Hazardous waste management in India

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Being an industrializing country, India's contribution to the generation of hazardous wastes is being considered significant. The waste is generated from a wide spectrum of industries in the country. The management of these wastes poses many challenges for the industry and the government as well. Policy and legislative frameworks have been put in place while a host of international programmes are supplementing national efforts in containing the problem. The article provides an overview of the hazardous waste management scenario in India.

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Introduction

Sources of hazardous waste in the country include those from industrial processes, mining extraction, tailings from pesticide based agricultural practices, etc. Industrial operations generate considerable quantities of hazardous waste and in rapidly industrializing countries such as India the contribution to hazardous waste from industries is largest. Since industrial units are spread all over the country, the impacts are region-wide. States such as Gujarat, Maharashtra, Tamil Nadu, and Andhra Pradesh, which have undergone relatively greater industrial expansion, face problems of toxic and hazardous waste disposal far more acutely than less developed states. Industries that are major producers of hazardous waste include petrochemicals, pharmaceuticals, pesticides, paints and dyes, petroleum, fertilizers, asbestos, caustic soda, inorganic chemicals and general engineering.

During the last 30 years, the Indian industrial sector has quadrupled in size. The main source of hazardous waste generation and impact on the environment is the chemical industry. There has been a significant increase in the number of tanneries and units manufacturing pesticides, drugs and pharmaceuticals, textiles, dyes, fertilizers, paint, chlor-alkali, etc. which have a major potential for generating hazardous waste such as heavy metals, cyanides, pesticides, complex aromatic compounds (such as PCBs), and other chemicals, which are toxic, flammable, reactive, corrosive or have explosive properties.

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 Act, respectively, were introduced. However, the concern and need to manage hazardous waste scientifically was felt only in the mid eighties after the Bhopal Gas Tragedy on 2/3 December in 1984.

Table 1: Status of hazardous waste generation

State	Number of HW generating units	Quantity of waste generated (waste type) TPA			
		Recyclable	Incinerable	Disposable	Total[a]
Andhra Pradesh	501	61,820	5,425	43,853	1,11,098
Assam	18	-	-	1,66,008	1,66,008
Bihar	42	2,151	75	24,351	26,577
Chandigarh	47	-	-	305	305
Delhi	-	-	-	-	59,423
Goa	25	873	2,000	3,725	8,742
Gujarat	2,984	26,000	19,953	1,50,062	4,30,030
Haryana	309	-	-	31,046	32,559
Himachal Pradesh	116	-	63	2,096	2,159
Karnataka	454	47,330	3,328	52,585	1,03,243
Kerala	151	84,932	5,069	6,90,014	7,80,015
Maharashtra	3,953	8,47,436	5,012	1,155,398	2,00,784
Madhya Pradesh	183	89,593	1,309	1,07,767	1,98,669
Orissa	163	2,841	-	3,38,303	3,41,144
Jammu and Kashmir	57	-	-	-	1,221
Pondicherry	15	8,730	120	43	8,893
Punjab	700	9,348	1,128	12,233	22,745
Rajasthan	306	9,487	19,866	2,242,683	2,27,203
Tamil Nadu	1,100	1,93,507	4,699	1,96,002	4,01,073
Uttar Pradesh	1,020	-	-	-	1,40,146
West Bengal	440	45,233	50,894	33,699	1,29,826
Total	**12,584**	**14,29,281**	**1,18,941**	**52,50,173**	**72,43,750**

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

The MoEF (Ministry of Environment and Forests) enacted the Environment (Protection) Act, in 1986, and an amendment to it in 2002. Subsequently the MoEF promulgated the Hazardous Wastes (Management and Handling) Rules in 1989 and amendments in 2000 and 2002, and efforts to draw up inventories of hazardous waste generated in the country were initiated. Though the hazardous waste rules were introduced in 1989, their implementation has remained very poor, the situation being worsened by a liberalized industrial policy that has resulted in an increase in the pace of industrialization.

Generation of hazardous waste

The CPCB started to make an inventory of hazardous waste in 1993. Information about the quantity of hazardous waste generated, and the facilities for their disposal has been collected by the MoEF through the SPCBs (state pollution control boards). Table 1 gives, state-wise, the status of the number of units generating hazardous waste and the quantity of waste generated till March 2000 for recyclable, incinerable and disposable waste. 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).

A significant number of hazardous waste generating units have not been included in this inventory. There are a number of units in the small scale and unorganized sector that handle hazardous wastes without pollution control safeguards. Although the hazardous waste they generate is in quantities that are not regulated by the Rules, their cumulative impact cannot be ignored. There are a large number of units located in Free Trade Zones that are not registered with the SPCB.

The ship breaking industry disposes of old ships and recovers the construction material for recycling. In the sixties, ship breaking was confined to the dismantling of small barges and coastal wrecks but grew into a full-fledged industry by 1979 when the Government of India recognized it as a small-scale industry. Ship-breaking is currently carried out at the following locations:

- Alang in Gujarat;
- Sachana in Gujarat;
- Tadri in Karnataka;
- Maipe in Karnataka;
- Baypore in Kerala;
- Cochin in Kerala;
- Azhical in Kerala;
- Vishakhapatnam in Andhra Pradesh;
- Valinokan in Tamil Nadu; and
- Tuticorin in Tamil Nadu.

The primary centres are along the West coast at Alang and Sachna. Ship-breaking generates the following resources:

Table 2: Sources and quantum of waste generated from major industrial sources

Waste	Quantity (in MTPA)		Source/origin
	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, fertilizer, 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

- Rerolling scrap;
- Melting scrap;
- Cast iron scrap;
- Non-ferrous metal;
- Machinery; and
- Wooden articles.

The ship-breaking activity produces around two million tonnes of re-rollable steel per annum. The industry also employs 40,000 people in direct and ancillary businesses. The following solid and hazardous wastes are associated with the ship-breaking industry. Approximately 4000 tonnes of these wastes are generated each year.

- Paint chips;
- Scale generated during cutting of steel;
- Ceramic tiles;
- Glass wool and fibrous insulation material;
- Oil sludge and waste oil;
- Asbestos sheets, ropes and insulation; and
- Thermocol, plastics, fibreglass, linoleum, lamination etc.

These wastes require proper treatment and disposal; at present they remain scattered on the seashore and contaminate the marine environment. Other significant 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; aluminium, zinc and copper smelters that produce red mud and tailings; sugar industries generating press mud; pulp and paper industries producing lime sludge; and fertilizer and allied industries producing gypsum. The quantity of industrial waste produced per annum from these sources is presented in Table 2.

The status of hazardous waste (battery scrap, lead and zinc dross, ash, skimmings and residues and galvanized zinc) imported for the recycling and recovery of metallic constituents is presented in Box 1.

Management of hazardous waste

As per the Waste Management Rules, 1989, and the MoEF's Guidelines (1991), hazardous waste generated by industries has to be disposed of in secured landfills and the toxic organic fraction of the waste needs to be incinerated. Currently, there are 116 hazardous waste incinerators in the country and 11 engineered landfills in operation all of which are located in Gujarat. Seventy-four other sites have been identified in various states to set up disposal facilities, of which 14 have been notified. As per the information provided by the MoEF, there are 323 hazardous waste recycling units in India; of these, 303 recycling units use indigenous raw material and 20 depend on imported recyclable wastes.

However, industries continue to store hazardous waste on their premises in improperly designed facilities or dispose the waste illegally in abandoned sites. This is largely because of the insufficient treatment and disposal facilities.

Problems with current management practices

Improper storage, handling, transportation, treatment and disposal of hazardous waste results in adverse impacts on ecosystems and the human environment. Heavy metals and certain organic compounds are phytotoxic and at relatively low levels can adversely affect soil productivity for extended periods. For example, uncontrolled release of chromium contaminated wastewater and sludge resulted in the 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 reduction of a number of species. It is said that one gallon of used oil can contaminate one million gallons of water rendering it unpotable. Marine species can be affected even if exposed to oil levels as low as 1 ppm. Boxes 2, 3, and 4 provide illustrations of contamination due to improper management of hazardous wastes in Gujarat, the Thane-Belapur Industrial Area, and Delhi-Rajasthan area, respectively.

It was the responsibility of the State Government under the HWM Rules, 1989 to identify sites for the safe disposal of hazardous waste. In 1992,

Box 1: Dumping of hazardous waste in India

India has become a 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 courts of law, 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, the 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 in the form of scrap lead batteries, zinc and copper ash to India. Huge quantities of PVC waste is still exported to Asia despite international agreements (Greenpeace 1998). A Greenpeace analysis of India's foreign trade data found that at least 1,127 tonnes of zinc ash had been 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 licenced to do so.

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 laying 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

grants ranging from Rs 5 to 15 lakhs were given to 15 states for identification of sites, conducting EIA, etc. However not a single common landfill facility has been established.

Policies for hazardous waste management

The Hazardous Wastes (Management and Handling) Rules, 1989 were 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 the control of generation, collection, treatment, transport, import, storage and disposal of wastes listed in the schedule annexed to these rules. The rules are implemented through the SPCBs and pollution control committees in the states and union territories. India is also a signatory to the Basel Convention, 1989 on the Control of Transboundary Movement of Hazardous Wastes and their Disposal. There were a few inherent limitations to the implementation of the HWM Rules, 1989, and amendments to this Rule were introduced in 2000 and 2002, widening the definition of hazardous waste and harmonizing the hazardous waste list with that of the Basel Convention.

Besides these rules, in 1991, the MoEF issued Guidelines for Management and Handling of Hazardous Wastes for (a) generators of waste, (b) transport of hazardous waste, and (c) owners/operators of hazardous waste storage, treatment and disposal facilities. These guidelines also established 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,

Box 3: Case studies from Maharashtra illustrating adverse impact of hazardous wastes

The Thane-Bealpur 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 has 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 8000 people in seven villages. The NEERI report to study the extent of contamination in this area says that an amount of Rs 44 crore will be needed for rehabilitation of 350 hectares of contaminated land.

Sources: Bhattacharya and Shrivastava 1994; Sharma and Bannerji 1996

these were followed by the 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 legislation and additional incentives for industries to comply with environmental provisions and bring out market forces 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 for expeditious remedies to parties injured by environmental crimes. Legislation on the Community's Right to Know, 1996, has been adopted to provide more access to information regarding potential hazards from industrial operations.

Initiatives taken for hazardous waste management

Emerging policy directions in the field of hazardous waste management emphasize 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 below:

- State governments are in 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 organized for concerned personnel in ports and the Customs and in pollution control boards so as to familiarize people working there with precautionary measures and testing methodologies for hazardous waste constituents.
- It has been decided to impose a ban on the 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 on matters related to hazardous wastes.
- In order to control the movement of Basel Wastes, the export and import of cyanide wastes and mercury- and arsenic-bearing wastes has been banned 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 will be regulated by the 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 hazardous waste disposal facility and DM 3 million for technical co-operation. In this project, the work completed includes an inventory of hazardous waste, a study of the existing status of the system, and evaluation of waste disposal alternatives with a 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.

Policy gaps

- The amendment rules promulgated by the MoEF in the years 2000 and 2002 dealing with hazardous waste management fail to provide any incentive for waste reduction/minimization efforts. Industries are therefore reluctant to adopt such measures.

- In the absence of standards for clean up of contaminated sites and limits for disposal of waste on land, 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 (Box 4).

Knowledge/ information/data gaps

- The hazardous waste inventory carried out by the states is proving to be a one time exercise. Data on hazardous waste generated is provided by the industry and not based on inspection or verification by the SPCB. The industrial sector is growing rapidly and there is a need to constantly update this inventory so that appropriate management strategies can be incorporated into waste management plans.
- In the absence of a reliable waste inventory, tools such as EIA are hardly ever put to use for tackling hazardous waste problems.
- 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 inability of regulatory authorities to achieve the 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.

Suggestions/ recommendations

- The strategy required to ensure scientific management of hazardous waste whose generation is expected to increase due to our liberalized economic policies should encompass training and institutional strengthening in all aspects of waste management cycles starting from its generation to its handling, segregation, transportation, treatment, and disposal.
- The strategy should also target waste minimization/reduction as its primary focus, a particularly important point in view of stricter environmental standards being enforced on industries. This would mean increased cost of treatment and disposal to meet stricter standards. Any waste minimization/reduction effort would generate less waste, reducing the cost of waste management. Recycle/reuse efforts may in fact, even earn net revenue on the waste generation.
- Although the Government of India recognises the localised nature of hazardous waste generators and significant progress has been made in identifying sources of hazardous waste, further efforts are required to quantify and characterize the volume of waste residues generated by industries. There is a need to constantly update waste inventories so that appropriate waste management strategies can be incorporated into waste management plans.
- Although substantial progress has been made in imparting training and capacity building of the SPCB officials, additional capacity is needed to deal with the analytical and monitoring requirements of tracking hazardous waste movement and management. 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 the new amended hazardous waste rules introduced in 2000 and 2002. The amended hazardous waste rules expand the definition of hazardous waste and incorporate the hazardous waste streams identified in the Basel Convention.
- Comprehensive approaches such as EIA should be adopted 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 or spillage or indiscriminate disposal of chemicals or waste on land causes contamination of soil and groundwater. Use of any treatment or clean-up option requires cleaning of soil and groundwater to some acceptable level. However, it is neither economically or technologically feasible to achieve a zero level after clean-up. The Government must set standards not only for the disposal of waste on land but also for the clean-up of contaminated soils and groundwater.
- Apart from some dedicated facilities in large chemical industries, India lacks the sort of infrastructure that is required for proper treatment and disposal of hazardous waste. The opportunity for setting up such facilities 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.

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