making it possible to get started quickly. Hence, market waste composting can be an entry point for a municipality through which they can gain experience and evaluate the technology. However, market waste is only a small portion of the total amount of MSW, so impact on reduced landfill disposal is limited.

4.3.4. Surabaya

Surabaya, the provincial capital of East Java, is the second largest city in Indonesia with a population of around three million. Surabaya has a collective composting system as well as household composting. In total, more than 40 t/d of waste is composted, around 30 tonnes from markets and 10 tonnes from households. Surabaya city has achieved about 10% reduction of waste (from 1,500 t/d in 2005 to 1,300 t/d in 2007) through composting and waste segregation at source. What makes the city unique is its success in implementing widespread household composting.

In 2000, a university-based NGO called Pusdakota was running campaigns trying to increase people's awareness around waste issues. Pusdakota also took the initiative to start some composting projects. At that time the system for collecting and treating MSW in Surabaya was in poor condition and many citizens were concerned about the situation. When the city's only landfill site was closed due to protests from neighbours, the waste management system in one part of the city essentially collapsed and the situation became unbearable during the transition period to a new landfill. In 2004, the Japanese organisation Kitakyushu International Techno-cooperative Association helped improve waste management in Surabaya and provided technical assistance on composting. The severe waste related problems seem to have motivated people to take action to improve the situation and over the following years small-scale household composting gradually became common. The city government became interested at an early stage and supported the replication of the composting practice in other areas of the city.

Households can use the compost themselves or sell it. However, for most households, it is not the income from the composting that is the primary motivator but rather the hygienic improvement and visible upgrading of the local environment. Composting is supported by many housewives in particular and efforts to spread composting actively target this group. Composting is carried out in special baskets subsidised by the city government and the technique is relatively easy to handle.

In addition to household composting, a collective system has been developed. This receives waste both from markets and households that cannot compost themselves or that prefer door-to-door collection. The compost product is used by the city government for parks and green areas. The city government has replicated this system by setting up 13 composting centres. NGOs and community groups are involved in collecting organic waste from households and bringing it to these centres. In many cases they are also trying to introduce household composting in the areas where they operate.

Pusdakota has sold nearly 20,000 units of household composting baskets in three years and their approach has also been adopted by other cities in Indonesia. The leading actors in this case are NGOs, community groups and the city government, supported technically by foreign expertise and financially by the private sector.

4.3.5. Phitsanulok

Phitsanulok, with a population of around 80,000, is the hub of socio-economic activity in the lower northern part of Thailand. Waste generation is 1.6 kg/capita/day, or 131 t/d. Composting is carried out at both household/community and municipality levels on the initiative of the municipality.

In the late 1990s the mayor of Phitsanulok started a composting programme based on household composting and small-scale collective composting, with financial and technical assistance from Germany. Households could either do the composting themselves or leave their organic waste to compost centres. The initiative was well received by the residents and composting increased gradually. In Thailand, Phitsanulok became known as a success story and visitors from other parts of the country came to learn from its experience. The municipality received funding from the Ministry of Natural Resources and Environment to carry out training sessions for staff from other municipalities.

After a few years, in spite of the initial success and publicity, the composting activity declined. Some new local community leaders were not as enthusiastic about composting as their predecessors. In addition, households were less willing than before to compost or segregate their waste. They claimed that the composting process was slow and that the time spent on composting did not pay off. The younger generation feel that they have little time to spend on composting and it is mostly in households where a senior person takes care of the compost that the activity continues. As a result, currently, only a small amount of waste is composted.

To improve the treatment of the organic waste that was not composted, Phitsanulok received additional financial assistance from Germany to build an MBT facility. Now operating for a few years, it takes care of all the waste that would otherwise have been disposed directly to landfill. The process degrades the organic waste under aerobic conditions to reduce volume, to stabilise the organic material and to reduce methane emissions from the landfill. Since the waste is not properly segregated at source, the residues are contaminated and not suitable for use in food production. Approximately 80 t/d of waste are brought to the treatment facility.

The municipality is currently planning to hire a private company to run its composting centre and to develop it further. Based on earlier experience with household composting, the municipality regards a centralised system as the only feasible solution. The municipality will pay the same amount or less as the current MBT and landfill operations, while the private company will own the compost and sell it for extra profit (Hantrakul 2007).

4.3.6. San Fernando

San Fernando is a regional capital in the Philippines with a population of around 120,000. It represents a well-functioning community-based composting system.

In San Fernando, the barangays (communities) collect segregated waste including organic waste from each household and compost it using a mechanical rotating system and vermicomposting. The municipality purchases the compost at a fixed price, thereby guaranteeing an income for the barangays. For additional income the barangays also sell recyclable wastes to junk dealers and charge collection fees for each household. When residents have to pay, they also demand a good service, so this system puts some pressure on the barangay leaders to provide good quality services. Some barangays have been able to buy their own waste collection trucks with the money earned from waste collection and recycling together with subsidies provided by the municipality. In some cases these barangays have expanded their waste hauling services into other barangays.

Since the barangays reduce the amount of waste and transport the remaining wastes to a landfill by themselves, they save money for the municipality. The money thus saved can be used to subsidise barangays that want to buy collection trucks and to cover the extra costs related with the guaranteed compost price. This model for financing community-driven activities, where the municipality's savings from reduced need for transportation and landfills are shared with those who do the extra work, seems to be successful and possible to replicate.

4.3.7. Analysis and policy recommendations

The cases presented illustrate that there are various types of composting initiatives. The waste sources targeted, the leading actor, the scale and technology used, and the intended use of the end product can differ. It is not possible to say that any specific model is most likely to succeed. The two cases with the largest amounts of waste composted – Bangkok and Surabaya – represent very different approaches. In Surabaya composting was a bottom-up process and engaged a significant number of households, while in Bangkok the activity is driven by the city government and focuses on composting waste from selected sources in a large-scale facility.

In most cities, households are the largest generators of organic waste and cities that want to achieve substantial reductions of landfill disposal need to develop solutions for this waste stream. The cases show that composting of household waste is a challenge but some initiatives have succeeded. Careful sorting at source is crucial for projects that need to create revenues by selling their product to farmers. The knowledge and motivation of the households is therefore a key factor. However, the Phitsanulok case shows that households' motivation needs to be continuously maintained. Good results at the beginning are no guarantee for success in the long run.

The reasons for citizens to participate are not necessarily economic as mentioned in the Surabaya case. While an economic benefit can make the introduction of composting easier, the local environmental improvement can be more important for many households. A cleaner neighbourhood is a tangible benefit which appears after a short time. Ironically, this means that it may be easier to engage households in areas where the waste collection system is in a poor condition, while households that are used to frequent door-to-door collection may be less motivated to participate.

Different actors have different goals and reasons for their interest in composting. In a typical case, households want clean and healthy neighbourhoods, the municipality wants low waste management costs and satisfied citizens, an environmental NGO wants low levels of pollution, entrepreneurs want profits, waste pickers and unemployed want stable jobs, and farmers may want safe and cheap soil improvers. It can be difficult to fully satisfy all these interests, and one model of composting might meet the goals of some actor groups but not of others. When planning composting projects it is important to clarify the expectations of each stakeholder group and evaluate how a proposed model can meet these expectations. Initiatives that can only meet the expectations of some actors, but actually need the cooperation of others in order to be successful, are likely to fail.

Composting requires continuous effort and quick results should not be expected. The successful cases typically started small and expanded over a number of years. Experience shows that good practices do not automatically spread even to a neighbouring community. Leaders with the ability to engage and encourage groups with different interests are needed.

Many different skills are required for success in composting initiatives. In addition to the technical know-how to carry out the composting, skills in marketing to the agricultural sector and in conducting awareness-raising and education campaigns directed at households may be needed. All these skills usually cannot be found in one single organisation, so the establishment of networks and partnerships is very important.

International cooperation played an important role in some of the cases presented. Development aid organisations can provide vital investment capital and technical expertise that may be lacking. By being active in a number of countries, these organisations can accumulate extensive experience from both successful cases and failures. Aid organisations are in a unique position to transfer know-how from one developing country to another. However, municipalities receiving financial support must be careful about how this affects local entrepreneurs and other actors, such as waste pickers, already involved in waste collection and treatment.

Financial assistance from the local government is vital for composting initiatives run by community groups or NGOs. It is difficult to make composting self-financing through the income from compost. Assistance can be of various kinds as shown by the cases presented; (i) direct subsidies to composting equipment as in Surabaya; (ii) subsidies to support the purchase of waste collection vehicles as in San Fernando; or (iii) in the form of land that is provided for free or at low rent as in Dhaka. The guaranteed compost price in San Fernando is another suitable form of support. Since the municipalities save money when less waste needs to be collected and treated, it is reasonable that they share this financial benefit with those groups who make an extra effort to the benefit of the whole city.

5. Conclusions and recommendations

Many cities in Asia are trying to upgrade their waste treatment systems from the currently prevailing open dumps. Although such upgrading of disposal sites can reduce the local environmental impacts, it is likely to also increase methane emissions and thus contribute to climate change. Decision makers responsible for waste management should be aware of this risk of burden shifting from the local to the global level and seriously consider treatment technologies that are less harmful for the climate.

If the treatment methods currently preferred continue to dominate, GHG emissions from waste treatment in developing countries are expected to increase sharply over the next few decades. To curb this trend, policymakers in charge of waste management, at both the national and the local level, need to promote the following:

(i) Waste reduction;
(ii) Introduction of biological treatment methods for organic waste, such as composting and anaerobic digestion;
(iii) Incineration, in cases where biological methods are not feasible, where the waste composition is suitable, and where gas treatment equipment with high environmental standards can be installed;
(iv) Landfill gas recovery and utilisation, for existing landfills and in cases where other options are unfeasible and where suitable land is available.

The waste sector is currently responsible for a small percentage of national GHG emissions and may not receive much attention in climate protection policies. However, this chapter has shown that improved treatment of organic waste has significant benefits in addition to climate protection, including:

(i) Reduced need for final disposal and thus:
   a. Reduced cost for disposal;
   b. Extended life-time of existing disposal sites; and
   c. Reduced need for new sites and thus fewer land use conflicts;
(ii) Reduced leakage to groundwater and surface waters;
(iii) Nutrient recycling and improved soil properties, if compost is used as fertiliser;
(iv) Additional income opportunities for households and communities, if the compost can be sold; and
(v) Possibility of additional revenue generation through CDM.

As illustrated in other chapters of the White Paper, climate policies cannot be developed in isolation from other sustainable development issues; to be effective they need to be integrated. Organic waste treatment in cities is a good example of an issue where an integrated approach can generate co-benefits as outlined above. By introducing alternative treatment methods, the local environment and the living conditions of citizens can be improved at the same time as GHG emissions are being reduced. For this reason, composting and other improved organic waste treatment methods deserve increased attention by national policymakers and support for such methods should be part of the national climate protection strategies of developing Asian countries.

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Endnotes – Chapter 6

[1] The waste expenditure data are based on per capita expenditure for the national capitals multiplied by the urban population of each country (Hoornweg et al. 1999).