12 Hazardous waste: special reference to municipal solid waste management

Introduction

Detection of traces of toxic chemicals in drinking water supplies, in polar ice caps, groundwater sources and episodes such as those in Minamata Bay, Japan and Love Canal, USA have focussed the attention of the public worldwide on the risks posed by the inappropriate disposal of hazardous waste and accidental release of toxic chemicals into the environment. In India regulations to control and manage air and water related pollution were in place as early as 1974 and 1981 when the Water Act and Air Acts, were respectively, introduced in country. However, the concern and need to manage the hazardous waste generated in the country in a scientific manner was felt only in the mid-eighties after the occurrence of the (in) famous Bhopal gas tragedy on 2/3 December 1984. The Government's attention was then drawn towards environmental damage and the casualties that hazardous chemical substances and toxic wastes can cause. In order to cover the environment in toto, the MoEF (Ministry of Environment and Forests) enacted an umbrella act i.e., the Environment (Protection) Act in 1986. Subsequent to this Act, in order to prevent indiscriminate disposal of hazardous waste, the MoEF promulgated the Hazardous Wastes (Management and Handling) Rules in 1989, and efforts to inventorise hazardous waste generation were initiated. Though the hazardous waste rules were introduced in 1989, the response towards their implementation has remained very poor. Also, due to the liberalised policy the pace of industrialisation has been accelerated, which has resulted in increasing amounts of hazardous wastes every year. This along with a growing amount of municipal solid waste due to rapid urbanisation and hospital waste due inadequate policy and technological measures continues to remain a daunting issue of environmental concern to India.

Pressure

Industrial and hazardous waste

Sources of hazardous waste include those from industrial processes, mining extraction, tailings from pesticide based agricultural practices, etc. Industrial operations lead to considerable generation of hazardous waste and in a rapidly industrialising country such as India the contribution to hazardous waste from industries is largest. Hazardous waste generation from industries is also critical due to their large geographical spread in the country, leading to region wide impacts. The annual growth in hazardous waste generation can be directly linked to industrial growth in the country.

States such as Gujarat, Maharashtra, Tamil Nadu, and Andhra Pradesh, which are relatively more industrialised, face problems of toxic and hazardous waste disposal far more acutely than less developed states. The major hazardous waste-generating industries in India include petrochemicals, pharmaceuticals, pesticides, paint and dye, petroleum, fertilisers, asbestos, caustic soda, inorganic chemicals and general engineering industries.

During the last 30 years, the industrial sector in India has quadrupled in size. The main source of hazardous waste and cause of an adverse impact on the environment has been the Indian chemical industry. Hazardous wastes from the industrial sectors mentioned above contain heavy metals, cyanides, pesticides, complex aromatic compounds (such as PCBs), and other chemicals which are toxic, flammable, reactive, corrosive or have explosive properties.

Municipal solid wastes

There has been a significant increase in the generation of MSW (municipal solid wastes) in India over the last few decades. This is largely a result of rapid population growth in the country. The daily per capita generation of municipal solid waste in India ranges from about 100 g in small towns to 500 g in large towns. Although national level data do not exist for municipal solid waste generation, collection and disposal, for the lack of a nation wide inventory, the growth of solid waste generation over the years can be studied for a few selected urban centres. The population of Mumbai increased from around 8.2 millions in 1981, to 12.3 millions in 1991, a growth of around 49%. The municipal waste generation however grew from 3,200 tonnes per day to 5,355 tonnes per day in the same period, a growth of around 67%. This clearly indicates that the growth in municipal waste generation in our urban centres has outpaced the growth in population in recent years. The reasons for this trend could be our changing lifestyles, food habits and changes in the standard of living. MSW in cities is collected by the municipalities and transported to designated disposal sites normally a low lying area on the outskirts of the city for disposal. The choice of a disposal site is more a matter of what is available than what is suitable.

State

Industrial and hazardous waste

The first few attempts to quantify hazardous waste generation in the country remain limited to indirect estimations. For instance, using the correlation between economic activity and hazardous waste generation established by the Organisation for Economic Cooperation and Development (OECD), the reported generation of hazardous waste was about 0.3 million tonnes per annum in 1984. World Bank estimates place this at approximately 4 million tonnes annually for the year 1995. These scattered inventories were not very useful in designing hazardous waste strategies for the country since hazardous waste generation is very dynamic owing to the intense growth in industrial activities taking place. In order to generate an updated inventory for hazardous waste in the country, an exercise in different states of India was initiated by the CPCB (Central Pollution Control Board) in the year 1993. The present information on total hazardous waste generated from industries and facilities available for its disposal in Indian states has been collected by the MoEF through the respective SPCBs (state pollution control boards). Table 12.1 gives the state-wise status of number of units generating hazardous waste as well as the quantity of waste generated till 24 March 2000, for recyclable, incinerable and disposable waste types. In total, at present, around 7.2 million tonnes of hazardous waste is generated in the country of which 1.4 million tonnes is recyclable, 0.1 million tonnes is incinerable and 5.2 million tonnes is destined for disposal on land (MoEF 2000).

As per the information provided by the MoEF, there are 323 hazardous waste recycling units in India, and of these 303 recycling units use indigenous raw material while 20 depend on imported recyclable wastes. The status of hazardous waste imported for recycling and recovery of mostly metallic constituents in country is presented in Box 1. The major types of hazardous waste imported by the country include battery scrap, lead and zinc dross, ash, skimmings and residues and galvanised zinc.

Table 12.1 Status of hazardous waste generation

State	No. of Units Generating HW	Quantity of Waste Generated (Waste Type) TPA			
		Recyclable	Incinerable	Disposable	Total[a]
Andhra Pradesh	501	61820	5425	43853	111098
Assam	18	-	-	166008	166008
Bihar	42	2151	75	24351	26577
Chandigarh	47	-	-	305	305
Delhi	-	-	-	-	59423
Goa	25	873	2000	3725	8742
Gujarat	2984	26000	19953	150062	430030
Haryana	309	-	-	31046	32559
Himachal Pradesh	116	-	63	2096	2159
Karnataka	454	47330	3328	52585	103243
Kerala	151	84932	5069	690014	780015
Maharashtra	3953	847436	5012	1155398	200784
Madhya Pradesh	183	89593	1309	107767	198669
Orissa	163	2841	-	338303	341144
Jammu and Kashmir	57	-	-	-	1221
Pondicherry	15	8730	120	43	8893
Punjab	700	9348	1128	12233	22745
Rajasthan	306	9487	19866	2242683	227203
Tamil Nadu	1100	193507	4699	196002	401073
Uttar Pradesh	1020	-	-	-	140146
West Bengal	440	45233	50894	33699	129826
Total	12584	1429281	118941	5250173	7243750

[a] Total of recyclable, incinerable and disposable will not add up due to waste sold or otherwise disposed

The contents of Box 1 indicate that the import of hazardous waste into the country for recycling purposes clearly needs guidelines to regulate it so that India does not become dumping ground. The MoEF has taken a few initiatives in this regard to regularise and track the hazardous waste imported. These are explained in more detail in the response section of the chapter.

The major generators of non-hazardous industrial solid wastes in India are thermal power stations producing coal ash, steel mills producing blast furnace slag and steel melting slag, non-ferrous industries such as aluminium, zinc and copper producing red mud and tailings, sugar industries generating press mud, pulp and paper industries producing lime sludge and fertiliser and allied industries producing gypsum. Since these wastes are generated in huge quantities in the country (147 million tonnes per annum as per a 1999 estimate), the recycle/reuse potential of these wastes should be explored, otherwise a huge land area would be required for disposal. The quantities of industrial waste produced per annum from these industrial sources are presented in Table 12.2.

Municipal solid wastes

As stated earlier, the daily per capita generation of MSW in India ranges from about 100 g in small towns to 500 g in large towns. The recyclable content of waste ranges from 13% to 20% (CPCB 1994/95). A primary survey in

Box 1 Dumping of hazardous waste in India

India has become the dumping ground for hazardous waste (Anjello and Ranawana 1996, Agarwal 1998). Cheap labour, poor environmental standards, a sieve-like import regime and a growing market for cheap raw materials are all here. Ignoring its law courts, India is helping rich nations beat an international ban on the dumping of toxic industrial waste in developing countries (Greenpeace 1997). 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. Every Indian port is a floodgate standing open for hazardous waste. Of course, Indian government is keeping a tight rein on hazardous waste imports by licensing only five companies to accept metallic waste and letting only three companies export such waste to India for recycling. In fact, 151 different importing companies have imported nearly 73,000 tonnes of toxic zinc and lead residues from 49 countries. In 1995, Australia exported more than 1,450 tonnes of hazardous waste like scrap lead batteries, zinc and copper ash to India. Huge quantities of PVC waste is still exported to Asia despite an international agreement (Greenpeace 1998). A Greenpeace analysis of India's foreign trade data found that at least 1,127 tonnes of zinc ash were imported mainly from the United States since May 1996. Some 569 tonnes of lead battery waste were brought in through the main seaport of Bombay between October 1996 and January 1997. About 40,000 tonnes of broken lead batteries were imported during 1996. While lead acid batteries are in the Basel Ban List, India's Directorate General of Foreign Trade last year allowed free imports of lead battery plates and terminals. Some 150 companies and trading houses are importing toxic waste into India though only seven are licensed to do so.

Table 12.2 Sources and quantum of waste generated from major industrial sources

	Quantities MTPA		*Source/origin*
Waste	*1990*	*1999*	
Steel and blast furnace slag	35.0	7.5	Conversion of pig iron to steel and manufacture of iron
Brine mud	0.02	-	Caustic soda industry
Copper slag	0.02	-	By-product from smelting of copper
Fly ash	30.0	58.0	Coal based thermal power plants
Kiln dust	1.6	-	Cement plants
Lime sludge	3.0	4.8	Sugar, paper, fertiliser, tanneries, soda ash, calcium carbide
Phosphogypsum	4.5	11.0	Phosphoric acid plant, ammonium phosphate
Red mud/bauxite	3.0	4.0-4.5	Mining and extraction of alumina from bauxite
Lime stone	-	50.0	-
Iron tailings	-	11.25	-
Total	77.14	147.05	

Source National Waste Management Council - Ministry of Environment and Forests

1971 estimated that the urban population generated 374 g/capita/day of solid waste (Bhide and Sundersan 1983). In another survey conducted by NEERI the quantity of waste produced has been found to vary from 200 to 600 g/capita/day. A survey in 1981 places this figure at 432 g/capita/day (Nath 1984) and yet another survey in 1995 at 456 g/capita/day (EPTRI 1995). A survey conducted by ORG in 1989 places total MSW generation for 33 Indian cities at 14,934 tonnes a day. The EPTRI estimates of the survey in 1995 for 23 Indian cities places it around 11 million tonnes a year. The survey conducted by CPCB puts total municipal waste generation from class I and II cities to around 18 million tonnes in 1997 (CPCB 2000a). The present annual solid waste generated in Indian cities has increased from 6 million tonnes in 1947 to 48 million tonnes in

Photo 12.1 Secured landfill for disposal of hazardous waste under construction

Source Parivesh Newsletter, June 1998, Vol. 5 (I), Central Pollution Control Board, Delhi

Table 12.3 Physico-chemical characteristics of MSW

Component	*% of wet weight* 1971-73[a] (40 cities)	*% of wet weight* 1995[b] (23 cities)
Paper	4.14	5.78
Plastics	0.69	3.90
Metals	0.50	1.90
Glass	0.40	2.10
Rags	3.83	3.50
Ash and fine earth	49.20	40.30
Total compostable matter	41.24	41.80
Calorific value (kcal/kg)	800-1100	<1500
Carbon-nitrogen ratio	20-30	25-40

[a] Bhide and Sundaresan 1983; [b] EPTRI 1995

1997 and is expected to increase to 300 million tonnes per annum by 2047 (CPCB 2000a).

The characteristics of MSW collected from any area depends on a number of factors such as food habits, cultural traditions of inhabitants, lifestyles, climate, etc. Table 12.3 presents the changes in the characteristics of waste over the past two decades. The data show the changes in the relative share of different constituents of waste in the past several decades. Table 12.3 shows that the percentage of recyclable waste is increasing in the municipal waste streams. This can be largely attributed to changing lifestyles and increasing consumerism. Photo 12.2 shows disposal of plastic bags along with other types of waste streams. The strategy to deal with municipal solid waste in the country, should therefore target maximising recycling/reuse efforts so that dependence on landfills for final waste disposal can be minimised.

Only few cities follow such good practice of waste disposal as tipping of waste using mechanised equipment for levelling and compacting and placing a daily cover of soil on top of it before compacting it further. Some municipalities also practise composting the organic fraction of the waste. Photos 12.3 and 12.4 show compacting of municipal waste and vermi-composting being practiced at one of the dumpsites, respectively.

However, overall, the average waste collection efficiency of the total generation in Indian cities is around 72% (NIUA 1989) and 70% of Indian cities do not have adequate waste transportation facilities. Lots of littering usually takes place while waste is stored in collections centres and also during its transport. Photos 12.5 and 12.6 show primary waste collection centre and transportation of municipal solid waste in the country.

In addition, till date, biomedical waste generated from clinics, hospitals, nursing homes, pathological laboratories, blood banks and veterinary centres, in absence of any legislation till very recently, and a lack of awareness of impacts due to its indiscriminate disposal, was also being disposed alongwith municipal waste in dumpsites. Photo 12.7 shows co-disposal of biomedical waste at municipal waste collection centre.

Assuming a waste generation factor of 250 g/bed/day for infectious biomedical waste, the Directorate General of Health Services

Photo 12.2 Disposal of plastic bags
Source Parivesh Newsletter, September 1998, Vol. 5 (II), Central Pollution Control Board, Delhi

Photo 12.3 Municipal waste being compacted at the dumpsite
Source Parivesh Newsletter, Highlights 1998, December 1998, Central Pollution Control Board, Delhi

Photo 12.4 Vermi Compost plant for treatment of solid waste
Source Management of Municipal Solid Waste, Central Pollution Control Board, Delhi

has estimated the total infectious biomedical waste generated from different states in India at 54 404 tonnes per annum as on 1 January 1993 (CPCB 2000b). A WHO study on health care waste has estimated that of the total waste generated in health care facilities, about 85% of the waste is non-infectious, 10% infectious but non-hazardous and 5% hazardous (CPCB 2000b). Based on these estimates, the total health care waste

Photo 12.5 Primary municipal waste collection centre
Source Management of Municipal Solid Waste, Central Pollution Control Board, Delhi

Photo 12.6 Transportation of municipal solid waste
Source Management of Municipal Solid Waste, Central Pollution Control Board, Delhi

Photo 12.7 Co-disposal of biomedical waste with municipal waste
Source Parivesh-Highlights 1999, Central Pollution Control Board, Delhi

generated as per the 1993 data in the country can be taken as 544 040 tonnes per annum and hazardous waste generation from health care facilities can be taken as 27,202 tonnes per annum. A proper waste segregation scheme for separating hospital waste into infectious and non-infectious categories is therefore desired. This should be coupled with separate and dedicated treatment facilities for infectious waste categories so that co-disposal of infectious waste with municipal waste can be avoided. Photo 12.8 shows a medical waste incinerator installed at Safdarjung Hospital in Delhi.

Impact

Industrial and hazardous waste

Improper storage, handling, transportation, treatment and disposal of hazardous waste results in adverse impact on ecosystems including the human environment. When discharged on land, heavy metals and certain organic compounds are phytotoxic and at relatively low levels can adversely affect soil productivity for extended period of times. For

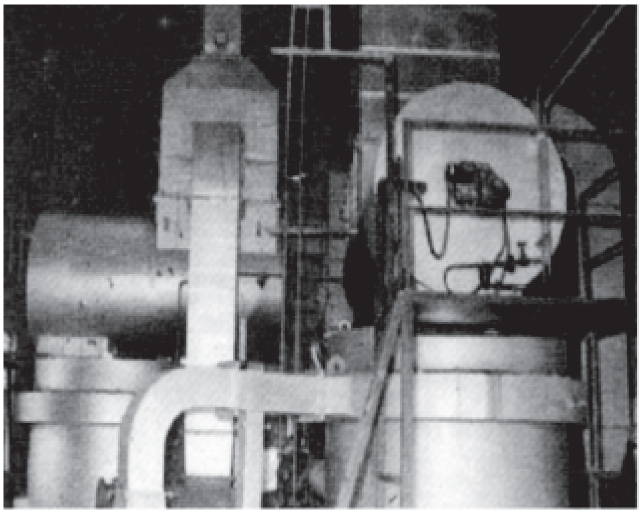

Photo 12.8 Hospital waste incinerator at Safdarjung hospital
Source Parivesh Newsletter, Highlights 1998, December 1998, Central Pollution Control Board, Delhi

example, uncontrolled release of chromium contaminated wastewater and sludge resulted in contamination of aquifers in the North Arcot area of Tamil Nadu. These aquifers can no longer be used as sources of freshwater.

Discharge of acidic and alkaline waste affects the natural buffering capacity of surface waters and soils and may result in the reduction of a number of species. The Boxes 2 to 4, provide illustrations of contamination due to improper management of hazardous wastes in Gujarat, the Thane-Belapur Industrial Area, and the Delhi- Rajasthan area, respectively.

Municipal solid wastes

At presently most of the MSW in the country is disposed off unscientifically (no 'sanitary landfill' exists) (Pachauri and Sridharan 1998). This has adverse impacts on not only the ecosystem but also on the human environment. Unscientific disposal practices leave waste unattended at the disposal sites, which attracts birds, rodents, fleas, etc. to the waste and creates unhygienic conditions (odour, release of airborne pathogens, etc.). The plastic content of the municipal waste is picked up by rag pickers for recycling either at primary collection centres or at dumpsites. Plastic are recycled mostly in factories, which do not have adequate technologies to process them in a safe manner. This exposes the workers to toxic fumes and unhygienic conditions. Moreover, since the ragpicking sector is not formalised, not all the recyclables, particularly plastic bags, get picked up and are found littered everywhere, reaching the drains and water bodies ultimately and choking them. Policy intervention to strengthen administrative structures can help in mitigating the adverse impacts of the waste on public health. The efforts of the Surat Municipal Corporation after the plague epidemic in 1994 have resulted in a complete metamorphosis of the city. This successful example has streamlined the management of solid waste and has

Box 2 Case Studies from Gujarat illustrating adverse impact of hazardous wastes

The Ahmedabad-Vadodara-Surat industrial belt has over 2 000 industrial units in the organised sector and more than 63 000 small scale units manufacturing chemicals like soda ash, dyes, yarns and fertilisers. Vapi in Valsad district has around 1 800 units of which 450 fall in category of polluting industries. Industries in all these areas usually dump their wastes in low lying areas within 2 km radius. As a result, a major illegal dump yard has sprung up on the banks of river Daman Ganga. Indian Petrochemical Corporation Limited (IPCL) at Vadodara dumps 1 800 tonnes of hazardous wastes every month at a site near Nandesari. The IPCL dumpsite is on hill. During rainy season, the hazardous constituents of these wastes are washed down into the river.

Source (Shankar, Martin, Bhatt, and Erkman 1994)

Box 3 Case Studies from Maharashtra illustrating adverse impact of hazardous wastes

The Thane-Belapur industrial area, in Maharashtra where about 1200 industrial units are housed on a 20 km stretch close to New Mumbai creates more than 100 tonnes of solid waste every day. About 85% of this waste is either acidic or alkaline in nature. The area also produces 5 tonnes of waste every day, which is difficult to treat because of its halogen content. The bulk of hazardous waste in this area is co-disposed with municipal waste in municipal waste dumpsites. The water bodies in the vicinity of this industrial area are polluted. The sediment in the Ulhas river has registered high levels of mercury and arsenic. Ulhas river empties into Thane Creek at its northern end. As a result, Thane Creek is one of the most polluted seawaters in the country.

Source (Shankar, Martin, Bhatt and Erkman 1994)

Box 4 Case Studies from Delhi and Rajasthan illustrating adverse impact of hazardous wastes

In the Wazirpur Industrial Estate and Shahadara-Maujpur Industrial Estate as well as along the Grand Trunk road in Delhi, small and tiny scale industries processing non- ferrous metals such as copper, brass, aluminium as well as steel rolling mills and pickling factories were dumping their heavy metal rich effluent and acids into open cess pools or drains. This had led to permeation of effluent into water table and has contaminated groundwater, which is used by local residents as potable water supply.

During 1988-89, M/s Silver Chemicals and Jyoti Chemicals located at Village Bichhri in Rajasthan were engaged in production of around 375 tonnes and 20 tonnes of H-acid (a naphthalene sulphonic acid based azo dye) respectively. This resulted in some 8 250 cu m of wastewater and some 2 400–2 500 tonnes of process sludge. The toxic wastewater was let out without treatment and the process sludge was dumped in the plant premises. The wastewater flowed through Udaisagar canal across the entire region while rainwater washed the sludge across the soil into the groundwater. An official survey indicates that groundwater up to 70 feet below the ground level had been contaminated over an area of 7 sq km affecting 8 000 people in seven villages. The NEERI report to study the extent of contamination in this area says that an amount of Rs 4 crore will be needed to reverse the process of soil and groundwater contamination.

Sources Bhattacharya and Shrivastava 1994; Sharma and Bannerji 1996

helped in creating an atmosphere where the urban local bodies and citizens can discuss the gravity of the problem and share responsibilities with a more positive attitude (Box 5).

Most biomedical waste generated from health care facilities are at present, collected without segregation into infectious and non-infectious categories and are disposed in municipal bins located either inside or outside the facility premises. Sanitary workers pick this waste from here along with other MSW and transport and dispose it at municipal dumpsites. Since the infectious waste gets mixed with municipal solid waste, it has potential to make the whole lot

Box 5 Surat: a success story

The plague outbreak in Surat in 1994 was a stern reminder of what negligence in the area of solid waste management can lead to. After that disaster the city diligently tried to improve its living conditions. Institutional changes were the first thing to happen when the city began its journey from a city ridden with plague to the second cleanest city in the country, a status it achieved in a short span of 18 months. The city was divided into six zones to decentralise the responsibilities for all civic functions. A commissioner was appointed for each zone with additional powers; the officials responsible for solid waste management were made accountable for their work; and field visits were made mandatory for them each day. The solid waste management department and other related departments were made to work in concert and cooperate with one another. Indeed, these are some of the very basic changes that need to be introduced in the functioning of all urban local bodies. Community participation played a key role in the rapid implementation of decisions taken by the corporation. People were issued grievance redressal cards, which they could fill in and drop at the zonal office to register their complaints. The complaint was attended within 24 hours and the card returned to the citizen. In addition to the administrative changes, the changed laws had an important role to play in improving the conditions by also making the citizens aware of and responsible for certain preventive actions. Initially, the Gujarat Municipal Act did not have the provision of imposing a penalty for littering, which was introduced later as a fine of Rs 50 for every offence of littering and the fine was doubled for every subsequent offence. The corporation, in an appreciable attempt, has now engaged private sweepers to cover different inner areas of the town. Private contractors are also actively involved in the transport, collection, and disposal of solid waste.

infectious in adverse environmental conditions. Moreover, biomedical waste also contains sharp objects (scalpels, needles, broken glasses/ampoules, etc.) the disposal of which poses a risk of injury and exposure to infection to sanitary workers and rag pickers working at these dumpsites. Since most of these dumpsites are unscientifically managed, the chances of pathogens contained in infectious waste becoming airborne and getting released to nearby water bodies or affecting the local resident population cannot be ruled out.

Projections

Industrial and hazardous wastes

As stated earlier, the present hazardous waste generation in the country is around 7.2 million tonnes out of which 1.4 million metric tonnes is recyclable, 0.1 million tonnes is incinerable and 5.2 million tonnes are destined for disposal on land. This indicates that discounting the recyclable fraction of hazardous waste, total of around 5.3 million tonnes of hazardous waste requires some treatment and disposal. Taking the unit average cost of treatment and disposal of hazardous waste at Rs 3,000 per tonne of the waste, this requires an investment of around Rs 15,900 million every year for treatment and disposal of the hazardous waste in a scientific way.

The land required to dispose this waste in an engineered landfill, assuming the average density of waste to be around 1.2 tonnes/m^3 and the depth of the landfill 4 m, would be around 1.08 km^2 every year. This data can be applied to future waste projections to arrive at future land requirements for the disposal of hazardous waste.

In addition to hazardous waste, industries also generate around 147 million tonnes of non-hazardous (high volume-low hazard) wastes every year at present (NWMC 1999) which is mostly disposed on open, low lying land.

Municipal solid wastes

A study conducted by the CPCB on management of municipal solid waste in the country estimates that waste generation from the present 48 million tonnes is expected to increase to 300 million tonnes per year by the year 2047 (490 g per capita to 945 g per capita). The estimated requirement of land for disposal would be 169.6 sq km in 2047 as against 20.2 sq km in 1997 (CPCB 2000a).

Response

Existing policy responses

Industrial and hazardous waste

The MoEF, Government of India is the nodal agency at the central level for planning, promoting and co-ordinating environmental programmes, apart from policy formulation. The executive responsibilities for industrial pollution prevention, and control, are primarily executed by the CPCB at the central level, which is a statutory authority, attached to the MoEF. The CPCB was constituted in September 1974, for implementing provisions of the Water (Prevention and Control of) Pollution Act, 1974. The State Departments of Environment and SPCBs and Pollution Control Committees (PCCs) are the agencies designated to perform these functions at the state and union territory level.

Policies for hazardous waste management

The Hazardous Wastes (Management and Handling) Rules, 1989 was introduced under Sections 6, 8, and 25 of the Environment (Protection) Act of 1986 (referred to as HWM Rules 1989). The HWM Rules, 1989 provide for control of generation, collection, treatment, transport, import, storage and disposal of wastes listed in the schedule annexed to these rules. Implementation of these rules is done through the SPCBs and pollution control committees in respective states and union territories.

Besides these rules, in 1991, the MoEF issued Guidelines for Management and Handling of Hazardous Wastes for (a) generators, (b) transport of hazardous waste, and (c) owners/operators of hazardous waste storage, treatment and disposal facility. These guidelines also established the mechanisms for the development of a reporting system for the movement of hazardous waste (the manifest system) and for the first time established procedures for closure and post-closure requirements for landfills. In 1995, these were followed by publication of Guidelines for Safe Road Transport of Hazardous Chemicals that established basic rules for Hazardous Goods Transport and provided for the establishment of a Transport Emergency Plan and for provisions on Identification and Assessment of Hazards.

In addition to these direct rules dealing with issues of hazardous waste management, the Government has moved to enact into legislation, additional incentives for industries to comply with environmental provisions and bring market forces out into the business of environment. In this vein, the Public Liability Act 1991 was adopted to require industries dealing with hazards to ensure against accidents or damages caused by release of pollutants. The National Environmental Tribunal Act 1995 provides provisions for expeditious remedies to parties injured by environmental crimes. Legislation on a Community Right to Know 1996 has been adopted to provide more access to information regarding potential hazards from industrial operations. India is also a signatory to the Basel Convention, 1989 on control of transboundary movement of hazardous wastes and their disposal. There were few inherent limitations observed in implementation of HWM Rules, 1989. To remove these limitations, the MoEF notified Hazardous Wastes (Management and Handling) Amendment Rules in January 2000.

Initiatives taken for hazardous waste management

Emerging policy directions in the field of hazardous waste management emphasise the need for scientific disposal of waste and policies to encourage waste minimisation and adoption of cleaner technologies. Various activities initiated by the Government of India to meet these objectives are listed and discussed below:

- MoEF has initiated task of hazardous waste inventory in various states to gather updated information
- State governments are in the process of identifying hazardous waste disposal sites based on EIA of the potential sites
- The CPCB has prepared a ready reckoner in 1998 providing technical information on sources of hazardous wastes, their characteristics, and the methods for recycling and disposal
- Training programmes have been organised for concerned personnel in ports and customs and in pollution control boards so as to familiarise them with precautionary measures and testing methodologies for hazardous waste constituents.
- It has been decided to impose a ban on import of hazardous wastes containing beryllium, selenium, chromium (hexavalent), thallium, pesticides, herbicides and their intermediates/residues based on recommendations by an Expert Committee constituted at the national level for advising in matters related to hazardous wastes
- In order to control movement of Basel Wastes, cyanide wastes and mercury- and arsenic-bearing wastes have been prohibited for export and import from December 1996.
- Import of waste oil and metal bearing wastes such as zinc ash, skimmings, brass dross and lead acid batteries for processing to recover resources would be regulated by MoEF and allowed only by environmentally acceptable technologies

In addition to these initiatives, various projects to regulate storage, treatment and disposal of hazardous wastes have been initiated in the country. These projects are discussed below.

Australian-Aid project

An Australian Aided Hyderabad Waste Management Project was initiated with a total cost of 8.4 million Australian Dollars in 1996 to develop a common treatment, storage and disposal facility for hazardous waste generated from industries located in Medak, Hyderabad, and Ranga Reddy districts. The SPCB is also receiving technical assistance through this Aus-Aid project for training in hazardous waste management.

German project

A German Technical Co-operation Project (GTZ) for assisting Karnataka in development of hazardous waste management infrastructure has been initiated in 1995 at an estimated cost of DM 3 million for creation of a hazardous waste disposal facility and DM 3 million for technical co-operation. In this project, the work completed includes a hazardous waste inventory, status of existing disposal system, and evaluation of waste disposal alternatives with focus on incineration and landfilling. The study has recommended setting up one single centralised landfill and development of one cement kiln in the state to incinerator status.

Municipal solid wastes

At the central level the responsibility of dealing with municipal solid waste lies with the MoUAE (Ministry of Urban Affairs and Employment). The other ministries involved are the MoEF and MNES (Ministry of Non-conventional Energy Sources). The MoUAE plays a coordinating and monitoring role, sponsors research and development projects, and organises training courses and workshops on issues related to solid waste management. After the MoUAE the second most important ministry involved in waste management is the MoEF. The MNES is currently implementing projects in areas related to waste and energy. At the local level it is urban local bodies like municipal authorities or corporations, which ensures waste collection, transportation and disposal. The collection, transportation and disposal of municipal solid waste is regulated and controlled by Municipal Acts in each municipality. These Acts also deal with environmental pollution caused by improper disposal of municipal solid waste.

Policies for municipal solid waste management

The MoEF, Government of India has now issued the Municipal Solid Wastes (Management and Handling) Rules in the year 2000. These rules identify the CPCB as the agency that will monitor the implementation of these rules and municipalities will be required to submit annual reports regarding municipal waste management in their areas to the CPCB. For management of biomedical waste, the MoEF has notified Bio-Medical Waste (Management and Handling) Rules in 1998 under sections 6, 8 and 25 of Environment (Protection) Act of 1986.

Initiatives taken for municipal solid waste management

Apart from notification of rules for management of municipal solid wastes in 2000 by the MoEF, several attempts are underway to improve the management of municipal solid waste. Some of the initiatives taken at the national level and efforts made by various ministries at the central level are as follows:

- NWMC (National Waste Management Council). The NWMC was constituted in 1990 and one of its objectives was municipal solid waste management. The council is at present engaged in a survey of 22 municipalities to estimate the quantity of recyclable waste and its fate during waste collection, transportation, and disposal. NWMC in 1993 constituted a national plastic waste management task force to suggest measures to minimise the adverse environmental and health impacts arising out of plastic recycling. Based on the recommendations of this task force, the MoEF in 1998, came out with draft Recycled Plastic Usage Rules, 1998 which bans storing, carrying and packing of food items in recycled plastic bags. It also specifies the quality standards for manufacturing recycled plastic bags.

- Strategy Paper. The MoUAE engaged NEERI (National Environmental Engineering Research Institute) for formulating a strategy paper on municipal waste management and also for preparing a manual on solid waste management. These documents highlight various critical issues relating to the management of solid wastes and have offered a number of suggestions for improving management practices.
- Policy Paper. The CPHEEO (Central Public Health Environmental Engineering Organisation) of MoUAE has prepared a policy paper on promoting the integrated provisions of water, sanitation, solid waste management and drainage utilities in India.
- Master Plan for MSW. The MoEF and CPCB organised an interaction meet on March 1995 with municipal authorities and other concerned ministers to evolve a strategy for the management of municipal solid wastes. CPCB also formulated guidelines for safe disposal of hospital wastes.
- Realising the potential and the need for proper treatment of wastes and resultant recovery of energy, the MNES, in June 1995, launched a National Programme on Energy Recovery from urban – municipal and industrial wastes, with a view to promoting the adoption of appropriate technologies. Various fiscal and financial incentives are offered by the MNES under this programme for energy recovery from wastes.
- High Powered Committees: A high powered committee on urban waste was constituted by the Government of India during 1975. The committee, in its report made 76 recommendations, covering eight important areas of waste management. Another high powered committee was constituted in 1995. The committee has given number of recommendations covering issues like segregation, door-to-door collection, proper handling and transportation, waste composting and treatment and use of appropriate technologies for waste treatment and disposal.

Judicial interventions

Failure in implementation of existing legislation to check the environmental damage caused by non-conforming industrial units has resulted in issue of directions in the year 1996 from Supreme Court (SC) of India ordering closure/shifting of industrial units using hazardous processes and hazardous chemicals from Delhi region to regions identified by government in the National Capital Region. In addition, SC has ordered closure of 200 tanneries in Tamil Nadu, and 35 foundries in Bengal.

Policy gaps

Hazardous waste management

- The rules promulgated by the MoEF in the year 2000 dealing with hazardous waste management fail to provide any incentive for waste reduction/minimisation efforts. Industries are therefore reluctant to adopt such measures.
- In absence of standards for clean up of contaminated sites and limits for disposal of waste on land, those industries which are causing contamination of land and water bodies through inappropriate waste disposal are not legally bound to clean the site unless ordered by judicial intervention to do so (refer to Box 4 – groundwater contamination at Village Bichchri).

Municipal waste management

- Though draft rules for the management of municipal waste were notified as early as 1998, the final rules could be notified only in the year 2000. These rules along with rules for biomedical waste management do not clearly identify the role and responsibilities to be undertaken by the CPCB and SPCBs.

Knowledge/information/data gaps

Hazardous waste management

- The hazardous waste inventory carried out by different states has been a one-time exercise. But since the growth of the industrial sector is dynamic in the country, there is a need to constantly update this waste inventory so that appropriate waste management strategies can be incorporated in waste management plans.
- In absence of a reliable waste inventory, there is very little practice at present for using tools such as EIA for hazardous waste problems. This has led to very little research on exploring the risks and health impacts of hazardous waste disposal on surrounding ecosystem and communities.
- Apart from some dedicated facilities at large chemical industries, India lacks the sort of infrastructure that is required for proper treatment and disposal of hazardous waste largely due to the inability of regulatory authorities to achieve strict enforcement of rules. This is also partly due to inadequate infrastructure including staff in different SPCBs assigned for hazardous waste management in the state.

Municipal waste management

- Although attempts have been made at the city level in some selected pockets of the country to identify and quantify municipal waste and biomedical waste, there are no state/nation-wide waste inventories available in both the cases. It becomes very difficult in the absence of such an inventory to prepare waste management plans.
- Most of the waste whether municipal or biomedical, is at present dumped in open low lying areas with no provisions for liners, leachate collection and treatment system or gas collection system.
- In absence of segregation of waste at source, waste treatment alternatives such as recycling, waste-to-energy projects and or composting become uneconomical to operate.
- Most infectious biomedical waste segregated at the source of generation gets disposed at municipal waste dumpsites in absence of dedicated waste disposal facilities for biomedical waste generators.

Policy recommendations

Industrial and hazardous waste management

- The strategy required to ensure scientific management of hazardous waste, which is expected to increase over the years due to our liberalised economic policies and related growth in industry should encompass all the aspects of waste management cycles starting from generation of waste to its handling, segregation, transportation, treatment, and disposal.
- In addition, the strategy should also target waste minimisation/ reduction as its primary focus. This becomes particularly important in view of stricter environmental standards being enforced on industries. This results in increased cost of treatment and disposal to meet the stricter standards. Any waste minimisation/reduction effort would thus result in less waste generation and lesser waste to be managed thus reducing the cost of waste management. In addition, any recycle/reuse effort may in fact earn net revenue on the waste generation.
- Although the Government of India recognises the localised nature of hazardous waste generators and while significant progress has been made in identifying large concentrations of hazardous waste, further

efforts are required to quantify and characterise the volume of waste residues generated by industries. As discussed above, there is need to constantly upgrade this waste inventory so that appropriate waste management strategies can be incorporated in waste management plans.

- Although substantial progress has been made in imparting training and capacity building to SPCB officials, additional capacity at SPCB is needed to deal with analytical and monitoring requirements regarding tracking of hazardous waste movement and management. In addition training is also required for critical industrial sectors generating hazardous waste to address their responsibility in handling, storage, transportation, treatment and disposal of hazardous waste. This becomes particularly important in light of new amended hazardous waste rules introduced in country in January 2000. The amended hazardous waste rules expand the definition of hazardous waste from previous one incorporating the hazardous waste streams identified in Basel Convention.
- It is suggested to incorporate comprehensive approaches such as EIA to carry out environmental and social assessments of hazardous waste management operations. This will help us assessing the risks and health impacts of inappropriate disposal of hazardous waste on surrounding ecosystem and communities.
- Environmental emergencies and accidental spillage or indiscriminate disposal of chemicals or waste on land causes contamination of soil and groundwater. Use of any treatment or cleanup option requires cleaning of soil and groundwater to some acceptable level of contaminants. Most of the time, in dealing with contaminated soil or groundwater, it is neither economically nor technologically feasible to achieve the zero level of cleanup. It is, therefore, necessary for the Government to set standards not only for disposal of waste on land but also for clean up of contaminated soils and groundwater.
- Apart from some dedicated facilities at large chemical industries, India lacks the sort of infrastructure that is required for proper treatment and disposal of hazardous waste. Opportunity of setting such facility at the state level, addressing the willingness-to-pay issue by participating industries, type of ownership, financial mechanisms to finance such ventures and extent of private sector participation need to be addressed/explored to ensure that such facilities come into existence.

Municipal solid waste management

In order to have a satisfactory, efficient, and a sustainable system of solid waste management, proper planning, implementation, and management systems must be incorporated in framing the national policy for solid waste management for the country. Present and future ways to manage solid waste stream need consideration of the following aspects.

- Setting targets for waste reduction. Reduction at source can be accomplished in three ways (1) fees and tax incentives to promote market mechanisms to effect source reduction, (2) mandatory standards and regulation, and (3) education and voluntary compliance with policies by business and consumers, (Marcin, Durbak, and Ince 1994). However, these strategies need to be sensitive to the concerns of possible loss of business and jobs in affected industries. Reduction in the quantity of municipal solid waste could affect employment, taxes/revenues, and economic activity in unpredictable ways (Marcin, Durbak, and Ince 1994).
- Technological interventions. India has lagged behind in adopting technologies for solid waste management. In particular, three technical components, collection, transportation, and treatment and disposal of waste need urgent attention.

- Collection of waste. One immediate measure to revamp the existing collection service structure is to provide community waste bins conveniently placed for the people to deposit domestic waste. As a first step, this will ensure that people do not throw their garbage on the roads and hence do not create open dumpsites. The second measure should entail separation of waste at source into biodegradable and non-biodegradable components.
- Transportation of waste. Waste should be carried in covered vehicles. For the narrow lanes in the congested Old City where a dumper placer cannot move and where the waste has to be carried longer than 1 km to the nearest municipal bin, small, covered vehicles built over a three-wheeler scooter, preferably with a tipping arrangement, may be used. Infectious and hazardous waste from health care facilities should be carried strictly in separate covered vehicles. Hospital waste of some categories, e.g. biomedical waste consisting of human body parts, body fluids, etc., has to be incinerated but for other categories of waste, methods like microwaving and autoclaving are possible.
- Treatment and disposal. Proper segregation would lead to better options and opportunities for scientific disposal of waste. Recyclables could be straightaway transported to recycling units, which, in turn, would pay the corporations for it, thereby adding to their income. The organic matter could be disposed of either by aerobic composting, anaerobic digestion or sanitary landfilling. Depending upon land availability and financial resources, either of these methods could be adopted. However, it appears that landfilling would continue to be the most widely adopted practice in India in the coming few years, in which case certain improvements will have to be done to ensure that it is sanitary landfilling and not merely dumping of waste.

- Institutional and regulatory reforms. The municipalities are the primary institutions responsible for solid waste management in India, but most of the urban local bodies, barring a few progressive ones, are unable to provide the desirable level of conservancy services. The 12th Schedule in 74th Amendment Act 1992, (Entry 6 in Schedule 12 (Article 243-W) empowers the local bodies by giving them independence, authority, and power to impose taxes, duties, tolls, and fees for services including public health, sanitation, conservancy, and solid waste management.

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