INTRODUCTION

Waste is an unavoidable by-product of most human activity. Economic development and rising living standards in the Asian and Pacific Region have led to increases in the quantity and complexity of generated waste, whilst industrial diversification and the provision of expanded health-care facilities have added substantial quantities of industrial hazardous waste and biomedical waste into the waste stream with potentially severe environmental and human health consequences. The Chapter discusses the generation, treatment, disposal and management of the growing volume of waste, which poses formidable challenges to both high and low-income countries of the region.

TYPES OF WASTES

A. Generation and Characteristics

A clear appreciation of the quantities and characteristics of the waste being generated is a key component in the development of robust and cost-effective solid waste management strategies. Although amongst some of the more developed countries within the region the quantification and characterization of waste forms the basis for management and intervention, elsewhere little priority is given to the systematic surveying of waste arisings and the quantities, characteristics, seasonal variations and future trends of waste generation are poorly understood. Although there is a lack of comprehensive or consistent information, at the country level, some broad trends and common elements are discernible.

In general, the developed countries generate much higher quantities of waste per capita compared to the developing countries of the region. However, in certain circumstances the management of even small quantities of waste is a significant challenge. For example, in the small islands of the South Pacific subregion, small populations and modest economic activity have ensured that relatively low quantities of waste are generated. However, many of these countries, particularly small atoll countries such as Kiribati, Tuvalu and the Marshall Islands, face considerable waste management challenges due to their small land areas and resultant lack of disposal options.

Throughout the region, the principal sources of solid waste are residential households and the agricultural, commercial, construction, industrial and institutional sectors. A breakdown of solid waste types and sources is provided in Table 8.1. For the purposes of this review these sources are defined as giving rise to four major categories of waste: municipal solid waste, industrial waste, agricultural waste and hazardous waste. Each of these waste types is examined separately below.

1. Municipal Solid Waste

Municipal solid waste (MSW) is generated from households, offices, hotels, shops, schools and other institutions. The major components are food waste, paper, plastic, rags, metal and glass, although demolition and construction debris is often included in collected waste, as are small quantities of hazardous waste, such as electric light bulbs, batteries, automotive parts and discarded medicines and chemicals.

Table 8.1 Sources and Types of Solid Wastes

Source	Typical waste generators	Types of solid wastes
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g. bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes
Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, hospitals, prisons, government centres	Same as commercial
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc.
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational area, sludge
Process	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing	Industrial process wastes, scrap materials, off-specification products, slag, tailings
All of the above should be included as "municipal solid waste."		
Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms	Spoiled food wastes, agricultural wastes, hazardous wastes (e.g. pesticides)

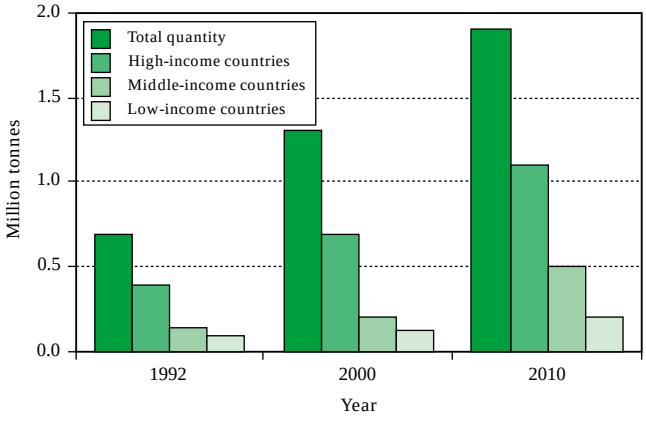
Generation rates for MSW vary from city to city and from season to season and have a strong correlation with levels of economic development and activity. High-income countries (such as Australia, Japan, Hong Kong, China, Republic of Korea, and Singapore) produce between 1.1 and 5.0 kg / capita / day; middle-income countries (such as Indonesia, Malaysia and Thailand) generate between 0.52 and 1.0 kg / capita / day, whilst low-income countries (such as Bangladesh, India, Viet Nam and Myanmar) have generation rates of between 0.45 and 0.89 kg / capita / day. Figure 8.1 shows MSW generation by the high, middle and low-income countries of the region.

Taken as a whole, the Asian and Pacific Region currently produces some 1.5 million tonnes of MSW each day and this is expected to more than double by 2025 (World Bank 1999). The current estimate for waste generation may be considered as extremely conservative; the actual levels are probably more than double this amount. Figure 8.2 presents the current contribution of the various subregions to the waste generated by the region (United Nations 1995, World Bank 1995 and 1998, UNEP / SPREP 1997).

The composition of municipal solid waste varies significantly across the region (see Figure 8.3) with some middle and low income countries generating waste containing over 70 per cent organic content, with a corresponding moisture content in excess of 50 per cent. Differences in the characterization and reporting of waste types also differ with some municipal authorities including construction and demolition waste and industrial waste as part of the municipal waste stream.

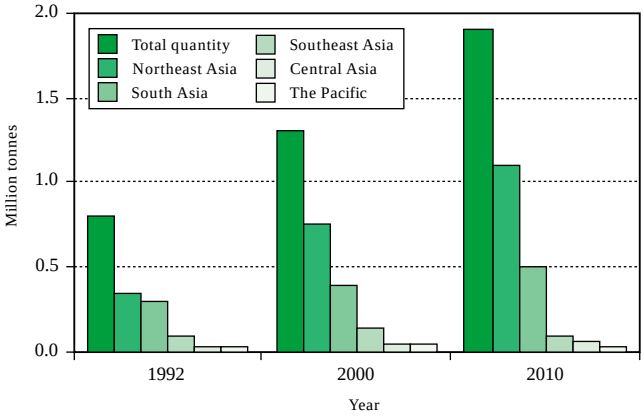
Some inter-urban differences relate to climate and fuel use. The cities where heating is needed in winter such as Beijing, Shanghai, Seoul and Tokyo and where coal is the main source of energy, have much greater amount of ash in the waste in those cold months. The basic infrastructure brings other variations in cities and towns (such as Calcutta, Dhaka, and Hanoi) with unpaved or poorly paved streets that have large amounts of dust and dirt from street sweeping. There are big differences in amounts of organic waste among cities according to the number of trees and shrubs in public places. Large and bulky waste items such as abandoned motorcars, furniture and packaging are found in the higher-income economies such as Brunei Darussalam, Japan, Republic of Korea and Singapore, but not in low-income countries such as Bangladesh, Cambodia, Myanmar, Nepal, Sri Lanka and Viet Nam. Table 8.2 provides an illustration of the quantities and types of MSW generated in selected countries of the South Pacific subregion.

Figure 8.1 Municipal Solid Waste Generation in Different Groups of Countries in the Region



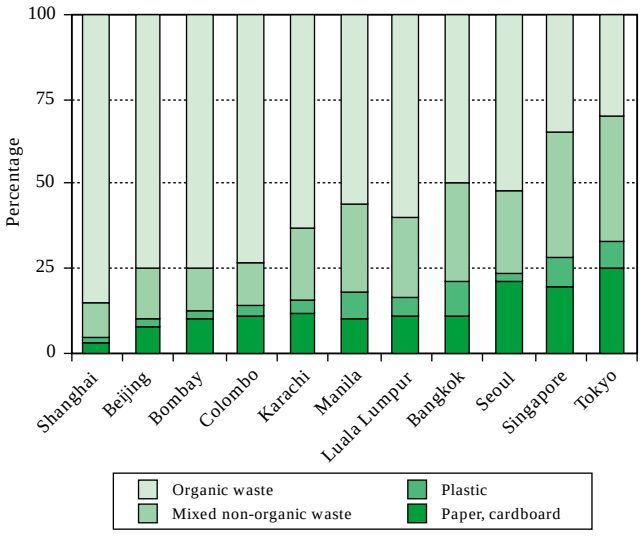
Source: World Bank 1999

Figure 8.2 Estimated Generation of Municipal Solid Waste in Different Subregions



Source: United Nations 1995, World Bank 1995 and 1998, UNEP / SPREP 1997

Figure 8.3 Approximate Composition of Municipal Solid Waste in Selected Cities of ESCAP Member Countries



Source: United Nations 1995, World Bank 1995 and 1998, UNEP / SPREP 1997

Table 8.2 Quantities and Types of MSW Generated in Selected South Pacific Countries

Selected Countries	Types of waste generated	% of total	Total Amount of MSW generated (tonnes per day)
Cook Islands			4.75
	Organic	32%	
	Glass	24%	
	Plastic	12%	
	Metals	10%	
Fiji (Suva, the capital)			35.6
	Metal	10-16%	
	Glass	5-10%	
	Plastic	7-12%	
	Vegetative debris	25-39%	
	Paper	27-34%	
Vanuatu			15
	Vegetative debris	35-40%	
	Wood	25-30%	
	Paper	10-12%	
	Plastic	6-8%	
	Glass / Ceramic	3-5%	
	Metals	2-3%	
	Textile	3-6%	

Source: World Bank 1997

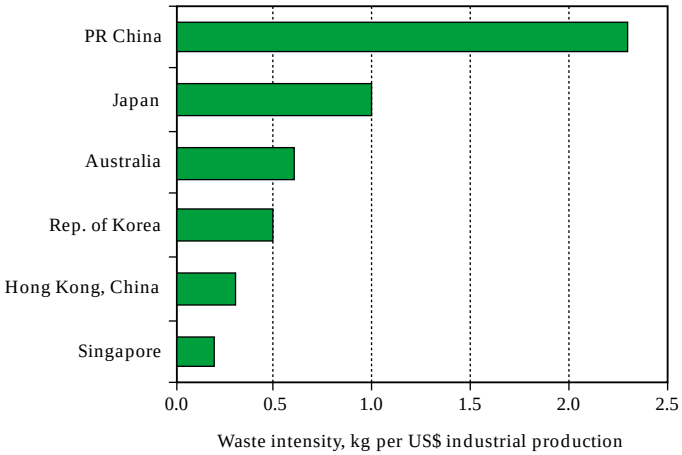
The amount of human faeces in the MSW is significant in squatter areas of many Asian and Pacific cities where "wrap and throw" sanitation is practised or bucket latrines are emptied into waste containers. The latter is common in many cities (such as Calcutta, Dhaka and Hanoi) of the region where sewerage systems are minimal.

2. Industrial Solid Waste

Industrial solid waste in the Asian and Pacific Region, as elsewhere, encompasses a wide range of materials of varying environmental toxicity. Typically this range would include paper, packaging materials, waste from food processing, oils, solvents, resins, paints and sludges, glass, ceramics, stones, metals, plastics, rubber, leather, wood, cloth, straw, abrasives, etc. As with municipal solid waste, the absence of a regularly up-dated and systematic database on industrial solid waste ensures that the exact rates of generation are largely unknown.

Industrial solid waste generation varies, not only between countries at different stages of development but also between developing countries (see Figure 8.4). In People's Republic of China, for example, the generation ratio of municipal to industrial solid waste is one to three. In Bangladesh, Sri Lanka and Pakistan, however, this ratio is much less. In high-income, developed countries, such as

Figure 8.4 Waste Intensity of Industrial Production in Selected Countries in the Region



Source: ESCAP 1997

Australia and Japan, the ratio is one to eight. However, based on an average ratio for the region, the industrial solid waste generation in the region is equivalent to 1 900 million tonnes per annum. This amount is expected to increase substantially and at the current growth rates, it is estimated that it will double in less than 20 years. As the existing industrial solid waste collection, processing and disposal systems of many countries are grossly inadequate, such incremental growth will pose very serious challenges.

3. Agricultural Waste and Residues

Expanding agricultural production has naturally resulted in increased quantities of livestock waste, agricultural crop residues and agro-industrial by-products. Table 8.3 provides an estimate of annual production of agricultural waste and residues in some selected countries in the region (ESCAP 1997); the implications of liquid and slurry waste for receiving inland and coastal waters is examined in Chapter 4.

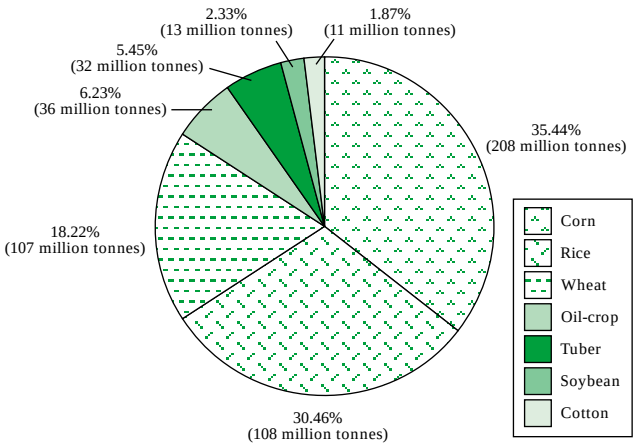
Among the countries in the Asian and Pacific Region, People's Republic of China produces the largest quantities of agriculture waste and crop residues followed by India. In People's Republic of China, some 587 million tonnes of residues are generated annually from the production of rice, corn and wheat alone (see Figure 8.5). Figure 8.6 illustrates the proportions of waste that Malaysia generates from the production of rice, palm oil, rubber, coconut and forest products (ESCAP 1997). In Myanmar, crop waste and residues amount to some 4 million tonnes per year (of which more than half constitutes rice husk), whilst annual animal waste production is about 28 million tonnes with more than 80 per cent of this coming from cattle husbandry.

Table 8.3 Approximate Estimate of Annual Production of Agricultural Waste and Residues in Selected Countries in the Region

Country	Annual production, million tonnes		
	Agricultural waste (manure/animal dung)	Crop residues	Total
Bangladesh	15	30	45
PR China	255	587	842
India	240	320	560
Indonesia	32	90	122
Malaysia	12	30	42
Myanmar	28	4	32
Nepal	4	12	16
Pakistan	16	68	84
Philippines	20	12	32
Rep. of Korea	15	10	25
Sri Lanka	6	3	9
Thailand	25	47	72

Source: ESCAP 1997

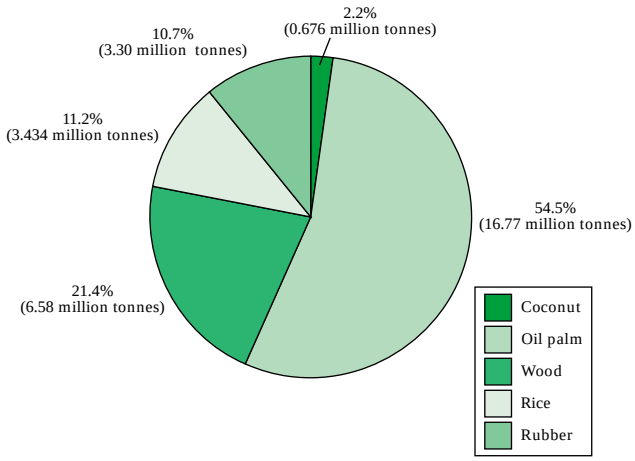
Figure 8.5 Proportionate Annual Production of Agricultural Waste in People's Republic of China



Source: ESCAP 1997

In Pakistan, about 56.22 million tonnes of different crop residues are generated of which 12.46 million tonnes originate from cotton, 2.90 million tonnes from maize, 12.87 million tonnes from sugarcane, 8.16 million tonnes from rice and 19.83 million tonnes from wheat. In addition, Pakistan produces other wastes amounting to some 28 million tonnes of which 58 per cent is animal waste, 40 per cent is sugarcane bagasse and the remaining two per cent comprises a mix of jute sticks,

Figure 8.6 Proportionate Annual Production of Agricultural Waste in Malaysia



Source: ESCAP 1997

mustard stalks, sesame sticks, castor seed stalks, sunflower stalks and tobacco stalks (ESCAP 1997).

In Sri Lanka, agricultural waste comprises animal waste, paddy husk, straw, coir fibre and coir dust, bagasse, as well as the waste from the timber industry, which comprises sawdust, off-cuts and charcoal. Commercial rice milling generates around 2 million tonnes of paddy husk per annum, whilst coir (the fibres from coconut husks) processing generates an annual 700 000 tonnes of coir dust (ESCAP 1997). Each year, Thailand produces about 4.6 million tonnes of paddy husk, 35 million tonnes of rice straw, 7 million tonnes of bagasse and more than 25 million tonnes of animal waste (ESCAP 1997). Other countries such as Australia, Cambodia, Japan, Lao People's Democratic Republic, Nepal, New Zealand, Republic of Korea, Viet Nam and Small Island States in the South Pacific also generate huge quantities of agricultural waste and residues (ESCAP 1997, UNEP / SREP 1997).

4. Hazardous Waste

With rapid development in agriculture, industry, commerce, hospital and health-care facilities, the Asian and Pacific Region is consuming significant quantities of toxic chemicals and producing a large amount of hazardous waste. Currently, there are about 110 000 types of toxic chemicals commercially available. Each year, another 1 000 new chemicals are added to the market for industrial and other uses.

The availability of robust data on the generation of hazardous waste for the Asian and Pacific Region is limited by the reliability of information on the quantities and types of hazardous waste produced at the country level. This is due to a

variety of reasons, including the lack of qualified personnel to undertake the necessary assessment, the reluctance of industries to provide process information (including waste arising data) and a poor appreciation of the extent to which generated waste is hazardous. Where data is available, significant difficulties are encountered in seeking to draw international comparisons due to differences in classification and definition of hazardous waste from country to country within in the region.

Most hazardous waste is the by-product of a broad spectrum of industrial, agricultural and manufacturing processes, nuclear establishments, hospitals and health-care facilities. Primarily, high-volume generators of industrial hazardous waste are the chemical, petrochemical, petroleum, metals, wood treatment, pulp and paper, leather, textiles and energy production plants (coal-fired and nuclear power plants and petroleum production plants). Small- and medium-sized industries that generate hazardous waste include auto and equipment repair shops, electroplating and metal finishing shops, textile factories, hospital and health-care centres, dry cleaners and pesticide users.

The principal types of hazardous waste generated in the Asian and Pacific Region, include waste solvents, chlorine bearing waste and pesticide-organophosphate-herbicide-urea-fungicide bearing waste. In particular, solvents are extensively used in the region and, as a consequence, large quantities of waste solvents are produced.

The types, quantities and sources of hazardous waste vary significantly from country to country and are influenced by the extent and diversity of industrial activity. Table 8.4 provides a conservative estimate of the past, current and future hazardous waste generation trends in a number of selected countries (Hernandez 1993, UNEP 1994, United Nations 1995, Nelson 1997). However, it must be stressed that such estimations are founded on data that may be considered incomplete and unverified. In the absence of reliable regional data, a study by the World Bank (WRI 1995) estimated the hazardous waste toxic releases in the Asian and Pacific region and predicted significant increases in hazardous waste production each year in People's Republic of China, India, Indonesia, the Philippines, and Thailand. An even more significant conclusion of the study was that the intensity of hazardous waste generation per unit of output is also set to increase (WRI 1995).

Better and more reliable data are available for the quantities of petroleum waste produced in countries that extract or process crude oil such as in Brunei Darussalam, People's Republic of China, India, Indonesia, Malaysia, Japan and Republic of Korea. In Malaysia, 0.71 metric tonnes of petroleum waste are generated annually (Malaysia Environmental Quality Report 1998), whilst it is reported that Fiji, Solomon Islands, Papua New Guinea, Federated States of Micronesia, Samoa, Vanuatu, Tonga, Marshall Islands, Nauru, Cooks Islands, Kiribati and Tuvalu collectively generate approximately 10.55 million litres of waste oil per year (UNEP/SPREP 1997).

Table 8.4 Conservative Estimate of Annual Production of Hazardous Waste in Selected Countries and Territories in the Asian and Pacific Region

Country/Territory	Estimated annual production, tonnes x 10^3		
	1993	2000	2010
Australia	109	275	514
Bangladesh	738	1 075	1 560
PR China	50 000	130 000	250 000
Hong Kong, China	35	88	165
India	39 000	82 000	156 000
Indonesia	5 000	12 000	23 000
Japan	82	220	415
Malaysia	377	400	1 750
Mongolia	15	26	45
Nepal	130	260	450
New Zealand	22	62	120
Pakistan	786	1 735	3 100
Philippines	115	285	530
Papua New Guinea	25	45	80
Rep. of Korea	269	670	1 265
Singapore	28	72	135
Sri Lanka	114	250	460
Thailand	882	2 215	4 120
Viet Nam	460	910	1 560

Source: Hernandez 1993, UNEP 1994, United Nations 1995, and Nelson 1997

B. Environmental Impacts of Waste

The economic growth and urbanization experienced in many parts of the Asian and Pacific Region over the past 10-15 years, has significantly escalated the quantities of MSW being generated in many cities, including Bangkok, Beijing, Mumbai, Calcutta, Colombo, Dhaka, Hanoi, Jakarta, Kuala Lumpur, Manila and Shanghai (United Nations 1995, Koe and Aziz 1995). Uncontrolled, open dumping on the peripheries of many of the region's cities has resulting in the degradation of valuable land resources and the creation of long-term environmental and human health problems. The events of July 2000 at the Quezon City garbage dump on the outskirts of Manila, where hundreds of people were killed by the collapse of a "seven storey high" open dump,

stands testament to the direct potential consequences of uncontrolled dumping.

Throughout the region, indiscriminate dumping has led to the contamination of surface and groundwater supplies, whilst open burning of waste contributes significantly to urban air pollution. At a global level, the uncontrolled release of methane, which is produced as a by-product of the decomposition of organic wastes, represents a significant proportion of the region's contribution to the greenhouse effect.

The increase in potentially hazardous industrial, biomedical and nuclear wastes has not been accompanied by a commensurate expansion in the provision of waste treatment and management facilities. The uncontrolled dumping of biomedical waste has the potential for transporting pathogens (disease producing organisms), whilst the indiscriminate disposal of oils, used batteries, discarded paints, spent chemicals and carcinogens, such as asbestos, can cause significant adverse impacts on human health and the environment. Various incidents of pollution have also been reported from industrial waste, abattoirs or food processing plants along with biocides and toxic effluents from sawmills and timber processing areas

Table 8.5 Impacts of Various Categories of Wastes on Water, Soil and Air in Selected Countries of Different Subregions

	Agricultural wastes and residues			Municipal wastes			Industrial wastes			Hazardous wastes		
	Water Pollution	Land Pollution	Air Pollution	Water Pollution	Land Pollution	Air Pollution	Water Pollution	Land Pollution	Air Pollution	Water Pollution	Land Pollution	Air Pollution
Australia	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍
Bangladesh	•	⊕	❍	•	⊕	⊕	•	⊕	❍	•	⊕	❍
Brunei Darussalam	❍	❍	❍	⊕	❍	❍	❍	❍	❍	❍	❍	❍
Cambodia	•	⊕	❍	•	⊕	❍	•	⊕	❍	•	⊕	❍
PR China	•	⊕	⊕	•	⊕	❍	•	⊕	❍	•	⊕	❍
Cooks Islands	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍
Fiji	⊕	⊕	❍	•	⊕	❍	•	⊕	❍	•	⊕	❍
Hong Kong, China	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍	⊕	❍	❍
India	•	⊕	❍	•	⊕	❍	•	⊕	⊕	•	⊕	❍
Indonesia	•	⊕	❍	•	•	❍	•	•	❍	•	⊕	❍
Japan	⊕	❍	❍	⊕	❍	❍	⊕	⊕	❍	⊕	⊕	❍
Kazakhstan	⊕	❍	❍	•	❍	❍	⊕	❍	❍	⊕	❍	❍
Kiribati	⊕	❍	❍	⊕	❍	❍	⊕	❍	❍	⊕	❍	❍
Lao People's Democratic Republic	•	⊕	❍	•	•	⊕	⊕	⊕	❍	⊕	⊕	❍
Malaysia	•	⊕	❍	•	⊕	❍	•	•	❍	•	•	❍
Maldives	⊕	❍	❍	⊕	❍	❍	⊕	❍	❍	⊕	❍	❍
Marshall Islands	⊕	❍	❍	⊕	⊕	❍	⊕	⊕	❍	⊕	❍	❍
Micronesia Federated States of	⊕	❍	❍	⊕	⊕	❍	⊕	❍	❍	⊕	⊕	❍
Mongolia	⊕	⊕	❍	•	⊕	❍	⊕	❍	❍	⊕	❍	❍
Myanmar	⊕	⊕	❍	•	•	❍	⊕	⊕	❍	⊕	⊕	❍
Nepal	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍
New Zealand	⊕	❍	❍	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍
Pakistan	⊕	⊕	❍	•	⊕	❍	•	⊕	⊕	•	⊕	⊕
Papua New Guinea	⊕	⊕	❍	•	⊕	❍	⊕	⊕	❍	⊕	⊕	❍
Philippines	•	⊕	❍	•	•	❍	•	•	❍	•	•	❍
Rep. of Korea	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍
Samoa	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍
Singapore	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Solomon Islands	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍
Sri Lanka	⊕	⊕	❍	•	⊕	❍	•	⊕	❍	•	⊕	❍
Tonga	⊕	⊕	❍	⊕	⊕	❍	⊕	❍	❍	⊕	❍	❍
Tuvalu	⊕	❍	❍	⊕	⊕	❍	⊕	❍	❍	⊕	❍	❍
Thailand	•	⊕	❍	•	•	❍	•	•	⊕	•	•	⊕
Vanuatu	❍	❍	❍	⊕	⊕	❍	⊕	⊕	❍	⊕	⊕	❍
Viet Nam	•	•	❍	•	•	❍	•	•	⊕	•	•	❍

Source: Anjello and Ranawana 1996, ESCAP 1997, Higham 1998, Hunt 1996, Kiser 1998, Koe and Aziz 1995, Leong and Quah 1995, ST 1995, World Bank 1995 and 1998, ENV 1997

Key: • severe ⊕ moderate ❍ moderate to negligible

(UNEP / SPREP 1997). The overall impacts of different categories of wastes on water, soil and air in some selected countries of various subregions are given in Table 8.5 (Anjello and Ranawana 1996, ESCAP 1997, Higham 1998, Hunt 1996, Kiser 1998, Koe and Aziz 1995, Leong and Quah 1995, ST 1995, World Bank 1995 and 1998, ENV 1997).

WASTE PROCESSING AND CONTROL

A. Current Waste Management Practices

As indicated in Table 8.6, the current practices employed in the management of solid waste within the Asian and Pacific Region vary considerably between the low, middle and high-income countries. The extent of application and the effectiveness of these practices are reviewed in the subsections that follow.

1. Municipal Solid Waste

(a) Collection and Transfer

In many cities of the region, municipal solid waste (MSW) is gathered in a variety of containers ranging from old kerosene cans and rattan baskets to used grocery bags and plastic drums or bins. In some cities, neighbourhood-dumping areas have been designated (formally or informally) on roadsides from which bagged and loose waste is collected.

Waste collection (and, where appropriate, waste transfer) frequently constitutes the major solid waste management cost for the region's cities. A wide variety of collection systems are used including door-to-door collection and indirect collection, by which containers, skips or communal bins are placed near markets, in residential areas and other appropriate locations. In the high-income industrialized countries of Australia, Japan, New Zealand, Republic of Korea

Table 8.6 Comparison of Typical Solid Waste Management Practices

Activity	Low income	Middle income	High income
Source reduction	No organized programmes, but reuse and low per capita waste generation rates are common.	Some discussion of source reduction, but rarely incorporated in to any organized programme.	Organized education programmes are beginning to emphasize source reduction and reuse of materials.
Collection	Sporadic and inefficient. Service is limited to high visibility areas, the wealthy, and businesses willing to pay.	Improved service and increased collection from residential areas. Larger vehicle fleet and more mechanization.	Collection rate greater than 90 per cent. Compactor trucks and highly machined vehicles are common.
Recycling	Most recycling is through the informal sector and waste picking. Mainly localized markets and imports of materials for recycling.	Informal sector still involved, some high technology sorting and processing facilities. Materials are often imported for recycling.	Recyclable material collection services and high technology sorting and processing facilities. Increasing attention towards long-term markets.
Composting	Rarely undertaken formally even though the waste stream has a high percentage of organic material.	Large composting plants are generally unsuccessful, some small-scale composting projects are more sustainable.	Becoming more popular at both backyard and large-scale facilities. Waste stream has a smaller portion of compostables than low and middle-income countries.
Incineration	Not common or successful because of high capital and operation costs, high moisture content in the waste, and high percentage of inerts.	Some incinerators are used, but experiencing financial and operational difficulties; not as common as high-income countries.	Prevalent in areas with high land costs. Most incinerators have some form of environmental controls and some type of energy recovery system.
Landfilling	Low-technology sites, usually open dumping of wastes.	Some controlled and sanitary landfills with some environmental controls. Open dumping is still common.	Sanitary landfills with a combination of liners, leak detection, leachate collection system, and gas collection and treatment systems.
Costs	Collection costs represent 80 to 90 per cent of the municipal solid waste management budget. Waste fees are regulated by some local governments, but the fee collection system is very inefficient.	Collection costs represent 50 to 80 per cent of the municipal solid waste management budget. Waste fees are regulated by some local and national governments, more innovation in fee collection.	Collection costs can represent less than 10 per cent of the budget. Large budget allocations to intermediate waste treatment facilities. Upfront community participation reduces costs and increases options available to waste planners (e.g. recycling and composting).

Source: World Bank 1999

and Singapore, collection and transfer services are capital-intensive and highly mechanized employing standardized collection vehicles, compactors and containers and providing collection rates in the range of 90 per cent and collection services to most urban and even rural areas. Source separation and subsequent collection of recyclables is governed by regulation and is facilitated by the provision of colour-coded bins or bags or by the establishment of area recycling centres. Whilst a significant number of these cities continue to retain parts of the collection process within their direct municipal control, many others have contracted private sector waste collection firms and have made private sector trade and industrial establishments responsible for the collection and disposal of their own solid waste.

In the middle-and low-income countries of the region, waste collection and transfer tend to be labour-intensive and are undertaken by personnel directly employed by the municipal authorities. Waste collection is undertaken using low-levels of mechanization with handcarts and tractor-trailers being used to collect waste from communal bins and neighbourhood dumping areas. The collection systems are relatively inefficient as the collection vehicles and containers are not fitted with compactors, necessitating the transportation of loose waste and, hence, imposing a constraint on the capacity of the collection system.

In some cities of the lower and middle income countries, such as Dhaka, Calcutta and Hanoi, collection rates are significantly less than 50 per cent, whilst collection rates of well over 50 per cent are achieved in Bangkok, Mumbai, Delhi, Jakarta, Kuala Lumpur, Manila and Shanghai. By comparison, collection rates in Hong Kong, China, Seoul, Singapore, Sydney and Tokyo are in excess of 90 per cent. There are, of course, disparities in collection services between the rich and poor areas and in a number of cities collection services are not extended to the poor, especially those in illegal settlements.

In some cities, decentralized pre-collection has proven effective in achieving increased collection rates. For example, the kampongs (villages) of Indonesian cities have formal responsibility for primary collection, the waste from each kampong being delivered to a transfer station or temporary storage point for collection by the city service. Delhi and Chennai employ similar systems and have achieved reasonably good collection systems as a result. Elsewhere, the lack of efficient transfer facilities represents a weak link in the MSW collection and transportation system. In cities such as Tokyo, Singapore and Sydney, transfer stations are used as a means of gathering waste from a sub-division of the city, compacting the waste to maximize transportation efficiency and then transferring the waste to larger haulage vehicles for delivery to the city's disposal sites. In addition, transfer stations often serve as material recovery centres where recyclables are separated for reuse/recycling. In developing countries, few cities have established well-designed transfer stations with sufficient facilities, equipment and vehicles to manage and process their collected waste.

Increasingly, collection services are being privatized. In the region as a whole, more than 20 per cent of the collection services are now contracted out to private waste collection companies. This practice is gaining momentum, especially in Australia; Hong Kong, China; Malaysia; Republic of Korea; Singapore and Thailand. In Singapore, as elsewhere, the main motivation for privatization is cost saving; the cost of collection and disposal of refuse has tripled during the last decade to more than US$700 million. In 1994, the Ministry of the Environment (ENV) with an authorized capital fund of US$250 million created a private limited company (SEMAC Pte Ltd.). In April 1996, SEMAC took over the collection unit of the ENV, allowing the Ministry to concentrates on its regulatory role of safeguarding public health and environmental standards through legislative and licensing controls (ENV 1997).

Financial constraints and the lack of technical expertise severely limit the effectiveness of solid waste management in the cities and towns of the poorer developing nations. Shortages of storage bins, collection vehicles, non-existent and/or inadequate transfer stations, traffic congestion and a lack of public compliance are factors affecting collection efficiency, resulting in low waste collection rates. In some cities, heaps of refuse are routinely left uncollected and there are illegal deposits on open land, drains and canals. The lack of coordination and overlapping of responsibilities among various government agencies and different levels of local government also contribute to the problem (UNEP/SPREP 1997).

(b) Material Recovery, Reuse and Recycling

In many countries of the region, including Japan, Republic of Korea and Singapore, the rate of recovery of recyclable materials from MSW has improved significantly in recent years (ENV 1997, Hara 1997). Within the region, overall resource recovery has grown from less than 10 per cent of all MSW in 1988 to 30 per cent in 1998, with much of the increase attributable to greater rates of recovery of paper and paperboard, plastics, glass and metals.

In terms of the total tonnage of materials recovered, paper and paperboard represent the largest category (almost 60 per cent of the total) and this

often masks the importance of recovery rates for other materials. For example, recovered aluminium represents only about 3 per cent of the total tonnage of recovered materials, yet in terms of its economic value, recovered aluminium far exceeds the paper product category.

Among the Asian and Pacific countries, Japan recycles huge quantities of materials from MSW stream. Almost half of the waste paper is retrieved or recycled in Japan and that the retrieval rate increased from about 48 per cent in 1990 to about 56 per cent in 1997. Similarly, between 1990 and 1997 the recycling rates of aluminium and steel cans increased from 40 per cent to 60 per cent and 45 per cent to 70 per cent respectively, whilst during the same period glass recycling rates increased from 48 per cent to 57 per cent (Hara 1997). Other countries of the region, such as Australia, Bangladesh, People's Republic of China, Malaysia, New Zealand, Philippines, Republic of Korea, Singapore and Thailand, recycle significant quantities of paper and cardboard, plastics, glass and metals; as an example the categories of materials recycled in Singapore in 1997 are shown in Table 8.7 (ENV 1997). In many cases, particularly in the more developed economies, recycling is undertaken at source (i.e. at the household, business and industry level) and is actively promoted by governments, NGOs and the private sector (United Nations 1995). Elsewhere, such as in Viet Nam (Hebert 1995, World Bank 1995), informal recycling networks have flourished despite the lack of formal promotion or support of the Government.

Waste recycling in developing countries relies largely on the informal recovery of materials by scavengers or waste pickers. In cities of the Asian and Pacific, it has been estimated that up to two per cent of the population survives by recovering materials from waste to sell for reuse or recycling or for their own consumption. In some cities these waste scavengers constitute large communities: approximately 15 000 squatters make their living by sifting through the Smoky Mountain municipal rubbish dump in Philippines (Anonymous 1995); it is estimated that in Bangalore there are between 20 000 to 30 000 scavengers (Hunt 1996); and Jakarta is served by between 15 000 and 20 000 waste pickers (Wahyono and Sahwan 1998). Some of these communities have high levels of organization and the creation of scavenger co-ops has gained momentum in some countries of the region including the Philippines, India and Indonesia (Medina 1998). The role and lifestyle of waste scavengers are highlighted in Box 8.1 (Hunt 1996, Pitot 1996).

Table 8.7 Various Categories of Materials Recycled from MSW in Singapore in 1997

Waste type	Estimated quantity in tonnes in 1997			Recycling rate (per cent)
	Total waste disposed	Total waste recycled	Total waste output	
Food waste	1 085 000	24 700	1 109 700	2.2
Paper/cardboard	576 000	324 000	900 000	36.0
Plastics	162 000	35 300	197 300	17.9
Construction debris	126 000	188 000	314 000	59.9
Wood/timber	249 000	34 800	283 800	12.3
Horticultural waste	75 400	67 600	143 000	47.3
Earth spoils	75 400	–	75 400	–
Ferrous metals	75 400	893 000	968 400	92.2
Non-ferrous metal	14 000	76 000	90 000	84.4
Used slag	120 000	135 000	255 000	52.9
Sludge (Industry/PUB)	50 200	–	50 200	–
Glass	30 800	4 600	35 400	13.0
Textile/leather	25 200	–	25 200	–
Scrap tyres	5 600	5 700	11 300	50.4
Others	126 000	1 300	127 300	1.0
Total	2 976 000	1 790 000	4 586 000	39.0

Source: ENV 1997

(c) Disposal Methods for MSW

Various disposal methods of municipal solid waste in selected countries/territories in the region are given in Table 8.8.

(i) Open Dumping

Open dumping is the most widespread method of solid waste disposal in the region and typically involves the uncontrolled disposal of waste without measures to control leachate, dust, odour, landfill gas or vermin. In some cities, open burning of waste is practised at dumpsites. In many coastal cities, waste is dumped along the shoreline and into the sea, such as Joyapura in Indonesian or dumped in coastal and inland wetlands and ravines as is being practised in Mumbai, Calcutta, Colombo, Dhaka and Manila (UNEP/SPREP 1997).

The scarcity of available land has led to the dumping of waste to very high levels; waste thickness is often over 12 metres and may be over 20 metres, which was the case of the Quezon City dumpsite in the Philippines.

An additional hazard on uncontrolled dumpsites arises from the build-up of landfill gas (predominantly methane), which has led to outbreaks of fire and to adverse health effects on workers and adjacent residents (Perla 1997, Wahyono and Sahwan 1998).

The scarcity of available land has also become a major problem for the disposal of solid waste in Small Island Developing States in the South Pacific subregion. Dumping at sea has frequently been

Box 8.1 Recycling: Fortunes and Costs

There are dozens of recycling enterprises in Hanoi, the Vietnamese capital, despite the fact that it remains one of Asia's poorest cities. The primary reasons for the scale of waste recycling are resource scarcity and poverty. It is estimated that scavengers in the city collect a daily average of 250 tonnes of waste materials, or more than ***one third*** of the 830 tonnes of refuse produced each day by the capital's 3 million residents. Amongst the materials collected are bottles, paper, metals and plastics.

As Hanoi is a resource-poor, labour-abundant city, nearly everything of value within the City's solid waste is extracted for recycling. The Hong Tien Industrial Cooperative, based in the Hai Ba Trung district, is typical of the enterprises that participate in the recycling of waste materials. The Cooperative specialises in transforming discarded plastic materials into marketable synthetic leather. Each week, during the four months preceding the start of the school year, the workers at Hong Tien take one tonne of old plastic sandals and turn them into 3 000 new red-and-black school bags. During the remaining eight months of the year, Hong Tien produces plastic sheeting that is used for many purposes. Hog Tien and numerous other similar enterprises form an extensive waste recycling network that has developed without government assistance and without the formation of commercial monopolies, as have emerged in many other big Asian cities including Bangkok, Dhaka, Calcutta, Jakarta, Manila and Beijing.

The waste scavengers of Hanoi operate at no cost to the city's municipal authority and provide both financial benefits to the society in the form of avoided costs (such as landfill space, collection and transportation, energy, employment generation, protection of public health) as well as ecological benefits in the form of resource conservation and environmental protection. The recycled materials from wastes work their way from the 'waste economy' back into a productive economy through an elaborate system of buyers. A network of scavengers and junk buyers (estimated to comprise some 6 000 people during the August peak season) collect discarded goods for onward sale to junk dealers, who in turn re-sell the materials in bulk to factories and exporters.

A large number of waste scavengers shuffle from house to house along the streets of Hanoi offering to buy empty beer cars, worn-out plastic sandals, old bottles and used newspapers. On productive days, each scavenger can earn up to Dong 20 000 (US$1.90), although on bad days they may take home almost nothing. It is estimated that some 1 500 families make their living by buying and selling waste materials and a trade network has emerged with clients from Hanoi and the surrounding provinces regularly visiting individual junk dealers to buy, and pre-order, specific types of recycled materials.

However, the business of waste scavenging is not without its human health costs and the rewards for some engaged in extracting materials from waste are inadequate to alleviate their poverty. In many cases, the scavengers picking over the mixed waste of the dumping grounds do not wear protective clothing nor do they have access to washing facilities. The majority of dumpsite scavengers are women and children, who live in overcrowded, poorly ventilated temporary huts, often on the peripheries of the waste dump. The scavengers seldom have access to public or private latrines, are malnourished and suffer from a range of illnesses including worm infections, scabies, respiratory tract infection, abdominal pain, fever and other unspecified diseases.

Source: 1. Hebert 1995
2. World Bank 1995

adopted as a solution with old cars and refrigerators being dumped into the lagoons of French Polynesia and municipal waste being bundled into wire gabions for use in sea wall construction in the Marshall Islands. In the latter case, the gabions allowed leachate and loose waste items to pass directly into the ocean water.

(ii) Landfilling

In the Asian and Pacific Region, the disposal of solid waste at a semi-engineered or full sanitary landfill has been adopted by cities from both low and high-income countries as the most attractive of disposal options. Bandung, Singapore, Hong Kong, China, Seoul, Chennai and Tokyo do have well-designed and reasonably operated sanitary landfills, whilst other cities in Australia, People's Republic of China, Japan, Republic of Korea, Malaysia and Thailand have adopted controlled tipping or sanitary land filling for solid waste disposal. Kuala Lumpur employs disused tin mines for MSW landfills around the city.

The generation of landfill gas has been turned to advantageous use at a number of landfills in the region through the development of electricity generation facilities. A landfill/biogas power generation facility is currently commencing construction in Ho Chi Minh City and others are planned for Chennai and, possibly, Colombo.

In the densely populated cities and towns of the region, the land availability for landfill siting is a major constraint. For example, in Hong Kong, China and in Singapore severe land constraints have led to complex engineering infrastructure solutions being developed to ensure high standards of operational and maintenance control and have enabled the development of acceptable landfill solutions in coastal areas, offshore islands and mountainous terrain. In Singapore, the two existing landfill sites are nearing their capacity and an offshore landfill at Pulau

Table 8.8 Disposal Methods for Municipal Solid Waste in Selected Countries of the Region

Country/ Territory	Disposal methods				
	Composting (per cent)	Open dumping (per cent)	Land filling (per cent)	Incineration (per cent)	Others* (per cent)
Australia	10	–	80	5	5
Bangladesh	–	95	–		5
PR China	10	50	30	2	8
Cook Islands	–	60	30	–	10
Fiji	–	90	–	–	10
Hong Kong, China	–	20	60	5	15
India	10	60	15	5	10
Indonesia	15	60	10	2	13
Japan	10	–	15	75	–
Kazakhstan	–	85	–	–	15
Rep. of Korea	5	20	60	5	10
Maldives	–	90	–	–	10
Malaysia	10	50	30	5	5
Mongolia	5	85	–	–	10
Myanmar	5	80	10	–	5
Nepal	5	70	10	–	15
New Zealand	5	–	85	–	10
Pakistan	5	80	5	–	10
Philippines	10	75	10	–	5
Papua New Guinea	–	80	–	5	15
Samoa	–	80	–	–	20
Singapore	–	–	30	70	–
Sri Lanka	5	85	–	–	10
Thailand	10	65	5	5	15
Viet Nam	10	70	–	–	20

Source: ENV 1997

*Animal feeding, dumping in water, ploughing into soil, and open burning.

Semakau is nearing completion at a cost of S$840 (US$500) million. The landfill consists of a 7 km long bund enclosing 350 hectares of sea that will take care of waste disposal needs of Singapore up to 2030 and beyond. The waste is put into cells and this will eventually rise to 15 metres above sea level (ST 1999).

(iii) Composting

Whilst small-scale composting of organic waste is widespread in the region, attempts to introduce large-scale composting as a means of reducing the quantities of municipal solid waste requiring disposal, or with the intention of creating a revenue stream from the sale of compost, have been met with limited success. Most of the composting plants in the region are neither functioning at full capacity nor do they produce compost of marketable value. The high operating and maintenance costs results in compost costs that are higher than commercially available fertilisers, whilst the lack of material segregation produces compost contaminated with plastic, glass and toxic residues. Under such circumstances, little of the compost produced is suitable for agriculture application.

The forced-air composting plant in Hanoi is a typical example. The plant is currently operating at 20 per cent of its design capacity, whilst the municipal authorities have been unable to persuade local farmers to take the product free as it is too contaminated with plastics and glass.

Elsewhere, small-scale neighbourhood composting is actively promoted through research and pilot projects. In Indonesia, such schemes have been underway for over a decade and small private enterprises have been established in Cipinang Besar and Watam (East Jakarta) that supply compost to estate gardens and golf courses. In Bandung, a box type windrow composting plant has been established alongside and existing dumpsite (Perla 1997), whilst Ho Chi Minh City has two small composting plants (World Bank 1995). Small-scale vermicomposting (a process that uses worms and micro-organisms to convert organic materials into nutrient-rich compost) of organic waste is carried out in open boxes or containers and is practised in People's Republic of China, India, Indonesia and Philippines (Perla 1997, Thom 1997).

At a slightly larger scale, the composting of organic MSW with agricultural waste and sludge from municipal sewage treatment plants is being piloted in Australia, Bangladesh, People's Republic of China, India, Philippines and Thailand. However, land availability, high operational, maintenance and transportation costs and incomplete waste material segregation remain major constraints to the adoption of co-composting.

(iv) Incineration

For much of the Asian and Pacific Region, the incineration of MSW remains an expensive and technically inappropriate waste disposal solution. The development of waste incineration facilities has been constrained by the high capital, operating and maintenance costs and by increasingly stringent air pollution control regulations (UNEP 1998). In addition, the combustible fraction of much of the MSW generated in the low and middle-income countries of the region is relatively low, with high organic and moisture contents. For example, the Indonesian city of Surabaya imported an incinerator that is currently operating at two-thirds of its design capacity as the waste needs to be dried on-site for five days before it is suitable for combustion. Even without the cost of air pollution control mechanisms, it is estimated that the cost of waste incineration in this instance is roughly 10 times greater than the cost of open dumping/land filling in other Indonesian cities.

Up-to-date, full-scale incinerators are currently in service only in countries such as Australia, People's

Republic of China, Hong Kong, China, Indonesia, Japan, Singapore and the Republic of Korea, where the combustible fraction of MSW is high and in some instances has been raised by moisture-reducing compaction at transfer stations.

The three incinerators operating in Singapore burn more than 75 per cent of the 6 700 tonnes of MSW that is collected each day (ENV 1997) and a fourth incinerator with a capacity of 3 000 tonnes per day is expected to become operational during 2000. The total electrical generated by the existing plants is about 60 megawatts (250 to 300 kWh / tonne MSW incinerated), a portion of which is used to run incinerator operations, and the balance is sold to the national electricity grid. The planned new plant, costing S$1 billion, will generate 80 megawatts of electricity of which 20 megawatts will be consumed by the plant and the remainder will be sold to Singapore Power (ENV 1997).

The Republic of Korea plans to raise the incinerated portion of their MSW from 8.9 per cent in 1998 to 20 per cent by 2001 (Government of the Republic of Korea, 1999), whilst Japan has 1900 existing waste incinerators, of which 1584 incinerators are operated by local governments with the balance run by private companies (ASIAN WATER 1999). In People's Republic of China, Beihai, Shenyang, Guangzhou, Beijing and Shanghai have all begun constructing incineration plants for MSW with foreign assistance. Hong Kong, China has closed its incinerators because they could not meet air pollution standards, but new plants are under consideration (Wan *et al* 1998).

2. Industrial Solid Waste

The methods employed in the disposal of industrial solid waste are broadly the same as those used to dispose of MSW and comprise open dumping, land filling (both semi-engineered and sanitary landfilling) and incineration.

In many countries, including Bangladesh, People's Republic of China, India, Indonesia, Malaysia, Philippines and Thailand, non-hazardous industrial solid waste is accepted at either open dumps or landfills along with municipal solid waste (although where facilities are available potentially hazardous industrial solid waste is disposed of either in secure landfills or is incinerated). In those developing countries with few waste management facilities, industrial waste is often dumped on private land or is buried in dump pits within or adjacent to the site of the industrial facility from which it has emanated.

3. Agricultural Waste and Residues

The principal disposal methods for agricultural waste, in a number of selected countries within the region, are presented in Table 8.9.

Table 8.9 Disposal Methods of Agricultural Waste and Residues in Selected Countries in the Region/Area

Country	Disposal methods of agricultural waste and residues						
	Land application	Fish farming	Composting	Biogas production	Utilization as		
					Fuel	Animal feed	Building materials
Australia	❍	❒	●	❍	❒	❍	❒
Bangladesh	❍	❒	❒	❒	●	❍	●
Cambodia	❍	❍	❍	❍	●	❍	●
PR China	●	●	●	●	●	●	●
India	●	❍	●	●	●	●	●
Indonesia	●	●	●	❍	●	●	❍
Japan	❍	❍	●	❍	❍	❍	❍
Lao People's Democratic Republic	❍	❍	❍	❒	●	●	●
Malaysia	❍	❍	●	❍	●	●	❍
Myanmar	❍	❍	❍	❍	❍	❍	●
Nepal	❒	❒	❒	❒	❍	❍	❒
New Zealand	❍	❒	❍	❍	❍	❍	❒
Pakistan	❒	❒	❍	❍	❍	❍	❒
Philippines	❍	❍	●	●	●	●	●
Rep. of Korea	❍	❍	●	❍	❍	❍	❍
Sri Lanka	❒	❒	❍	❍	❍	❍	❍
Thailand	●	●	●	●	●	●	●
Viet Nam	●	●	●	●	●	●	●

Source: ESCAP 1997

Legend: ● High ❍ Moderate ❒ Low

In most traditional, sedentary agricultural systems, farmers use the land application of raw or composted agricultural wastes as a means of recycling of valuable nutrients and organics back into the soil and this remains the most widespread means of disposal. Similarly, fish farming communities in Bangladesh, People's Republic of China, India, Indonesia, Malaysia, Philippines, Thailand and Viet Nam commonly integrate fish rearing with agricultural activities such as livestock husbandry, vegetable and paddy cultivation and fruit farming (Fauzia and Rosenani 1997, UNEP 1997).

Many countries with agricultural-based economies use agricultural wastes to produce biogas through anaerobic digestion. The biogas (approximately 60 per cent methane) is primarily used directly for cooking, heating and lighting, whilst the slurry from the anaerobic digesters is used as liquid fertiliser, a feed supplement for cattle and pigs and as a medium for soaking seeds prior to germination (Hendersen and Chang 1997).

Purpose-built sanitary landfills have been developed to receive hazardous waste in Australia, Japan, Malaysia, New Zealand and Republic of Korea, whilst hazardous waste incinerators have been developed in Australia, Japan, Hong Kong, China, Malaysia, Republic of Korea, Singapore and Thailand (ASIAN WATER 1998, World Bank 1998). Other countries such as Bangladesh, People's Republic of China, India, Mongolia, the Philippines, Pakistan, Sri Lanka and many Island States in the South Pacific subregion usually co-dispose hazardous waste along with MSW in open dumps or seek to store particularly toxic wastes in sealed containers (United Nations 1995, UNEP / SPREP 1997).

In some countries, including Australia, Japan, Hong Kong, China, Republic of Korea and Singapore, progress has been made on methods for detoxification of hazardous waste and subsequent immobilization by fabrication into bricks and other usable materials.

In Thailand, a major programme of hazardous waste management is underway along the Eastern Seaboard where petrochemical, chemical and non-ferrous industries produce some 250 000 to 300 000 tonnes of commercially viable hazardous industrial waste each year. A hazardous waste treatment plant, managed by the Industrial Estate Authority of Thailand, has been established at the Map Ta Phut Industrial Estate, a focal point of the country's petrochemical and chemical industries.

In Malaysia, the Bukit Nanas Integrated Waste Treatment Facility is the country's first comprehensive treatment plant possessing various facilities including high-temperature incineration, physical and chemical treatment, stabilization and a secure landfill (Malaysia 1998). A centralized hazardous waste treatment facility has also been developed in West Java (Indonesia) to treat hazardous waste from JABOTABEK (Jakarta, Bogor, Tangeran, and Behasi) industrial area. Between 1994 and 1997, the facility increased the quantities of treated hazardous waste from 9.7 tonnes to 29 tonnes, although the economic and political crisis of 1998-1999 saw industrial production slump with a commensurate decline in the quantities of waste treated to 16.6 tonnes in 1998, before increasing to 18.8 tonnes in 1999.

Japan possesses well-developed systems for treating and disposing of the 500 million tonnes of hazardous waste produced by its industries each year. Recycling and material recovery are encouraged to reduce the net amount of wastes requiring treatment and disposal and purpose-build landfills have been developed to receive hazardous waste. However, the most widely practised disposal options is incineration with some 3 840 hazardous industrial waste incinerators across the country (ASIAN WATER 1999), many of which have energy recovery facility to provide heating or for electrical power generation.

In Hong Kong, China, the Chemical Waste Treatment Centre (CWTC) receives most of the hazardous wastes generated by industries (Chua et al 1999) with some solid chemical wastes, including asbestos, tannery off-cuts and treatment residues being co-disposed at landfills.

4. Biomedical Waste

The number of hospitals and health care institutions in the Asian and Pacific Region has been increasing to meet the medical and health care requirements of the growing population. Although city planners have long taken into consideration the provision of medical and health care institutions and services, until recent years, they, and even municipal waste management authorities, have paid very little attention to the wastes generated from these facilities, which are potentially hazardous to human health and the environment.

In recent years, however, serious concern has arisen regarding the potential for spreading pathogens, as well as causing environmental contamination due to the improper handling and management of clinical and biomedical waste. Whilst regulatory programmes and guidelines to control waste from such institutions have been introduced in most developed countries, including Australia, Japan, New Zealand, and Singapore, in developing countries, such as Bangladesh, People's Republic of China, India, Indonesia, Pakistan and the Philippines, such programmes have yet to be fully developed (Ogawa 1993, WHO 1996, UNEP / SPREP 1997).

In Australia, the National Health and Medical Research Council has published national guidelines

for management of clinical and related wastes and similar biomedical management guidelines have also been produced at the state level. In Japan, the Ministry of Health and Welfare has established a working group who has prepared guidelines for medical waste management. The Standards Association of New Zealand has published the "New Zealand Standards on Health Care-Waste Management" to rationalize and recommend methods for the management of health care wastes within the country. In Singapore, guidelines were drafted for the management and safe disposal of hospital wastes in July 1988 and the Ministry of the Environment subsequently produced the "Hospital Waste Management Manual," which included detailed guidelines for hospital waste handling and disposal and a standard format to assist hospitals in preparing their written policies and procedures. Similarly, in Malaysia the Ministry of Health prepared preliminary guidelines for the management of hospital waste in 1988, whilst the Philippines' Department of Health prepared guidelines in 1990 on effective and efficient methods of collection, storage, and disposal of hazardous waste by hospitals, clinics, and research laboratories.

However, whilst China's National Environmental Protection Agency has recently formulated the Solid Waste Pollution Prevention and Control Law and the Regulations on Management of Hazardous Wastes, hospital waste is generally collected and disposed of together with other domestic wastes and the hospital and waste management authorities have low levels of awareness regarding the dangers associated with infectious biomedical waste (WHO 1996).

In many of the countries of the region, individual hospitals have installed on-site incinerators for the disposal of clinical wastes, although these are often poorly designed and operated and the level of awareness of the dangers by workers is low (UNEP/SPREP 1997).

5. Radioactive Waste

Information regarding disposal practices for radioactive waste is not extensive and few systematic country surveys have been conducted. In Japan, low level radioactive waste generated from 46 operating nuclear power plants is packed into 2 000 litre drums and temporarily stored in on-site storehouses. Special enclosed containers are used to package eight drums together and these are then sea and land transported to the Rokkasho-mura Burial Centre in Aomori Prefecture for permanent storage (Tanaka 1993). In Indonesia, low level radioactive waste generated from four nuclear research centres is conditioned into cement matrices in blocks and the embedded waste blocks are transported to the RWMC (Radioactive Waste Management Centre) at Serpong for permanent burial (Suyanto and Yatim 1993). Other countries of the region such as India, Pakistan and Republic of Korea uses permanent land burial methods for the disposal of radioactive waste (Greenpeace 1998).

6. Transboundary Movement of Hazardous Waste

The Asian and the Pacific Region is under considerable pressure as a favoured dumping ground for hazardous waste, particularly as domestic pressure has been exerted on industries operating in the industrial nations to dispose of their hazardous waste in a controlled, and hence expensive, manner. Between 1994 and 1997, the industrialized nations sent a total of 3.5 million tonnes of hazardous waste to countries in the Asian and Pacific Region. The first documented case of such imports to People's Republic of China occurred in September 1994 and by the first quarter of 1995, Chinese customs identified 22 separate incidents involving some 3,000 tonnes of foreign hazardous waste. From 1995 to 1996 Chinese customs uncovered almost one case per week of mislabelled hazardous waste, mostly from United States, Republic of Korea, and Japan in particular (Greenpeace 1997). In June 1998, 640 tonnes of Californian waste was found dumped in a Beijing suburb; the waste included toxic sludge, used syringes and decomposing animal bodies (Greenpeace 1997).

Over the same period, India has also seen an increase in the dumping of hazardous waste from industrialized nations (Anjello and Ranawana 1996, Agarwal 1998). Thousands of tonnes of toxic waste are being illegally shipped to India for recycling or dumping, despite a New Delhi court order banning imports of toxic materials. In 1995, Australia exported more than 1 450 tonnes of hazardous waste, including scrap lead batteries, zinc and copper ash, to India, whilst some 569 tonnes of lead battery waste were brought in through the main seaport of Mumbai between October 1996 and January 1997 (Greenpeace 1998).

Despite international agreements, substantial quantities of PVC waste is still exported to Asia as shown in Box 8.2 (Greenpeace 1998).

Various attempts by industry to use the islands of the Pacific as dump sites for hazardous waste (in association with power co-generation) have not been successful largely due to heightened awareness created through the negotiation of the subregional Waigani Convention on transboundary movement of hazardous and radioactive wastes.

However, other countries of the region like Bangladesh, Pakistan, Indonesia, Philippines and Thailand have become dumping grounds of huge

Box 8.2 PVC Waste Export to Asia Despite International Agreement

Between 1990 and 1998, over 100 000 tonnes of PVC waste produced in the Netherlands have been exported to Nigeria, Pakistan and the Philippines. For example, investigations undertaken by the environmental activist organization, Greenpeace, have identified the Dutch export company, Daly Plastics BV, as the holders of a permit for shipping 3 500 tonnes of PVC (approximately 140 truckloads) to one single company in the Philippines in 1998. This quantity of PVC waste is more than the post consumer waste that is recycled in the Netherlands every year.

The Dutch plastic waste exported to Asia is recycled into a range of often poor quality products for which there is no demand in the Netherlands or elsewhere in the industrialized world. For example, the pipes manufactured in the Philippines from recycled plastic are suitable only for temporary projects or low-cost housing. Furthermore, the recycling of PVC in countries with few or unenforced environmental regulations results in workers and nearby residents being exposed to chlorine and other toxic additives that are released during the recycling process. Workers in recycling factories in Pakistan and the Philippines often operate under unhealthy working conditions and respiratory problems, allergies, skin and eye irritations are common.

The primary reasons for PVC waste not being recycled in the country of origin, are the higher wages and production standards of the home market. Unfortunately, even recycled PVC from the industrialized nations often ends up on an Asian dumpsite; such plastics are frequently incinerated in open fires on the dumpsites, thereby releasing dioxin and other toxic substances into the surrounding environment.

In 1994, the Parties of the Basel Convention agreed to ban the export of hazardous waste from OECD to non-OECD countries for dumping and recycling purposes. The ban, which took effect in January 1998, was ratified by the European Union in September 1997. European legislation has been amended accordingly. Since it came into existence, the ban has faced fierce opposition from countries that wanted to keep exporting hazardous waste.

Greenpeace continues to oppose the export of PVC waste and recommends that countries that cannot fully manage the lifecycle of PVC should not be producing it and that instead of assessing poor countries for their capacity to treat PVC waste, the countries producing such waste should rather assess their own production technology, so as to promote non-toxic alternatives.

Source: Greenpeace 1998

quantities of hazardous waste for the exporters of industrialized countries both within and outside the region (Greenpeace 1998).

B. Critical Problems and Shortcomings

Many countries in the Asian and Pacific Region face critical problems with regard to waste management. A range of common shortcomings has been identified, including insufficient government priority and political support for action; lack of finance; inadequate long-term planning, indiscriminate disposal of waste; poor handling and disposal of hazardous and biomedical wastes; insufficient recycling and reuse; ineffective legislation and institutions; lack of skilled personnel; and poor monitoring and enforcement.

The prevailing view in many countries, particularly in respect of industrial waste, is that it is not possible to constrain the growth of economy by forcing industry and municipalities into introducing sophisticated and expensive waste treatment and disposal technologies. The short-sighted nature of such a policy, with implications for the long-term problems and costs of waste treatment has yet to be realized or understood in many countries in the region.

A number of problems lie in the political structure of the countries and the government authorities and in the inadequate enforcement of environmental legislation. Roles and responsibilities of many government agencies dealing with waste involve a complex mixture of operational, industrial, commercial and administrative functions. These agencies suffer from a high degree of inefficiency caused by: highly bureaucrat structure; lack of transparency and accountability in decision-making; low salaries; corruption; nepotism and/or selection of inadequate qualified personnel; difficult and complicated methods of procurement; and strong influence of political authorities in technical decisions regarding waste management. Very often, this is connected with the lack of appropriate management systems and a high level of dependency on the budget allocated. The often extremely low levels of salary paid to the government officers forces them towards corruption.

Private sector incentives and initiatives in waste management in many countries are still rare and the responsible authorities are seldom willing to see the provision of waste management services given into private hands. There is a general lack of funding which may be used to establish a waste management system operated by private contractors. In addition, there is also a very low level of public awareness and participation regarding waste management. This is because people are not sufficiently informed about

the health and economic benefits of proper waste collection, treatment and disposal.

Much of the existing infrastructure and facilities for the waste collection, treatment and disposal have not kept pace with the economic development in recent years. It is not the lack of knowledge but the lack of finance and administration that is the main reason for the growing inefficiency of waste management practices in the region. Particularly in smaller cities and rural areas (where the patterns of consumption have also changed), the existing standards of waste collection, treatment and disposal remain very low. Adoption of inappropriate technologies creates many problems in the region. There are countless examples of plant failure.

Many problems exist especially for municipal solid waste collection, processing and disposal in the cities of Asia and the Pacific. Waste collection services are often sporadic as they rely upon insufficient numbers of vehicles, which are often old, under-maintained and unreliable. Open vehicles lose part of their load during their trips to the disposal site. Another severe problem is the lack of spare parts of collection vehicles. Collection workers try to earn extra money (sometimes they even have contracts with junk dealers) by sorting out materials or other items from the waste awaiting collection, i.e., they devote much time to this activity and neglect their main duty. Generally, a great deal of time is lost in transporting waste; collection vehicles sometimes need several hours just to travel from the city to the dump site/landfill site because of the heavy traffic and crowded streets. Collection is irregular: again open dumping at the roadside, along and in water channels, rivers and along railways is quite normal. Disposal is often to uncontrolled open dumping sites and, in many countries, industrial hazardous waste and biomedical waste are brought to the same dumpsites.

Waste management practices are most effective where they form part of a robust and integrated approach to the collection and disposal of all generated wastes. At present, however, waste management is given relatively low priority in many countries of the region despite increasing loads that stretch the already limited resources of waste collection and disposal agencies.

WASTE MANAGEMENT POLICIES AND STRATEGIES

Waste management, like many other environmental issues, is multisectoral in nature and encompasses policy making, strategies thinking, the development of legal-institutional-financial-and-administrative frameworks as well as the functional design, implementation, operation and management of waste handling facilities. Although within the region there are excellent examples of integrated waste management systems (including the policies and strategies, developed in Australia, Japan and Singapore, designed to manage waste using a cradle to grave approach), most countries have not developed the necessary waste management policies and strategies, legislation and institutional frameworks. For example, whilst environmental legislation appears on the statute books, few countries have introduced specific waste management regulations relying instead upon outdated unspecific legislation (e.g. public health acts, litter laws) which are seldom or poorly enforced.

Waste management is often hampered by a lack of national policy direction with no clear allocation of responsibilities and little or no national level planning to develop integrated waste management policies and strategies.

Financing remains a critical issue in most regional waste management operations. No sustainable funding plans have been developed or are in place in many countries. Of great concern is that most of the recent documentation on the regional waste management contains little or nothing on this key issue. In addition, there seems to be reluctance or lack of initiatives to move to commercialising waste management activities and few realistic ideas have been tested in raising revenues in the region.

A. National Policies and Strategies

1. Stakeholders, Institutions and Legislation

Many groups of stakeholders, including waste producers, regulators, legislators, consultants, contractors, process and equipment suppliers, educators, NGOs, media and the general public, are involved in national waste management policies and strategies in the region. Although each of these stakeholders plays a potential role, three groups (municipalities and industry (generators), governments (regulators) and legislators provide the key to effective national waste management policies and strategies that integrate the responsibilities of all stakeholders in making waste management a successful venture.

Institutions and legislation at the national level generally provide the basic infrastructure for the implementation of policies, strategies and actions for waste management. In recent years, three general trends in waste management institutions and legislation have been evident in the region. These are the creation of institutions for the strengthening of environmental policies and strategies, the

development of more focussed environmental legislation, and the increase of manpower capabilities through education and training.

There has been an upward trend in the status of the above three aspects of waste management, as government ministries and high level agencies have been established specifically to control such activities. However, the lack of funds impedes implementation and enforcement actions and sometimes a lack of community involvement and community participation is a major constraint on improving the standard of waste management services. In some countries, there is an encouraging trend in increased budgetary resources and manpower capabilities for the waste management sector. The current status of national institutions, legislation and manpower capabilities for overall waste management in selected countries of the region are given in Table 8.10 (ESCAP 1994, United Nations 1995, 1996; Blum 1995; CITYNET/UNDP 1996, UNEP/SPREP 1997; World Bank 1998). However, despite these advances, solid waste management in many countries remains diffused due to parallel and over lapping responsibilities.

Table 8.10 Current Status of Overall Waste Management in Selected Countries of the Region

Country /Territory	Legislations	Institutions	Manpower capabilities
Australia	XXX	XXX	XXX
Bangladesh	XX	X	X
Brunei Darussalam	XX	XX	XX
PR China	XX	XX	XX
Cooks Island	XX	XX	XX
Fiji	X	X	X
Hong Kong, China	XXX	XXX	XXX
India	XX	XX	XX
Indonesia	XXX	XX	XX
Japan	XXX	XXX	XXX
Kazakhstan	X	X	X
Rep. of Korea	XXX	XXX	XXX
Maldives	X	X	X
Malaysia	XXX	XX	XX
Mongolia	X	X	X
Myanmar	X	X	X
Nepal	XX	X	X
New Zealand	XXX	XXX	XXX
Pakistan	XX	XX	XX
Philippines	XX	XX	XX
Papua New Guinea	X	X	X
Samoa	XX	XX	XX
Singapore	XXX	XXX	XXX
Sri Lanka	XX	XX	XX
Thailand	XXX	XX	XX
Viet Nam	XX	X	X

Source: United Nations 1995, Blum 1995, CITYNET/UNDP 1996

Legend: XXX Extensive coverage
XX Moderate coverage
X Minimal coverage

2. Waste Minimization and Recycling

Minimizing the quantities of waste requiring disposal, through source reduction, material recovery and reuse and recycling, is increasingly being realized as the central basis of an integrated approach to waste management. In some countries, such as Japan and Singapore, a reduction in the quantities of waste generated at source has been promoted through the regulation of industry, economic instruments to encourage plant modification or redesign and the education of consumers in the benefits of environment-friendly products. However, the ultimate success of waste minimization depends on cleaner production, which is increasingly being advocated in many developed and developing countries in the region as a more efficient and modern practice than conventional waste management practices (ASEAN/UNDP 1998, World Bank 1998). In some countries, the adoption of cleaner production programmes has reduced the need for end-of-pipe investments in waste treatment in industries and has therefore provided both financial and economic net benefits; these are discussed further in Box 8.3 (United Nations 1995, Aziz and Ng 1998, ASEAN/UNDP 1998, World Bank 1998).

Waste minimization by waste exchange is another option which is practised in some countries. The Industrial Waste Exchange of the Philippines (IWEP) serves as a link between companies that mutually benefit from a waste exchange. At least 600 industrial waste products (including organic and inorganic chemicals, solvents, oils, greases, waxes, acids, alkalis, metals, metallic sludges, plastics, textiles, leather, rubber, wood, paper, and glass) are advertised for exchange with other industries and the IWEP catalogue lists over 130 further waste products that are sought for exchange. Each product is assigned a code to ensure that the producing company's identity and location remain confidential and technical information, such as pH and the presence of any contaminants present is indicated. When two companies come to an agreement, the IWEP withdraws and leaves the producers and users to negotiate directly.

In addition to achieving reductions in the quantities of materials disposed of as waste, the waste exchange scheme has provided substantial benefits to a variety of companies through providing savings in disposal and raw materials costs and in improving the company's public image. For example, Del Monte Philippines, Inc. once spent over P 1.5 million a year to dispose of waste pulp generated by the processing

Box 8.3 Waste to Profits: Some Success Stories of Waste Minimization through Cleaner Production (CP) Programmes

People's Republic of China – At the request of China's National Environmental Protection Agency (NEPA), a US$6 million cleaner production component was included in the World Banks' Environmental Technical Assistance Project, approved in 1993. Under this Cleaner Production Programme, studies were undertaken of waste arisings in 18 industries. A large distillery was one of the plants involved and an initial assessment of the bottling plant identified good housekeeping options that costs less than US$2 000 to implement and resulted in savings of over US$70 000. This initial success was followed by a detailed study of an alcohol plant that identified a number of equipment optimizations, which produced nearly US$700 000 in savings. Three technology replacement options were also identified, costing up to US$500 000 and with paybacks of between one and a half to four and a half years.

India – In 1993, a cleaner production demonstration project targeting small and medium sized enterprises (SMEs) was initiated by UNIDO, in cooperation with the Indian National Productivity Council and other industry associations. This DESIRE (Demonstration in Small Industries for Reducing Waste) project focused on three sectors: agro-based pulp and paper, textile dying and printing, and pesticides formulation. Collectively, the 12 companies spent US$300 000 on the implementation of pollution prevention options through cleaner production and saved US$3 milion in raw materials and wastewater treatment costs. The most impressive savings were in the pulp and paper sector, where the Ashoka Pulp and Paper Company invested a total of US$95 000 in the implementation of 24 recommended production changes and achieved a net annual saving of about US$160 000. In this case, the overall payback of the investment was less than seven months.

Philippines – Through the Philippines Clean Technology Initiatives, companies such as Del Monte Inc. Philippines, Peter Paul Philippine Corporation, Central Azucarera Sugar Milling and Refining (the Philippines), and Pilipinas Kao Inc., adopted cleaner production systems. Each of these companies obtained significant economic benefits through measures such as water saving, reduction in waste loads, and cost saving in waste treatment and disposal.

Other Countries – ICI P Paints, PT Unilever, PT Tifico, PT Semen Cibinong, PT Indah Kiat Pulp and Paper Corporation of Indonesia, Golden Hope Plantations Berhad of Malaysia. Chartered Metal Industries Pte Ltd. of singapore and Cheng Sang industry Co., Ltd. of Thailand adopted cleaner Production techniques which resulted in economic benefits in the form of increased productivity, savings in chemicals, water and fuel, and reductions in waste load and the cost of waste treatment and disposal.

Source: UNIDO 1997, World Bank 1998, and ASEAN / UNDP 1998

and canning of pineapples. The waste pulp is now sold to the Philippines Sinter Corporation (PSC) for P 1.4 million a year for a total of nearly P 3 million in savings and additional revenue. The PSC dries the pulp and exports it to Japan to use as cattle feed. Similarly, Maria Christina Chemical Industries Corporation (MCCI) now sells its carbide sludge wastes to the National Steel Corporation (NSC) for use as a neutralizer in its waste treatment plant at P 330 per tonne – compared to the P 1 500 per tonne that the NSC previously paid for fresh reagent. For its part the NSC produces about 15 000 tonnes per year of mill scale waste which is sold to MCCI for use in the production of ferrosilicon alloys (United Nations 1995, ASEAN / UNDP 1998).

The rate of recycling materials from waste has increased dramatically in recent years in the Asian and Pacific Region. Recycling of waste materials grew from less than 10 per cent in 1990 to 22 per cent in 1998. Most of that increase is attributable to greater rates of recovery of paper and paperboard, plastics, aluminium cans, glass, etc. The paper and paperboard category is dominated in terms of total tonnes of material recovered (almost 60 per cent) followed by plastics, aluminium cans, and glasses. The informal sector plays a significant role in waste recycling in the region. Waste pickers perform the recycling operations in many cities of the region and in resource-poor and labour-abundant economies, such as those in Bangladesh, People's Republic of China, India, Indonesia and Thailand, material recovery and recycling assume particular economic significance. Recycling not only reduces the volume of wastes to be disposed, but also saves these countries valuable foreign exchange which would otherwise be used to import raw materials. Waste reduction through recycling and reuse in People's Republic of China and Singapore has emerged recently as an environmental priority. The governments' goal is to increase recycling of waste from present 10 per cent to 25 per cent in 2002. Republic of Korea recycled 59.5 per cent of its waste in 1998 and, the following year, introduced a system for controlling the use of disposable goods, such as disposable cups and containers, plastic bags, and disposable razors and toothbrushes. Recycling in Australia, People's Republic of China, India and the Philippines has improved dramatically over the last decade and such improvements are likely to continue in the foreseeable future.

3. Private Sector Participation

The rationale for the privatization of waste management services is mainly economic. Evidence

seems to indicate that public provision is more costly and frequently unsatisfactory due to the inefficiency and rigidity of public bodies. Privatization basically involves the transfer of management responsibility and/or ownership from the public to the private sector and has proven to be a powerful means of improving the efficiency of some waste management services such as collection, haulage, and disposal. There are even examples where such initiatives have been led by direct partnerships between the local community and the private sector in the management of urban waste (see Box 8.4).

A number of countries in the Asian and Pacific Region have introduced at least partial privatization into their waste management systems. Hong Kong, China has entered into long term DBO (design build and operate) contracts for three major sanitary landfills and four large transfer stations as well as for the collection and treatment of chemical waste (Fernandez 1993, United Nations 1995). It is also expanding the participation of the private sector through the intended placing of contracts for the collection and treatment of medical waste, the storage of low-level radioactive waste and the remediation of its closed landfills. Macao, China has let two fourteen-year contracts for the operation and maintenance of its waste-to-energy incinerator and for waste collection, street cleansing and beach cleaning services.

In Malaysia, the privatization of solid waste management commenced in 1997 with a privatization policy oriented towards reducing the Government's financial and administrative burden; promoting competition, increasing the role of the private sector in nation building and providing opportunities to meeting the targeted new economic policy. Privatization has also resulted in the growth of private companies specialising in the waste business and these often complement the services that are mainly provided by the Local Authorities. Several municipalities in Malaysia have let smaller-scale solid waste collection contracts. Selangor and Penang are currently using private sector landfill arrangements and the Federal Government is planning to extend these schemes nationally. Singapore has already engaged private contractors to collect municipal solid waste and private contractors will have roles in its Tuas transfer station and Pulau Semaku landfill. Several cities in People's Republic of China are finalising deals both from local and foreign contractors, mainly in the waste-to-energy field.

In Thailand and Indonesia, there are limited attempts to contract-out the disposal of hazardous wastes, but there are some contracting-out

Box 8.4 Private Sector Initiative towards Urban Waste Management in Pakistan

Rotting garbage creating a health hazard is a common sight in many parts of Karachi. It is also a civic menace for city-dwellers. Municipal authorities have failed to address the issue of solid waste disposal due to lack of capacity. Once it leaves the house, waste is often dumped on any vacant plot of land, or on streets, for want of a proper neighbourhood dumpsite. Where a site exists-usually a low four-wall structure open to the air-waste is more likely to be found lying outside rather than within this makeshift "receptacle". Scavengers rummage there for recyclables, but a large part of garbage remains because there is no regular waste collection service to ensure that the waste is cleared away daily. Waste Busters, a private enterprise has now become active to offer a solution to the poor.

Waste Busters began life three years ago as the Lahore Sanitation Programme. They aimed at providing solid waste disposal services through recycling. They are now called Waste Busters and have branches in Islamabad and Karachi. For Rs100 a month, Waste Busters provide a daily collection service to households who share a concern for the environment. In Lahore, Waste Busters service 10 000 eco-conscious households in Gulberg, Shadman, Model Town, Muslim Town and Cantonment areas. They employ 200 people and an average 50 tonnes of waste is collected and disposed of daily.

In order to manage waste properly, collection isn't enough. Waste Busters now sorts out materials like plastic, glass, paper and organic waste retrieved for recycling purposes. The enterprise divides the city into zones and each zone requires a transfer station where the waste is taken after being collected, for sorting.

In Lahore, organic waste is being efficiently sorted and turned into compost which is sold to farmers and nurseries to be used as fertilizer. The sorting is done at transfer stations set up by Waste Busters at sites allocated by the local municipal administration.

Unfortunately, sorting at source, the mode employed in the West, doesn't work in Lahore. The Waste Busters tried getting households just to separate the organic waste from other household waste but it didn't happen.

Waste Busters are not keen to incur the wrath of the big waste dealers, nor do they want to rob scavengers of their livelihood. "In fact, in Lahore they invite the scavengers to their transfer stations to sort the waste for them and buy it off them."

Eventually the Waste Busters would like to progress from a self-sustaining to a profitable operation. That has already begun to happen in Lahore where the daily production of an average 500 bags of the organic fertilizer, along with the sale of other recyclable material to recycling industries, has brought Waste Busters out of the red.

Source: Sahar Ali 1999

arrangements for collection and disposal of municipal solid wastes and non-hazardous industrial waste generated in Bangkok (Kiser 1998). The Bangkok Metropolitan Administration (BMA) strongly supports privatising medical waste management services. There are some private arrangements for solid waste collection in Japan, Republic of Korea, the Philippines and in Sri Lanka and contracting out of hazardous waste disposal is being pursued in Malaysia and Thailand (Sandra 1994).

Throughout the region, there is a discernible trend towards private sector participation in solid waste management. The examples of Hong Kong, China and Macau China are extremely useful model for cities that have reached the point at which they were ready to improve their waste management arrangements and which carefully considered why and how contracting-out to the private sector was the best means of accomplishing their objectives. The results, in terms of environmental improvement and financial savings, are amply documented in these two cities.

4. Economic and Financial Strategies

In some countries of Asia and the Pacific, including Australia, Japan, the Philippines, Republic of Korea and Singapore, a number of different economic tools have been integrated into their strategic waste management plan to ensure that waste in all its forms is minimized, that revenues for waste management are raised, and that, wherever possible, the polluter / user pays.

Different stages of the production and consumption process have produced different forms of waste in the region. The challenge has been to choose the right economic tool given the stage at which the waste has been produced. For example: licences, permits and extraction charges have been used to ensure that excessive use and waste of natural resources inputs does not occur; tax deductions, pollution taxes, and input and product taxes have been used to ensure that clean production practices are encouraged and rewarded; refundable deposits have been used to ensure the recycling of end products when it is economically viable; and performance bonds have been used as an incentive for enterprises to manage their affairs in an environmentally sound manner (Keen et al 1997). However, the use of economic measures to assist in waste management in the region is minimal and sparsely spread throughout a limited number of sectors. The use of economic tools in the overall environmental policy setting in many countries is almost non-existent.

A number of criteria / options have been used in choosing between various policy instruments and strategic alternatives with respect to economic and financial aspects of waste management services in the region (Leong and Quah 1995). The chosen criteria / options have been compatible with the national regulatory objectives and existing legislation, as well as the long term plans of the national environmental protection plan (such as Singapore Green Plan). In addition, this approach has ensured that selected policies are credible substitutes for, or supplements to regulatory legislation, and that they conform to the principle of institutional concordance. Some of the economic and financial criteria / options employed in the region are examined below.

(a) User or Waste-end Fees

These fees are based on the weight or volume of waste generated. They are meant to encourage more recycling as disposal becomes more expensive. There are some cities such as Canberra, Tokyo and Seoul that have successfully implemented kerbside charging schemes (see Box 8.5). Residents are charged per bag which appears to be more effective than the can system in which residents are charged monthly for the use of a specific number of garbage bins per week. These bags are provided for non-separated waste and aluminium cans, glass, cardboard and newspapers are collected separately. Bag users can save money by putting out fewer bags in a given week. Households have to use garbage bins with differentiated charges according to the size and number of bins that are used. Residents are not charged for the removal of various types of separated waste. For example, in Canberra, the cost per week per household (of which there are 94 000) is between A$1.32-1.43 which includes weekly collection of a 140-litre bin and fortnightly collection of a 240-litre-recycling bin (ACT 1996). In some Asian and Pacific households, charges per week range from nothing at all to top figures of less than one US dollar. Higher charges for waste collection are unlikely to be a socially acceptable solution in most Asian and Pacific countries except when the increase in costs is small given the high social benefits.

(b) Waste Disposal Fees

Certain fees (termed *tipping price* or *gate fees*) are payable for disposal of waste at dumping grounds, landfill sites or incinerating plants. Some countries such as Australia, Japan and Singapore impose fees for disposing waste into the designated waste disposal facilities. Table 8.11 shows fees payable for disposal of waste at dumping ground / incinerator in Singapore (ENV 1997).

Box 8.5 Volume-based Collection Fee System for Municipal Waste in the Republic of Korea

The volume-based Collection Fee System for Municipal Wastes was introduced in the Republic of Korea to minimize the generation of waste and encourage households to separate their wastes for recycling. The system was put into effect nationwide on January 1, 1995. Until that time, waste collection fees had been calculated for each residence based on the level of property taxes imposed on houses or apartments, or the size of buildings regardless of the actual volume of wastes that residents generated. The volume-based collection fee system however strongly adhered to the "Polluter-Pays Principles".

Under the system, household waste was to be discarded in the officially designated plastic trash bags, which were manufactured and sold by city, county, and district governments. These regulations, however, did not apply to the discharge of burned coal briquettes and recyclable wastes including paper, waste iron, metallic cans, bottles, and plastics. These were collected at no charge if discarded properly at designated locations as determined by the local governments. Local governments also were given the discretion to set the collection fees for discarded furniture and major home appliances. Waste collected during street cleaning and park cleaning was to be discarded in trash bags for public purposes provided free of charge. The prices of official trash bags were to be determined by ordinance of the local municipal and county governments after consideration of waste treatment costs and the financial state of the local government in question.

The results of a two-year study on the performance of the system in 15 cities and provinces revealed that after the system was introduced, the volume of waste discarded decreased 29.4 per cent to 34 726 tonnes a day from 49 191 tonnes a day previously. The availability of recyclable goods increased 28.5 per cent to 11 468 tonnes a day after the introduction of the system from 8 927 tonnes a day beforehand. By region, the rate of reduction in waste generation was most pronounced in small and medium cities and rural areas than in large cities. Per capita waste generation dropped to 1.01 kg a day.

Performance of the Volume-based Collection Fee System

	Reduction in waste generation (%)	Increase in recyclable wastes (%)	Per capita waste generation (kg/day)
National average	>29.4	28.5	1.01
6 major cities	>24.9	33.2	1.10
Provinces	>35.6	22.6	0.90

Residents of large housing units such as apartment complexes were found to be more conscientious about separating wastes before disposal than residents in areas of individual houses. Wastes such as paper, waste metals, cans, and bottles which are discarded separately for recycling purposes are thoroughly treated by private sector recycling agencies, these agencies account for 30-50 per cent of the volumes of these goods recycled. Only 13 per cent of plastics are collected, however, due to the lack of plastic recycling facilities. Recyclable plastics are therefore stocked in collection sites of local governments and the Resource Recovery and Reutilization Corporation.

The implementation of the Volume-based Collection Fee System served as an opportunity to heighten the general public's awareness of the environment in addition to producing visible benefits such as a meaningful reduction in the volume of wastes generated, an increase in recycling, and an improvement in waste administration service. The entire process of production, distribution, and consumption of goods was shifted to a more environment-friendly paradigm. That is, when consumers buy goods at retail establishments, they have come to prefer goods which entail less waste generation in their production, distribution, and consumption and also good in refillable containers. Enterprises, for their part, have shifted to more efficient production processes to reduce the volumes of waste generated. Consumers cannot be expected to bring packaging materials such as Styrofoam to retail establishments when they buy goods, and in response to changing consumer attitudes, enterprises have been making efforts to develop less voluminous packaging materials. The launching of the system served as an opportunity for local governments to become business minded regarding waste management administration. With the supply of recyclable goods increasing, the recycling industry is also beginning to flourish.

Source: Government of the Republic of Korea

(c) Deposit-Refund System (DRS)

A combination of a tax and subsidy, under a DRS the consumer has to pay a deposit at the time of purchase, usually as part of the product price. The consumer is given a refund if the waste product, such as empty bottles and aluminium cans, is returned to the seller or to an authorized recycling / reuse centre. The consumer has an incentive to bring back the used item rather than dumping it. For example, in Australia, a glass bottle deposit refund (adopted voluntarily by the soft drink industry) was set at a rate of between 10 and 15 per cent of the value of the item and effected a return rate of over 80 per cent of bottles, whilst a mandatory deposit for PET bottles,

Table 8.11 Fees Payable for Disposal of Solid Waste in Singapore

Disposal site	Cumulative load per vehicle per day	Charges S$
All disposal sites	below half a tonne	Free
Lorong Halus Dumping Ground Senoko Incineration Plant Tuas Incineration Plant	first half a tonne every additional 0.05 tonne or part thereof	23.50 2.35
Ulu Pandan Incineration Plant	first half a tonne	28.00
a. between 7.30 am & 2.00 pm	every additional 0.05 tonne or part thereof	2.80
b. between 2.00 pm & 5.00 pm	first half at tonne every additional 0.05 tonne or part thereof	25.00 2.50
Kim Chuan Transfer Station	first half a tonne	23.50
Refuse disposal fees	every additional 0.05 tonne or part thereof	2.35
Haulage fees	first half a tonne or part thereof	11.00
a. between 8.00 am & 2.00 pm	every additional 0.05 tonne or part thereof	0.55
b. between 2.00 am & 5.00 pm	first half a tonne or part thereof every additional 0.05 tonne or part thereof	5.60 0.28

Source: ENV 1997

at a rate of 24 per cent, effected a return rate of 62 per cent. The economic benefits of encouraging recycling can be high (ACT 1996) and a recycling study (Keen et al 1997) found that after allowing for the cost of handling, transport and cleaning, the use of returnable bottles is cheaper in economic terms than non-refundable bottles or cans.

(d) Government Grants / Foreign Aid

In some countries, government grants or foreign aid is arranged for the capital investments necessary to modify existing manufacturing facilities to produce products that generate less waste. Funds are made available for research projects on seeking ways to remove institutional and social obstacles to reduce waste generation and creative ideas for use by non-manufacturing establishments.

(e) Incentives

In some countries, incentives are provided in the form of preferential tax treatment, like tax credits, on the importation of waste treatment facilities that are not locally available. Loans and other assistance programmes are used to encourage compliance with regulatory standards for a limited period of time after new standards are introduced. The common form of incentive is a tax deduction for the installation of anti-pollution equipment by the industrial sector. This has been successfully introduced in the Philippines and in the Republic of Korea and has stimulated the installation of pollution control devices in both countries. In India, a 35 per cent investment allowance (against the general rate of 25 per cent) towards the actual cost of new machinery or plant is provided.

(f) Disincentives

Disincentives are measures to discourage the discharge of wastes into the environment and are based on the Polluter-Pays Principle (PPP). The principle implies that the polluter should bear the financial responsibility (and hence bear the costs) of measures undertaken by public authorities to treat or dispose of wastes in an environmentally acceptable manner. Disincentives take the form of user charges and pollution taxes in some countries of the region, including People's Republic of China, India and Singapore, although their specific application to waste disposal is limited.

(g) Pollution Fines

Pollution fines are prevalent in some countries in the region. Singapore provides a current example of the imposition of pollution fines to waste generators for violating waste management regulations. This measure is particularly effective when the pollution fines are set sufficiently high to make investments in pollution control financially attractive to firms. In this way, the polluters are forced to internalize the environmental costs of their activities.

(h) Economic Sanctions

These deal with the enforcement of compliance with waste management regulations. Although often referred to as economic remedies, these are usually framed as direct penalties that are equal or greater than the costs of compliance. These should not be confused with effluent charges or pollution taxes, but are an economic penalty, which works by imposing on a company a liability that is directly related to the financial savings which results from not complying with waste management regulations. Economic sanctions are prevalent in some countries of the region, including Australia, Japan and Singapore.

(i) Environment Funds

In Thailand, the Government established a five billion baht (US$200 million) Environment Fund to be used for the clean-up of cities and for industrial pollution control (United Nations 1995). In the Philippines, two mining companies were instructed

by the Government to create an Environmental Guarantee Fund in the form of security bonds to provide for the rehabilitation and restoration of areas detrimentally affected by mining operations. This scheme has become a part of standard procedure for the issuance of environmental compliance certificates for mining operations. An additional Reforestation Fund has also been instituted as part of the scheme to counter deforestation in areas being mined. People's Republic of China uses Revolving Funds for the purchase of pollution abatement equipment and for introduction of waste minimizing technology (United Nations 1995).

B. Regional and International Initiatives

1. *Control of Transboundary Movement of Hazardous Waste*

Some 98 per cent of the world's hazardous waste is produced in the industrialized countries and, over the years, international waste traders have increasingly sent hazardous industrial waste from developed countries to the countries of the Asian and Pacific Region. The main impetus of this process is the economic gradient which leads firms to search for the cheapest and easiest dumping grounds, shipping them to those developing countries which have less stringent environmental laws or inadequate enforcement of such laws. The growing concern over the health and environmental implications of the hazardous waste traffic led to the Basel Convention, which was adopted unanimously on 22 March 1989 (Rumel-Bulska 1993). The Final Act of the Basel Convention was signed by 105 States, as well as the European Community (EC), and the Convention entered into force on 5 May 1992. However, by mid-2000, the Basel Convention had been ratified by only some fifty per cent of the ESCAP member countries.

Though the Asian and Pacific Region still remains open to the importation of hazardous waste, progressive governments and activists throughout the region are resisting further imports. In the Southeast Asian subregion, activists met in 1993 to develop and coordinate campaigns to make Southeast Asia a waste trade-free zone and today, Southeast Asian countries are beginning to respond to their citizen's concerns about illegal waste dumping. In November 1992, the Indonesian government prohibited plastic waste imports and also expanded this prohibition to include other types of waste (Indonesia 1997). In August 1992, the government of Malaysia announced a new prohibition on the import of certain hazardous waste (Malaysia 1998). Other countries of the region, including India, Pakistan, Singapore and Thailand, have announced similar prohibitions on the import of hazardous wastes produced outside the region and also on the movement of hazardous wastes generated within the region (Agarwal 1998, Greenpeace 1997). In the South Pacific, waste traders continue to attempt the importation of foreign generated hazardous and radioactive waste into the Pacific Islands such as Marshall Islands, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu (UNEP/SPREP 1997). To ban importation and to control hazardous wastes generated in the region, the Waigani Convention was adopted in 1995 (Mowbray 1997). The Waigani Convention is "Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region" and it is closely associated with the Basel Convention as a subregional complement.

However, according to some reliable sources (Angellow and Ranawana 1996, Greenpeace 1997, Nelson 1997, UNEP/SPREP 1997, Agarwal 1998, etc.), waste exports to the region and within the region continue despite the adoption of Basel Convention and Waigani Convention.

2. *Activities of International and Regional Organizations*

Various United Nations Agencies, the World Bank and the ADB have been financing and providing technical assistance for solid waste management services in the countries of the region. The UNCHS and World Bank have undertaken a number of projects on urban waste management with UNDP funding. In addition, some developed countries such as Australia, Japan, USA, Canada, UK, Germany, Netherlands, Denmark, Norway and Singapore are also providing financial assistance to waste treatment and disposal facilities in the region (UNEP/SPREP 1997, ASEAN/UNDP 1998, World Bank 1998).

Similar projects were also undertaken by the United Nations ESCAP, both independently and in close cooperation with UNDP, ADB, CITYNET and other agencies. UN ESCAP was responsible for three projects specifically aimed at waste management and comprising the development of guidelines on the monitoring methodologies for toxic chemical and hazardous wastes; on the managerial and human resources requirements of hazardous waste management in the developing countries of the ESCAP region; and on the legal and institutional frameworks required to prevent the illegal traffic in hazardous products and wastes (ESCAP 1994, United Nations 1995). ESCAP also implemented a project on Capacity Building in Industrial Audit for Waste Minimization which reviewed existing methodologies

and guidelines for waste minimization techniques and waste auditing procedures and recommended revised guidelines and procedures (United Nations 1995).

UNEP/EAS/RCU initiated a study on Regional Action Programme on Land-based Activities Affecting Coastal and Marine Areas in the East Asian Seas, which provided technical support to East Asian countries in addressing their coastal and marine pollution problems (Koe and Aziz 1995). Improvement of both hazardous and nonhazardous waste management practices and reduction of waste generation from land-based sources were the prime focus of the study.

CONCLUSIONS

Available data on the quantity and types of solid waste generated, and the methods employed in the treatment and disposal of generated waste, are incomplete, inconsistent and unreliable due to wide variations in data recording, definitions, collection methods and seasonal variations (World Bank 1999). Whilst at a regional level this mitigates against a clear view of the overall status and trends, at the local level the lack of robust data acts as a barrier to the development and implementation of efficient and cost-effective waste management practices.

From the available data, it is clear that, in recent years, there has been a sharp increase in the solid waste generation in the Asian and Pacific Region and estimates indicate that generation rates are set to double over the next 25 years.

Despite the increasing urbanization and industrialization, the economic activity of the region remains predominantly agricultural and, as a consequence, generates substantial quantities of agricultural wastes. However, much of the waste is utilized within rural communities through composting, direct land application, biogas generation or is used as construction materials.

Generation of municipal solid waste from within the region varies enormously from as little as 0.4 kg per person per day to as high as 5 kg per day for people living in the region's high-income, developed countries. Whilst most of the region's municipal waste continues to be indiscriminately dumped on open land, land filling, controlled incineration and composting are increasingly being employed. Industrial solid waste generation rates vary from country to country and even within a country depending upon the nature of the active industries. Open dumping, land filling and incineration are the major disposal processes of industrial solid waste.

Generation of hazardous waste from manufacturing, hospital and health-care facilities and nuclear power and fuel-processing plants is rising and has been estimated to more than double within next 10 to 15 years time. The region's capacity for adequately managing the disposal of such wastes is extremely limited, particularly when additional wastes enter the region through the dumping activities of some industrialized nations.

Over the forthcoming five to ten years, the region faces many waste management challenges that will require clear and effectively implemented policies and strategies. Efforts to develop inter-regional discussions on joint strategies and common approaches are continuing (see, for example, the proposed common strategic considerations presented in Box 8.6), although individual countries will need to address specific issues associated with the current lack of long-term planning, proper policy formulation, insufficient government priority, lack of finance, lack of skilled personnel; lack of public awareness and public participation, inadequate legislation and institutions and poor monitoring and enforcement. These have led to escalating environmental pollution and health problems in the region and, in the long term, may have implications for the continued economic development of the region.

However, evidence from the region indicates that environmental awareness and consciousness of waste is taking roots in industry and business. Australia, Japan, Republic of Korea and Singapore are leading in the waste management area by not only actively pursuing environmental protection through proper institutions and legislation but also developing new and innovative technologies for waste disposal. Countries like People's Republic of China, India, Indonesia, Malaysia, Pakistan, Philippines and Thailand have also made good progress in waste management practices.

Multi-lateral and bi-lateral development agencies (including various United Nations agencies (UNDP, UNEP, UNIDO, WHO, ESCAP), World Bank, ADB, and some donor countries) are offering both technical and final assistance for waste disposal in countries of the region. There is however, a need to intensify efforts towards development of indigenous capabilities in the countries of the region in terms of expertise, equipment manufacture, process technology guidelines, design, construction/installation, operation and maintenance of waste treatment/disposal and pollution abatement facilities.

Box 8.6 Integrated Solid Waste Management – Key Strategic Considerations

There is a striking degree of similarity in the solid waste management needs and constraints within the Asian and Pacific Region and policy makers, municipal managers and practitioners may be assisted in the resolution of these needs and constraints through the adoption of a number of key strategic considerations:

1. Developing waste disposal facilities such as landfills and incinerators often generates tremendous concern – both warranted and reactionary. However, it is possible to reduce opposition to new facilities by involving the community and following a technically sound and transparent site selection process and, wherever possible, using local conditions to ameliorate potential environmental impacts and costs, e.g. siting landfills in geotechnically superior locations. Waste disposal facilities, which often have a useful life in excess of 25 years, need to be well integrated within a sound master plan that reflects regional requirements, standard operating procedures, and financing mechanisms. Sound technical justification and a transparent planning process that respects the general public's valid concerns may not eliminate public opposition, but it is the best way to minimize it.
2. Local governments should minimize residential waste collection frequency to a maximum of twice per week, which is adequate from a public health perspective, but requires social acceptance. Citizens should be encouraged to place their waste in containers that enhance collection efficiency.
3. Local governments should focus primarily on residential waste collection, especially from poor and densely populated areas, and empower the private sector to pick up waste from non-residential sources. Commercial, institutional and industrial waste collection can usually be self-financing. Local governments should license private hauliers to generate revenue and to ensure proper collection and disposal.
4. Waste collection and disposal fees should be based on waste generation rates. Direct user charges and waste fee collection should begin with the business community.
5. An integrated approach toward solid waste management needs to be followed. Municipal waste managers should opt for the least technically complex and most cost-effective solution (e.g. limited mechanization and incineration). Waste diversion should be maximized.
6. All levels of government, including multi-national agencies and transnational corporations must play a role in long-term programme development,. e.g. extended product responsibility, life-cycle analysis, waste exchanges, and natural resources tax regimes.
7. Local governments must honestly and respectively gauge the public's willingness and ability to participate in the design and implementation of waste management programmes. Through good partnerships, progressive programmes can be developed in a complementary manner. These programmes include community-based operations, micro-enterprise development, waste separation for increased recycling and composting and reduced collection frequency.
8. All levels of government should promote the hierarchy of waste management (i.e. reduce, reuse, recycle, recover) and encourage waste separation to maximize flexibility to deal with future changes. Wherever appropriate, governments should view solid waste as a resource, rather than just a "local problem".
9. Although waste collection, treatment and disposal costs often place a large burden on local government finances, improper disposal is far more expensive on the long run. With costs accruing over many years.
10. Local governments are usually in the best position to assume key responsibility for municipal solid waste collection and disposal. However, sustainable financing and sustainable service provision still needs to be defined by a broader set of stakeholders. Local governments need the assistance of all levels of government to provide waste management services efficiently. Regional approaches to waste disposal e.g. shared landfills are especially important.

Source: World Bank 1999