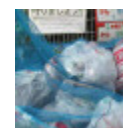




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Eastern prospect: Municipal solid waste management

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Eastern prospect: Municipal solid waste management in Asian cities

The huge amounts of municipal solid waste create enormous challenges for all Asian cities across the whole economic spectrum. The issues vary, as do the characteristics of their MSW. Waste management methods must be chosen carefully to suit local conditions in order to move towards sustainability.

[Mara Regina Mendes and Hidefumi Imura](#)

Asian cities are home to more than one billion people today. But by 2025, Asia will be inhabited by more than four billion people - half of them in cities - and will produce more than 180 million tonnes of municipal solid waste (MSW) per day.¹ The waste managed by municipalities usually includes household waste and waste from small business, offices, restaurants, etc. But in some countries (particularly those with limited waste legislation), it may also include waste from small industrial plants.

Asia's diverse nature (e.g. economic development, institutional framework, climate and culture) means that waste management characteristics and issues vary across the region. This article discusses MSW management in Asian cities, which are classified into less developed (or poor), developing (or rapidly industrializing) and developed (or mature) cities. It also discusses recent trends towards a more sustainable cycling of resources, which adds a new dimension to waste management.

'Waste is rising to levels that are both difficult and costly to manage'

Main issues

The high rate of population growth and urbanization, together with economic growth, not only accelerates consumption rates in developing cities of Asia, but it also accelerates the generation of waste. The amount of waste is rising to levels that are both difficult and costly to manage. In addition, poor and developing cities in the region lack the management capacity to deal with the increasing volume of waste and its changing characteristics - as a city becomes richer, its waste composition changes due to increased consumption of paper, plastics, packaging and multi-material items. In addition, poverty still leads to urban problems such as irregular settlements and scavenging. Even in economically developed Asian countries, waste management is overwhelmed by overpopulation and economic affluence.

Common problems for MSW management in developing countries in Asia include institutional deficiencies, inadequate legislation and resource constraints. Long- and short-term plans are lacking due to capital and human resource limitations. There is a need for financing instruments for MSW management, training specialists and capacity-building. National policies are now being formulated in several countries, but a lack of effective enforcement of environmental regulations is a major problem. Recycling laws, even if they exist, are not enforced. Although there are recycling activities promoted by communities, non-governmental organizations (NGOs) and the private sector, these are 'informal' and are not supported by the municipal authorities. China and Vietnam are exceptions among Asian developing countries in that they have formal structures for recycling.²

TABLE 1. Overall issues in Asian cities

	Less developed cities	Rapidly developing cities	Developed cities
Examples	Dhaka, Kathmandu, Karachi, Phnom Penh	Beijing, Shanghai, Guangzhou, Bangkok, Kuala Lumpur, Manila	Tokyo, Taipei, Seoul, Hong Kong, Singapore, Macao
Trends	Population growth Urbanization	Population growth Urbanization Industrialization and economic growth	Stable population Affluent society 'Throw-away' consumption

			pattern
Urban characteristics	Mix of semi-urban and urban areas	Rapidly urbanizing and sprawling Number of irregular settlements such as slums and shanty towns	Highly urbanized Dense area
Barriers	Poverty Financial constraints Poor management capacity	Urban growth Low management capacity	Excess of waste Varied waste composition Land scarcity
GNI PPP per capita^a 2002	Less than 2000	2000-15,000	16,000-30,000
MSW generation per capita (kg/person/day)	0.3-0.7	0.5-1.5	>1.0
Waste characteristics	High bulk density High organic content	Evolving or changing characteristics (transition)	Low bulk density High plastics content
Waste management	Priority to collection and transportation	Gradual improvement of final disposal	Advanced treatment Appropriate and well monitored final disposal
MSW collection rate (%)	<70	80-95	95-100
Recycling	Informal	Formal + informal	Formal
Rate of expenditure in total budget (%)	15-40	5-25	1-5

^a GNI PPP per capita is the gross national income in purchasing power parity.

The picture is different in developed areas of the region. Financial resources and skills are available and there are waste management plans with short-, medium- and long-term objectives. Although waste is well managed, the large amount as well as land scarcity pose challenges to the authorities. Treatment usually consists of incineration of combustible waste and landfilling of inert waste and incineration residues. There are well structured programmes to monitor waste management operations (including landfill leachate and gas emissions). Japan, South Korea, Singapore and Taiwan have all been implementing policies since the late 1990s for the promotion of recycling and more efficient use of resources.



'Waste separation - good for the country and people' - recycling in Guangzhou. China is one of the two Asian developing countries that have formal structures for recycling supported by municipal authorities. PHOTO: ISWA GENERAL SECRETARIAT

Baled aluminium cans for recycling at a plant in the 'Eco-Town' recycling park in Kitakyushu City. Japan has been implementing policies since the late 1990s for the promotion of recycling and more efficient use of resources

Table 1 summarizes the conditions of urbanization, economic indicators and waste management for each type of Asian city. Figure 1 highlights the waste management issues that continue to affect Japan, as well as the extremes in MSW management found in less developed and mature cities.

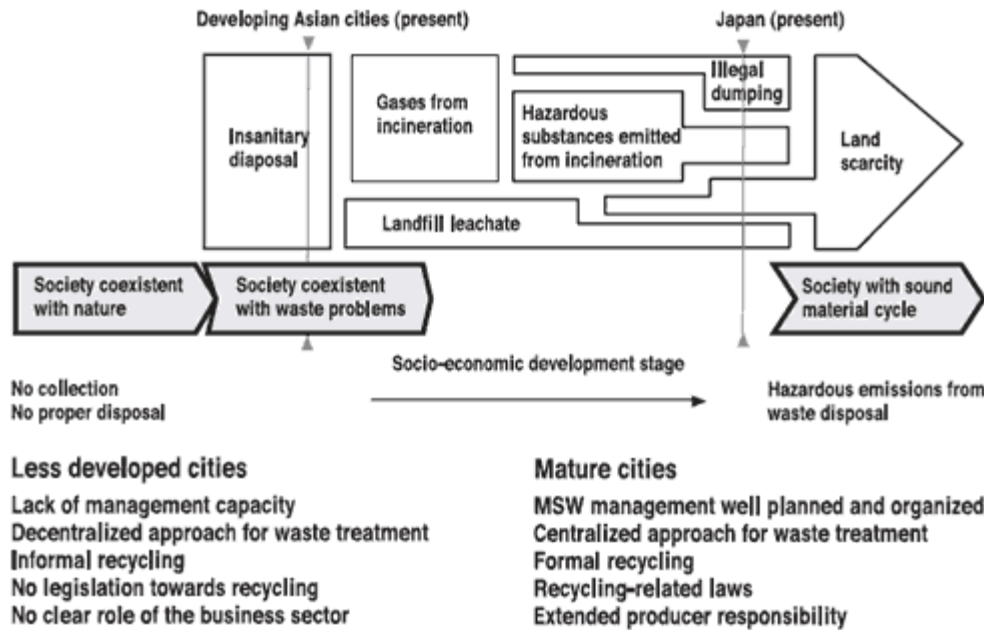


FIGURE 1. Urban solid waste: comparison of the current situation in Japanese and developing Asian cities

Increasing expenditures

Figure 2 shows the relationship between per capita expenditure for MSW management and per capita income in Asian countries. It suggests that the increase in per capita income will accelerate the demand for both public and private services for MSW management. Much more expenditure will be necessary for collection services and for the construction and operation of treatment and disposal facilities.³ Methods of financing the improvement of MSW management thus become important for cities that have achieved a certain level of economic development.

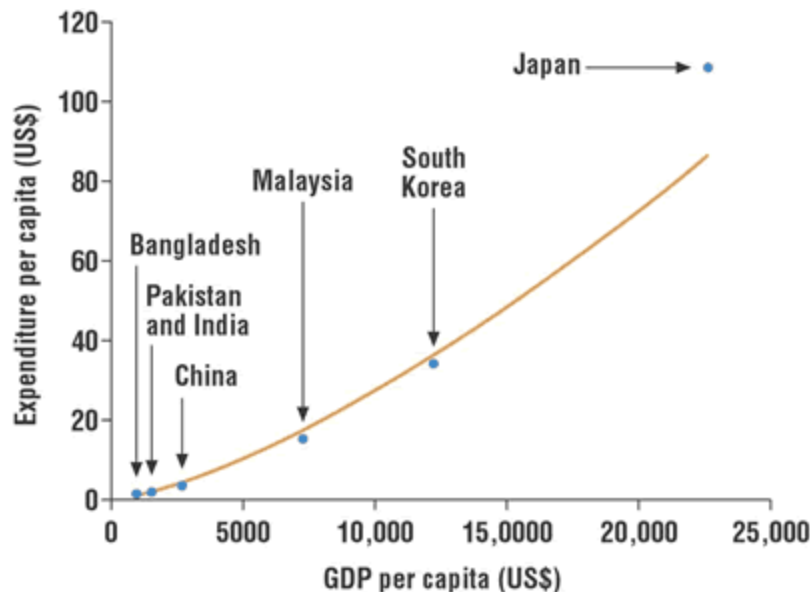


FIGURE 2. Relationship between expenditure on MSW management and GDP in Asian countries³

Financing and partnerships

Financial constraints are one of the main barriers for proper MSW management. Reform of fiscal measures and adoption of economic instruments can help to enhance local financial capacity for MSW management. MSW management authorities in Asia are increasingly seeking to recover their costs by levying fees for services provided. These take several forms:

- direct fees based on waste volume
- indirect fees derived from, for instance, property taxes
- fees collected with electric or water bills based on floor area and annual rental values of properties

In the 1990s, Asian cities began to levy charges on residents to subsidize the construction and operation of waste disposal facilities and to provide incentives to residents to separate daily refuse in different packages according to treatment requirements. For instance, Tokyo adopted the use of different bags for combustible and non-combustible wastes. All cities in Japan and South Korea have some type of charging system for waste, but the number of cities in Asia with waste fee systems is still limited. Charging systems - especially those based on waste volumes - are a promising way of inducing residents to change their lifestyles and to reduce the amount of waste requiring treatment. However, public awareness and commitment are vital to avoid an increase in illegal dumping.

In East and South-east Asia, the private sector is becoming involved in lease and concession contracts in the construction and operation of facilities for MSW disposal. In Malaysia, waste collection and the construction/operation of MSW disposal facilities have been transferred to a number of private companies through concession contracts. Lease and concession contract projects for the construction and operation of MSW treatment facilities have also been adopted in the Philippines, Thailand, Hong Kong, Macao and Singapore. However, the private sector is often unable to acquire land for disposal sites due to opposition by local residents concerned about pollution, health risks and the loss of economic value of their property. Leadership by government and the involvement of local communities are both necessary in order to reach a compromise solution for siting waste treatment facilities.

Nonetheless, private sector participation in MSW collection, transport and recycling has increased. In many East Asian cities, leasing refuse collection and its transfer to disposal dumps to the private sector has conserved managerial resources.³ Traditionally, waste recycling in many East Asian countries has involved individuals, private companies and the public sector. Governments are urged to encourage their continued active participation and to organize them properly by formulating relevant policies. Research into advanced recycling process technologies by universities and the private sector also needs to be encouraged.

However, the social implications of such privatization have yet to be evaluated. Fees, labour relations and the role of waste pickers and dealers are points of tension in some developing countries when privatization is introduced.



ABOVE LEFT Kitakyushu City and several other cities in Japan have adopted a waste charging system based on bags designated for waste collection **ABOVE RIGHT** Uncollected waste at a river bank in Cambodia. Public awareness and commitment are vital to avoid an increase in illegal dumping

In developing Asian countries, community participation in waste management is vital for improvement while NGOs could play a more effective role in improving MSW management if they were given more recognition by municipal authorities. Decision-making has traditionally been 'top-down', with no input from the local communities. In places where the local authority does not carry out primary collection, however, people have created community organizations to collect waste. Community-based waste collection has been adopted in localities such as:

- Bangalore, Madras and Mumbai in India
- Jakarta in Indonesia
- Colombo in Sri Lanka
- Karachi in Pakistan
- Patan and Kathmandu in Nepal
- Manila, Cebu and Quezon in the Philippines

In developed Asian countries, the municipal authorities have the necessary skills and resources to manage MSW. The management approach is therefore centralized and NGOs are not directly involved. In Japan, for instance, NGOs restrain their activities to recycling and awareness campaigns.

Climate change mitigation

Waste disposal in open dumps and landfills is a major source of methane, a powerful greenhouse gas. Proper management of MSW can thus contribute to climate change mitigation. But financial constraints often prevent the improvement of MSW management in developing countries. The Clean Development Mechanism (CDM)⁴ - one of the three so-called flexible mechanisms of the Kyoto Protocol - allows developing cities to obtain financial resources and state-of-the-art technology from industrialized countries in order to mitigate their greenhouse gas emissions. Incineration, biogasification and landfill with gas recovery are the main types of waste treatment that can mitigate greenhouse gas emissions and could be promoted in developing cities through CDM projects.

Waste generation and composition

Accurate information on waste generation and composition is necessary to monitor existing management systems and make regulatory, financial and institutional decisions. However, reliable data are difficult to obtain in less developed and developing cities. However, the amount of waste collected by municipalities is generally much less than that generated.

Due to inconsistencies in definitions and methodologies, comparing MSW data between countries and cities in Asia is difficult and should be performed with caution. For example, waste characterization studies, if carried out, tend to be ad hoc and do not consider seasonal variations. Waste characterization also tends to be carried out at the final disposal site rather than at the source of waste before any scavenging or recycling activity occurs.

The amount of MSW is expected to rapidly increase in Asian cities that are predicted to have
high
economic growth

A rapid increase of the amount of MSW is expected to take place in Asian cities where high economic growth is predicted. Cities in such countries as Japan, South Korea and Malaysia have already entered, or will be entering, a new realm of waste management. In these cities, the income level of residents has increased rapidly and the quantity and quality of waste generated is similar to that of western countries. There is thus a significant difference in the type and content of problems between industrialized and developing cities in Asia. In industrialized cities with higher income levels, the amount of waste generated per person is more than 1 kg/day, and the government and residents have initiated measures to stabilize or reduce it. In developing cities with lower income levels, the corresponding figure is around 0.5 kg/person/day.

A comparison of the current waste composition in Asian countries (see Table 2) shows that about 70% or more (by weight) of the waste is combustible (i.e. organics, paper and plastics), apart from China where there is a high percentage of ash. However, the composition differs depending on the economic level of cities as well as other factors such as geographic location, energy sources, climate, living standards and cultural habits, and the sources of waste that are considered as MSW or are collected by the municipality.

TABLE 2. Composition of urban solid waste in selected Asian countries³ (%)

Country	Organic waste	Paper	Plastic	Glass	Metal	Others
China	35.8	3.7	3.8	2.0	0.3	54.3
Hong Kong	37.2	21.6	15.7	3.9	3.9	17.6
Indonesia	70.2	10.9	8.7	1.7	1.8	6.2
Japan	17.0	40.0	20.0	10.0	6.0	7.0
Laos	54.3	3.3	7.8	8.5	3.8	22.5
Malaysia	43.2	23.7	11.2	3.2	4.2	14.5
Myanmar (Burma)	80.0	4.0	2.0	0.0	0.0	14.0
Philippines	41.6	19.5	13.8	2.5	4.8	17.9
Singapore	44.4	28.3	11.8	4.1	4.8	6.6
South Korea	31.0	27.0	6.0	5.0	7.0	23.0
Thailand	48.6	14.6	13.9	5.1	3.6	14.2

Table 3 compares MSW composition in the three different categories of Asian cities. The ratio of paper and plastics including voluminous materials such as food containers and wrapping materials is higher in mature cities, while organic waste accounts for most of the waste in developing cities. Moreover, the calorific value of waste in mature cities is high. The shift from landfill to incineration is desirable in handling such bulky waste and recovering energy. However, incineration is expensive and generates hazardous gaseous and solid emissions such as dioxins and ash. On the other hand, waste in developing cities has a high organic content and a low calorific value; biological treatment such as composting and biogasification (i.e. anaerobic digestion) are thus more suitable. Since suitable treatment methods are different for different waste compositions, they thus differ among cities with different levels of economic development. However, other factors have to be taken into account when choosing the most appropriate waste treatment method such as markets for the by-products, costs, energy sources, environmental impact, public acceptance, etc. The choice of waste treatment and the role of system analysis tools such as life-cycle assessment (LCA) are discussed below.

TABLE 3. Typical waste composition in low-, medium- and high-income Asian cities

	Less developed cities	Rapidly developing cities	Developed cities
Paper (%) ^a	3-10	10-25	20-50
Plastics (%) ^a	2-8	8-14	9-22
Ash, fines, others (%) ^a	2-62	6-18	3-10
Organics (%) ^a	35-80 ^b	40-50	15-40
Moisture (%)	30-60	20-50	10-30
Bulk density or density (kg/m ³)	300-550	200-350	150-300

^a Dry basis

^b The waste in Chinese cities has a low organic content due to the high ash content.

Waste management in less developed Asian cities

Cities such as Dhaka, Kathmandu and Phnom Penh are challenged by urbanization and industrialization trends, increases in population and consequent increases in waste. Poor government policy and response, lack of political will, lack of appropriate economic and human resources, and weak local institutions result in poor waste management (especially in large cities). These cities therefore face major problems relating to public health and environmental pollution.

Waste collection is inefficient (a collection rate of 30%-70%) and the collected waste is disposed of in open dumps. Inefficient collection and disposal are associated with litter on roads, waste spilling around the bins, obstruction of drains and indiscriminate dumping on empty plots of land.

MSW management services account for a high percentage of municipal budgets. In some Asian cities, expenditure on MSW management can reach 40% of the municipal operating budget and, of this, 70%-90% is spent on collection. For instance, Kathmandu spends 38% of the municipal budget on MSW management; 93% of this is spent on sweeping, collection, transfer and transport.⁵ Financial approaches vary. In Phnom Penh, for example, part of the collection service is performed by a private company, which demands the waste collection fee from households directly in their electricity bill.

Recycling is generally carried out by the informal sector. There is no policy to promote recycling or resource conservation, and the municipalities do not have the expertise to launch recycling activities. In several places, such as Kathmandu, more of the waste could be recycled if there was a better infrastructure for collecting recyclables. Due partly to faulty collection systems and the low quality of scrap, the recycling rate is low despite the number of waste pickers working in these cities.



MSW collection in Tokyo, Japan. Small trucks are used to collect waste in Asian cities, which normally have narrow roads



Waste pickers collecting recyclables in a waste transfer area in Phnom Penh, Cambodia



Waste burned along a road in the vicinities of Phnom Penh. Only the central area of Phnom Penh is attended by the regular collection of waste, carried out by a private company

International collaboration has had a limited role in improving waste management in these cities. Some projects carried out by support agencies from developed countries have failed to take into account local characteristics, resulting in unsustainable waste management practices. Some agencies tended to promote technologies developed or used in their countries, regardless of their applicability to the

recipient country.⁶ Some technologies from the donor country have been adopted, but because the recipient country lacked expertise and economic resources, their operation was interrupted or was never put into practice. For example, a mechanized composting plant installed in Kathmandu in the 1980s was unused for almost a decade - reportedly due to local opposition,⁷ but high running costs and lack of expertise in running and maintaining a mechanized composting plant may have also played a part.

Inefficient collection and disposal are associated with litter on roads and waste spilling around the bins

In recent years, some initiatives have been taken by the private sector, NGOs, non-profit organizations (NPOs) and community-based organizations (CBOs). The adoption of community-based waste management (i.e. a decentralized approach) has been seen as a viable option for coping with the problems found in these cities. In several localities in India, Cambodia, Pakistan, the Philippines, etc., teams of former waste pickers have been trained and organized by the municipality, NGOs or CBOs into 'self-help groups' to provide door-to-door collection of waste with pushcarts in areas of difficult access. The organizer - either the municipality, an NGO or a CBO - charges the households receiving this service. Several international groups have launched pilot projects on recycling and composting in communities in Dhaka, Kathmandu, Phnom Penh, Nonthaburi and other cities. The Kitakyushu Initiative, developed by the UN Economic and Social Commission for Asia and the Pacific (UNESCAP), is an example of a programme that has provided expertise and capacity-building to member cities to develop community-based waste management.⁸

Waste management in rapidly developing Asian cities

The larger amounts of waste and changes in its characteristics have made it more difficult to manage, and the problem of waste has been gradually recognized as an important issue in rapidly developing cities. However, lack of funds, low capacity management and inefficient regulation enforcement, together with the increasing amount of waste, are barriers for proper management. Several national and local governments (such as in the Philippines and Indonesia) are developing policies towards proper waste management, but enforcement and monitoring remain deficient.

Waste collection is either carried out by the municipality or by contracted companies; the collection rate varies between 50% and 90%. Waste treatment and disposal usually consist of open dumps, but some cities are adopting controlled dumps and partially engineered landfills. Composting and recycling are increasing. The high costs of incineration means it is not adopted, except for hospital waste.



Odaiba is an island constructed over a landfill site in Tokyo Bay

Developing Asian cities tend not to have a formal policy on recycling, but some municipalities carry out source-separated collection and recycling. In practice, recycling is a mix of formal and informal entrepreneurship. Waste with any economical value is usually separated from the waste stream by waste pickers; NGOs, CBOs, schools and companies also carry out separation of recyclables and sell them to waste dealers. The recycling industry is growing in industrializing countries, but the local scrap material is usually of low quality (i.e. dirty or mixed with impurities). Although many groups are involved in collecting recyclables, a more efficient infrastructure for collecting waste would increase recycling capacity.

Recycling is cheaper in industrializing countries than in developed countries. Thus there is a trend towards importing recyclable materials from developed countries. However, the local and national authorities in developing countries need to develop strict policies to ensure proper recycling practices and to ban imports of hazardous waste. Authorities in developed countries must be vigilant against inappropriate activities.

Waste management in developed Asian cities

Although industrialized Asian cities have the necessary skills and resources for waste management, the large amount of waste and lack of disposal sites make it a demanding activity. Developed cities across the region are highly populated, land prices are costly and opposition to new waste facilities make the development of disposal sites difficult. In smaller cities, local governments involve the population in reuse and recycling activities aimed at minimizing the amount of waste for disposal. In larger cities, however, the 'throw-away' consumer culture has increased the amount of waste generated.

Despite the large waste volumes, waste management is efficient. Planning is good and the waste bureaus are well equipped and employ skilled workers and technicians. The collection rate reaches 100% and most waste is incinerated. Most of the MSW incinerators in the world are located in developed countries in Asia:

- 1800 in Japan (21 in Tokyo, as of 2003)
- 19 in South Korea (as of 2000)
- 19 in Taiwan (as of 2003)
- 4 in Singapore (as of 2004)

Incineration residues and waste that cannot be incinerated are disposed of in well controlled landfill sites. Due to land scarcity, Tokyo, Singapore, Hong Kong and several other cities have

adopted offshore landfilling (i.e. sea reclamation), with several islands being constructed using inert wastes; after landfill closure, these areas are used as new development sites for business, industrial, residential and harbour activities. A famous one is Odaiba - a leisure and tourist spot located in Tokyo Bay.

However, a fundamental change in waste management policy is needed in order to cope with the increasing volume and variety of waste, the increased difficulty of processing and the shortage of landfill space. Waste management in Japan today consists mainly of 'burning and burying.' Recycling is recognized as a way of decreasing waste for final disposal and saving resources. But high labour and transport costs and the limited market for recycled goods make recycling economically unattractive for the private sector and it is performed almost exclusively by the public sector.



Collecting plastics waste in Seoul. South Korea is one of the developed regions in Asia that have launched specific policies aimed at waste minimization and recycling. PHOTO: ISWA GENERAL SECRETARIAT

In practice, recycling is a mix of formal and informal entrepreneurship

Policy is slowly changing in order to transform the socio-economic structure of these countries towards a 'cycling economy' - that is, by avoiding the generation of waste, recycling the generated waste as much as possible, and recovering the thermal energy when waste is burned. For example, the Japanese Ministry of the Environment launched a policy in 2000 aimed at promoting a recycling-based society or sound material-cycle society,⁹ which aims to create mechanisms for a more sustainable use of material resources (see Figure 3). The objective is to create a more environmentally sound socio-economic system, which is detached from mass production, mass consumption and mass disposal. South Korea, Singapore and other developed regions in Asia are following this approach by launching specific policies aimed at waste minimization and recycling.

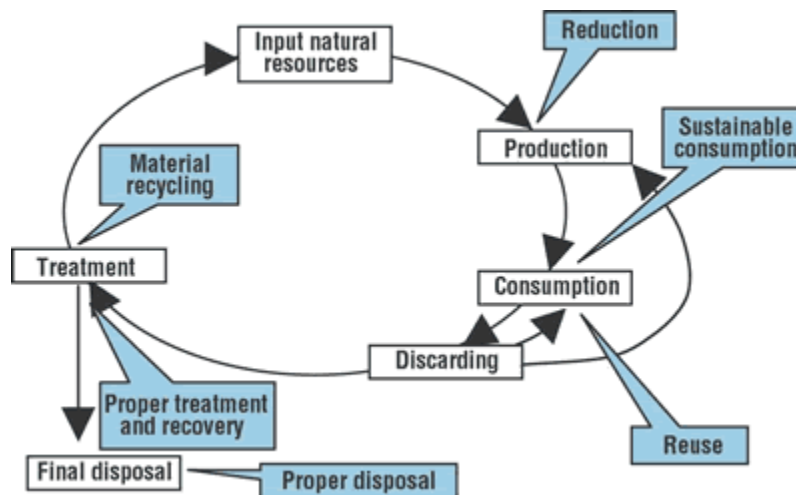


FIGURE 3. Concept of a sound material-cycle (adapted from The challenge to establish a sound material-cycle society⁹)

Waste management approaches

A popular approach in Europe to waste management is the 'waste hierarchy.' One example of ranking different treatment options is:

- prevention or waste minimization reuse
- materials recycling and composting
- incineration with energy recovery
- incineration
- landfilling

This approach has been critically reviewed recently because it fails to take into account which options have the lowest cost and lowest environmental impact.^{10,11} Because the hierarchy makes no attempt to measure the impact of individual options, the use of system analysis tools such as LCA is recommended. A holistic approach called 'integrated waste management' has been urged.¹⁰ This considers that all types of treatment can play a role in decreasing the cost and environmental impact of the waste management (see

Figure 4). Unlike the hierarchy approach, the integrated approach does not suggest the 'best' treatment.

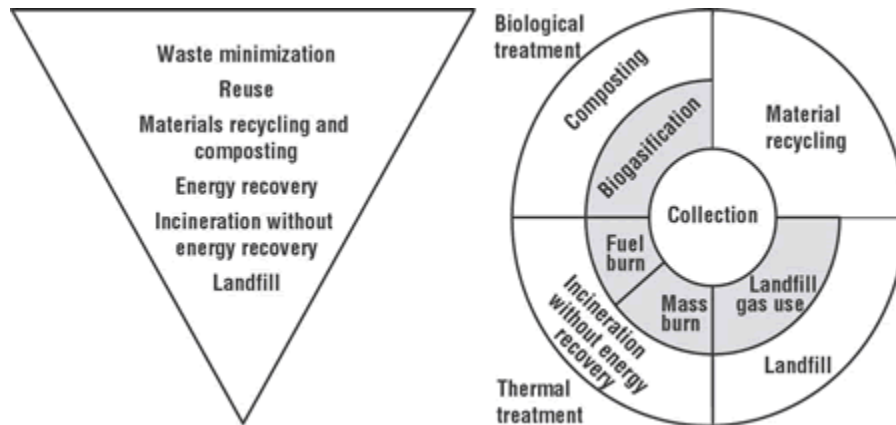


FIGURE 4. Two main approaches for waste management: hierarchy (left) and integrated approach (right)

It is not possible to choose one waste management system as being the most appropriate for all places as there are local differences in:

It is impossible to choose one waste management system for all places due to local differences

- the composition and quantities of waste generated
- the availability of some disposal options
- the demand for products derived from waste management

Specific analysis of each city or place is recommended as studies have shown that some options considered more appropriate according to the 'waste hierarchy' were less appropriate from an environmental viewpoint. In Guangzhou, for example, the high organic content of its MSW would suggest that composting is the best treatment option. However, an LCA study found that energy recovery from waste may have lower emissions. Because China depends mainly on sulphur-containing coal as a fuel source for electricity generation, thermal treatment of waste to generate power would reduce its overall SO_x and NO_x emissions.¹²

Japanese cities adopted incineration as their main method of waste treatment, and large developed cities in other countries have tended to adopt the same method. Developing cities need to find their own approach; they should not follow blindly the models of developed cities in Europe or other Asian countries, but develop processes appropriate to their own conditions.

Outlook

Despite the challenges posed by the huge amounts of MSW generated in Asia, there is a trend in Japanese and other developed cities towards a more sustainable approach - the so-called sound material-cycle society. Among the strategies, a remarkable one in Japanese cities is the Eco-Town Project (see below). The sound material-cycle concept can also be an example to developing Asian cities. There is a need to develop local strategies so these cities can advance from their current insanitary conditions to a 'cycle economy'.

The Kitakyushu Eco-Town Project

The Japanese Ministry of Economy, Trade and Industry (METI) launched the 'Eco-Town Project' in 1997 to provide assistance to local governments planning to achieve regional development through the promotion of environmental industry. Provided that their master plans were approved, local governments received various forms of financial aid from the national government including subsidies for private companies that agreed to construct recycling and other facilities and financial support for the demonstration of new eco-technologies.

The city of Kitakyushu has vast areas of land where industrial facilities have been abandoned. It has also accumulated expertise in the processing of metals, chemicals and other materials, which can be applied to the development of resource recycling and recovery technologies. Kitakyushu promoted a new urban industrial development policy to invite recycling and other eco-industries to an unused and reclaimed site in the Hibikinada area of the city. The first Eco-Town project involves an eco-industrial complex and a research centre for the development and evaluation of recycling technologies. The city provides various benefits to small- and medium-sized companies seeking to develop diverse technologies. So far, recycling factories for PET bottles, cars, electrical appliances and construction materials have begun operation and the number of factories is increasing.

The ultimate aim of the Kitakyushu Eco-Town is not only to develop recycling industries, but also to create a new industrial system in which resources are used more efficiently.

International co-operation is one way of transferring the experiences of mature cities to developing cities

The choice of processes and technologies for waste management are important but not enough to ensure sustainability. Other factors such as legislation, political will, partnerships and public participation play a fundamental role. International co-operation is one way of transferring the experiences of mature cities to developing cities. Such initiatives have already started in Asia; for instance, the Kitakyushu Initiative for a Clean Environment⁸ promotes collaboration among Asian cities. However, developing cities in Asia must follow the example of developed cities and establish an approach to MSW management that takes into account local and unique conditions.

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