Parivesh

A News Letter from ENVIS Centre - Central Pollution Control Board

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Editorial

The 'PARIVESH' has entered the fourth year, Through the 'PARIVESH', we shared information on various aspects of pollution to strengthen our linkage with all concerned for the cause of environmental protection. The information related to status and trends of pollution; policies and laws; important events and initiatives; research & development; waste management; environmental planning and zoning atlas; pollution control norms and their enforcements etc. have been shared. I am thankful to Dr. S.P. Chakrabarti, Member Society, Shri R.N. Jindal and the ENVIS team for regularly bringing out the thematic issues of the PARIVESH which have been well received by the readers.

The Present issue of the PARIVESH deals with Municipal Solid Wastes (Garbage). The primary responsibility for collection, transportation, disposal and utilisation of garbage is with the civic authorities. However, for various reasons, these authorities have been finding it difficult to cope up with this task, the consequences of which are evident through pollution and health hazards.

Compiled by my colleagues, Dr Avinash Akolkar, Shri Mahendra Pandey and Shri Sunil Anand, this issue of the PARIVESH provides an overview of the existing practices vis-a-vis possibilities for better management of municipal solid wastes, through adoption of innovative approaches and public participations in reducing, recycling and reuse of wastes.

(Dilip Biswas)
Chairman, CPCB

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MUNICIPAL SOLID WASTES

GROWING PROBLEMS :

Solid wastes generated by domestic, commercial and industrial activities are often indiscriminately disposed. Unscientific management of such wastes leads to serious environmental problems. The problems are already acute in cities and towns, as the disposal facilities are not keeping pace with the quantum of waste being generated. It is very common to find large heaps of garbage in disorganized manner at every nook and corner of the cities.

In sanitary method being adopted for disposal of solid wastes is a serious health concern. Particularly, during rainy season, run-off and high humid conditions increase the health hazards. The landfill sites, which are not well maintained, are prone to groundwater contamination due to leachate percolation. Open dumping of garbage serves as breeding ground for disease vectors such as flies, mosquitoes, cockroaches, rats and other pests.

High risks of spreading diseases like typhoid, cholera, dysentery, yellow fever, encephalitis, plague and dengue fever may not be ruled out. There are three major steps involved in the management of garbage viz. collection, transportation and disposal (CTD).

The collection methods currently adopted by the civic authorities are primitive and lacking in specific standards or guidelines, which are required to be laid for designing and sitting of collection centers.

Transportation of garbage is carried out using old outdated trucks, tippers and refuse collectors. Inadequacy of transportation fleet and frequent breakdown of vehicles are the major hardship in proper collection of garbage.

Disposal of municipal solid wastes is generally done through landfilling. Most of the cities have acquired land for landfilling years ago, and now these sites are over-used. Acquisition of the new sites is a tough task for the authorities.

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CHARACTERISTICS OF GARBAGE :

Quantity

It is estimated that solid waste generated in small, medium and large cities and towns is about 0.1 kg, 0.3-0.4 kg and 0.5 kg per capita per day respectively.

CPCB sponsored a survey to ascertain the status of municipal solid waste disposal in metro cities, Class-I cities and Class-II towns of India. The survey was conducted by the Environment Protection Training Research Institute (EPTRI), Hyderabad. As per the survey, the quantities of municipal solid wastes generation in metro cities are presented in Table1.

Table 1 Municipal Solid Wastes Generation in Metro Cities

Sr. No.	City	Municipal Population	Municipal Solid Wastes (tpd)	Per capita waste (kg/day)
1.	Ahmedabad	2,87,610	1,683	0.585
2.	Bangalore	41,30,288	2,000	0.484
3.	Bhopal	10,62,771	546	0.514
4.	Calcutta	96,43,211	3,692	0.383
5.	Chennai	47,52,974	3,124	0.657
6.	Colimbatore	8,16,321	350	0.429
7.	Delhi	84,19,084	4,000	0.475
8.	Hyderabad	40,98,734	1,566	0.382
9.	Indore	10,91,674	350	0.321
10.	Jaipur	14,58,483	580	0.398
11.	Kanpur	18,74,409	1,200	0.640
12.	Kochi	6,70,009	347	0.518
13.	Lucknow	16,19,115	1,010	0.623

14.	Ludhiana	10,42,740	400	0.384
15.	Mumbai	1,22,88,519	5,355	0.436
16.	Madurai	9,40,989	370	0.392
17.	Nagpur	16,24,752	443	0.273
18.	Patna	9,17,243	330	0.360
19.	Pune	22,44,196	700	0.312
20.	Surat	14,98,817	900	0.600
21.	Vadodara	10,31,346	400	0.389
22.	Varanasi	10,30,863	412	0.400
23.	Visakhapatnam	7,52,037	300	0.400

Composition

The composition of garbage in India indicates lower organic matter and high ash or dust contents. It has been estimated that recyclable content in solid wastes varies from 13 to 20% and combustible material is about 80-85%. A typical composition of municipal solid waste is given below.

Description	Percent by weight
Vegetable, leaves	40.15
Grass	3.80
Paper	0.81
Plastic	0.62
Glass, ceramics	0.44
Metal	0.64
Stones, ashes	41.81
Miscellaneous	11.73

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PRESENT MANAGEMENT PRACTICES :

Collection of Garbage
Garbage is generated from residential and commercial complexes. Current practices in residential areas for collection of garbage differ from city to city and even within the city. Door to door collection is not widely practiced. A few residential societies hire private scavenging staff for door-to-door collection of solid waste.

The local authorities do not have proper provision to collect waste from narrow residential and commercial lanes, and in areas with high traffic.

The slums and squatters in cities also create in sanitary conditions. Open defecation and disposal of sewage and garbage from such settlements need proper attention. Similarly, operation of dairy related activities in residential areas cause nuisance. Cow-dung and other waste is not properly managed. Vendors selling eatables, vegetables, fruits etc. also thro their wastes recklessly, which need to be regulated

Collection Centres
The findings of survey carried out by CPCB indicate that in some of the cities, no norms/guidelines have been followed in setting up of waste collection centers. Each city has its own system for setting up of waste collection centers, which are still using primitive methods. In some cities, both the collection and transportation of waste id done by using mechanized bins. At primary level, the waste is collected from communities in a smaller bin, which is then transported, to larger bins known as secondary collection facility. Maintenance of such waste collection centers is also an important aspect which needs proper attention.

Transportation of Garbage
Transportation of waste from collection centers to final disposal site is another important step in the management of garbage. It has been estimated that approximately 60% of waste is collected for transportation to the disposal sites and the main constraints are: non-availability of sufficient transportation fleet; frequent breakdown of vehicles; and absenteeism of crew etc. The garbage during transportation to the disposal site is exposed to the open conditions thus causing public nuisance. The vehicles carrying garbage should be covered.

Loading of garbage for transportation is done manually. Workers are exposed to the garbage. During manual loading, 6-8 workers are deployed on each truck. In smaller towns, tractor-trailers are commonly used and at times, animal drawn carts are also being used. In some cases, front-end loaders are also used, though; the receptacles are not well designed to suit such system.

Transportation of waste should be done on everyday basis throughout the year. Vehicles and equipment, to transport the waste should synchronize with primary and secondary collection centers. In smaller towns, either tractor-trailer or tricycle or any indigenous vehicle should be used for the transport of waste from the community bins to transfer stations. In the areas where large sized waste collection centers are difficult to place, waste collection vehicle of appropriate size may be introduced. Such system has been practiced in Ahmedabad.

Disposal of Garbage
The disposal of garbage in a well-managed land, adopting scientific methods of operation is termed as sanitary land-fill (SLF). Most important aspect relating to landfill is, identification of a suitable site. Landfilling is a slow and time-consuming process. Therefore, careful operations are required throughout the period.

Most of the landfill sites in India are uncontrolled dumps and are not sanitary landfills where domestic, commercial; industrial and hospital wastes are dumped together. The garbage on such sites is not properly speedy and compacted. Thus, sites identified for filling are not properly maintained. As per information collected by CPCB through EPTRI, the average disposal by landfill is about 91%.

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COMMUNITY PARTICIPATION :

Collection and Segregation of Waste

Door to door collection of waste is not a common practice in India and is being done through privately hired scavenging staff to some extent. Such services must be utilized individually. Thus, primary collection system by and large is optional. It is essential to search suitable methods by which garbage load on land can be reduced to cope up with the non-availability of land for land-filling in future. Segregation of waste at source level may therefore be insisted upon.

A new scheme to collect the garbage from its source has been introduced by the Calcutta Municipal Corporation (CMC). House to house collection of garbage is carried out using handcarts. Scavenging officials of CMC carry handcart during a scheduled time. This practice of collection of garbage was initiated on 1st November, 1994 from Jodhpur Park and at present is in operation in more than 40 wards of the city. A study was taken up for collection and sorting of domestic waste into bio-degradable and non-degradable material by the households of the Purbanchal Housing Estate in Salt Lake City to establish an appropriate system for sorting domestic garbage and recycle them economically. The Nodal Research Centre is collaborating this work with the Paschim Banga Vigyan Manch.

New Delhi Municipal Council (NDMC) introduced a scheme of door-to-door collection of garbage on experimental basis in some of the colonies. Under this scheme, on 1st May, 1994, NDMC supplied 25 polythene bags of 90' X 25" capacity of about 10-12 kg of garbage at the subsidized price of Rs.15/- per house/month. The garbage is collected on daily basis by the NDMC staff and then deposited in the nearby dustbins for further transporting them to the dumping ground. 40% of the residents were covered under this scheme.

The garbage quality and quantity is also affected with the rise in living standard and modern styles. Use of packaging material and plastic bags, has become a part of day-to-day life. All such bags after usage are indiscriminately thrown here and there and one can see colourful bags flying all around the waste dumps, markets, parks and also can be seen in water bodies and to the extent of choking sewers. It is necessary that allindustries, which produce non-biodegradable materials and where such material after usage is thrown away, may be encouraged to recycle such materials.

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INVOLVMENT OF NGOs :

During the recent years, NGOs have taken up initiatives to work with local residents to improve the sanitation. The NGOs have been organizing surveys and studies in specified disciplines of social and technological sciences and came up with ideas and scheme supported by unbiased analysis of facts and figures. In the field of garbage management, such studies are useful in identifying areas of commercial potential to attract private entrepreneurs.

NGOs can play an important role in segregation of waste, its collection and handing over to local authorities. They can also help in bringing up the awareness and consciousness for good sanitation. Through such programmes, NGOs can help in:

- creating mass awareness, ensuring public participation in segregation of recyclable material and storage of waste at source;
- ensuring public participation in community based primary collection system;
- organizing ragpickers for collection of recyclable material at the community level;
- providing health education to the ragpickers and suggesting tools for safety;
- providing employment through organizing door to door collection of waste; and
- encouraging minimization of waste through in-house backyard composting, vermiculture and biogas generation etc.

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RECYCLING :

Surveys carried out by Government and Non-Government agencies in the country have recognized the importance of recycling of wastes. However, methodology for safe recycling of waste have not been standardized. The steps involved in theprocess prior to recycling includes;

- Collection of waste at door steps, commercial places and from other placements;
- Collection of wastes from community dumps; and
- Collection/picking up of wastes from final disposal sites .

Studies reveal that about 7 to 15% of the waste is recycled. However, it is difficult to establish the quantum of waste recovery. There are various types of waste, which are recycled to produce different products. The process of recycling and its environmental implications are yet to be studied in detail. On one hand recycling helps in reducing the quantity of waste but on the other it may invite some of the pollution problems. There is a need to develop waste recycling center (WRC). Such centers could develop simple processes for the segregation of the refuse and to produce the desired reclaimed products.

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WEALTH FROM WASTES: TECHNOLOGIES :

In the recent past, private sectors have taken initiatives to use the garbage as profitable venture. Some of the technological options available are summarized below:

Energy Recovery Technologies

Biomethanation
Anaerobic digestion is process used for biological decomposition of organic wastes. The organic wastes are hydrolyzed, liquified and gasified with the help of methanogenic bacteria. There is an appreciable saving in recurring costs in such prcesses because of the utilization of bio-gas.

Sanitary Land-fill Gas
Sanitary land filling is a process of dumping of solid waste in a scientifically designed land area spreading waste in thin layers, compacting to the smallest practicable volume and covering with soil on daily basis. The methane rich biogas is produced due to anaerobic decomposition of organic matters in solid wastes. Garbage has a potential to generate about 150-250 cubic metre biogas per tonne waste depending upon the quality.

Pelletisation
Fuel pellets also referred as refuse derived fuel (RDF) are small cubes/cylindrical pieces made out of garbage. Its calorific value, 4000 Kcal/kg of the product is quite close to the coal, therefore, it can be good substitute for coal, wood etc.

Pyrolysis/Gasification
In this process, combustible matter of garbage is allowed to dry/dewater and then is subjected to shredding. Incineration of waste under oxygen-deficient conditions is called pyrolysis. The objective of pyrolysis has generally been to produce gas, which would be stored and used when required.

Incineration
Incineration is a process of controlled combustion for burning of wastes and residue, containing combustible material. Carbon dioxide, water vapour, ash and non-combustibles are end products. The heat generated during incineration is recovered and utilized for the production of steam, heating water and generating electricity. Incineration is used to achieve maximum volume reduction of solid waste and when there is shortage of land filling facilities. It is usually cost effective method of disposal.

Composting
Composting is one of the methods of waste utilization. It is defined as the decomposition of heterogeneous organic matter by a mixed microbial population in the moist, warm and aerobic environment. These microorganisms convert organic wastes into humus, which has significant value to agriculture farming.

Merits of the composting process

1. Foul smells is quickly eliminated.
2. Processing site is made hygienic for workers.
3. Harmful pathogens are killed by exothermic heat. .
4. Waste becomes free from flies and vultures.
5. Chances of smoke and fire hazards are minimized.
6. Weed seeds, fruit nuts are made unviable.
7. Waste material becomes safe for re-transportation etc.

8. Value added matured organic manure is derived for use in agriculture, horticulture, landscaping etc.
9. ecyclable products like glass, metals; plastics are recovered at the end of the process. .
10. Minimizes production and release of gases like methane, ammonia, hydrogen sulphide etc., in the environment.

Vermiculture

Vermiculture is an aspect of biotechnology involving the use of earthworms as natural and versatile bio-reactors for cleaning up the environment by adoption of cost-effective waste management technique. Vermiculture means culturing of earthworms in a scientific manner. It is a simple low-cost and appropriate biotechnology using earthworms systematically. By providing them with optimum conditions for rapid multiplication and conversion of farm wastes and bio-degradable urban wastes into bio-fertilizers, it can preserve and improve the soil fertility.

Various Waste Disposal Methods and Their Merits/demerits

Method of Disposal	Demerits	Merits
Land Filling Open land dumping Burning/Incineration Bio-conversion into organic manure	- Restricted site availability cannot last longer - Contaminated water sources - Anaerobic gas production explosions - Environment pollution - Costly large area occupied - Increasing maintenance cost of open dumps - Ugly look to the cities & surroundings - Smoke and fire - Shifting of locations due to space becoming full - Smoke and gaseous contamination of environment - Temperature rise - Diesel costs higher - Capacity for incineration is a constraint - Technological constraints - Higher capital costs - Requires Govt. support production - Value addition to waste resource - Sustainable approach	- Easy operation - Land gets leveled - Lower initial costs - Easy for Ragpickers - Non-skilled job - Incineration is a standard hygienic operation - Burning is easy operation - Highly useful product for land improvement crop

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NATIONAL PLANS FOR MANAGEMENT :

Several attempts are underway to improve better management of municipal solid wastes. Deliberation on administrative, technical, financial and legal issues are being considered for the feasible means of management. Foreign investment in garbage management has been appreciated and modalities on bilateral collaboration with willing countries have been explored. Some of the initiatives taken at national level and efforts made by various ministries at central level are as follows:

National Waste Management Council (NWMC)
NWMC was constituted in 1990 and one of its objectives was municipal solid waste management. The council decided that sample survey be carried out in various cities to find out recyclable material in the municipal waste which is picked up by ragpickers and sold to industrial establishments through contracts (kabariwalas). Financial assistance was provided to 22 municipalities to undertake such survey. They report expected to provide concrete methods to improve solid waste management.

Strategy Paper
The Ministry of Urban Affairs and Employment (MoUAE) engaged the National Environmental Engineering Research Institute (NEERI), Nagpur for formulation of a strategy paper on municipal waste management and also for preparing manual on solid waste management. These documents highlight various critical issues relating to management of solid wastes and have offered number of suggestions for improving the management practices.

Policy Paper
The Central Public Health Environmental Engineering Organization (CPHEEO) of the MoUAE, Government of India has prepared a policy paper on promoting the integrated provisions of water, sanitation, and solid waste management and drainage utilities in India.

Master Plan for MSW
The Ministry of Environment and Forests (MoEF) and the Central Pollution Control Board (CPCB) organized an interaction meet (March 1995) with municipal authorities and other concerned ministries to evolve a strategy for the management of municipal solid waste. CPCB has also formulated guidelines for the safe disposal of hospital wastes.

FICCI's contribution
The Federation of Indian Chambers of Commerce and Industry (FICCI) proposed a background paper on solid waste management in connection with round table organized on 5th June 1995 in New Delhi.

High Powered Committees
A high-powered committee on urban waste was constituted by Government of India during 1975. The committee, in its report made 76 recommendations, covering eight important areas of waste management.

An another high-powered committee was constituted in 1995, under the chairmanship of Prof. J.S. Bajaj, Member, Planning Commission, Government of India. The Committee has given a number of recommendations and some of them are as follows:

- Segregation of waste at household level should be encouraged and promoted.
- Primary level of collection should be ensured from each household. Private agencies/NGOs may be involved in primary collection.
- Monthly charging for door-to-door collection based on income groups may be implemented.
- The vehicles for transporting solid waste from the transfer point to the disposal site should be of appropriate design, suiting the waste characteristics.
- Along with land filling, composting of municipal solid wastes should be the next appropriate option.

- Private participation in setting up pilot plants utilizing appropriate technologies for urban solid waste management should be encouraged.

National Programme on Sanitation and Environmental Hygiene

An interactive workshop, for formulation of national programme on sanitation and environmental hygiene was held at Vigyan Bhawan, New Delhi in April, 1995. Its recommendations are:

- Source segregation into two receptacles
- one for putrescible and another for non-putrescible waste from household, shops, establishments, slums and squatter settlements, be done.
- Wherever, economically viable, door-to-door collection of waste should be encouraged on cost recovery basis. In other areas, smaller bins with two compartments to collect putrescible and non-putrescible garbage should be introduced.
- All open dustbins, masonry bins, round concrete bottomless bins should gradually be phased out by replacing good mobile community bins.
- Disposal of solid waste should be done by encouraging composting of waste. Load on sanitary landfill sites should be reduced by filling only inert materials.

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FEATURES OF THE EXISTING LAWS :

Municipal Acts are the first legislations in the country, which deal with environmental pollution caused by municipal solid wastes. Although, environmental pollution is not dealt with under municipal enactments, the provisions which deal with prevention or suppression of nuisance are generally aimed at combating pollution at the local level

Some of the provisions of the Municipal Acts relating to solid waste management are as follows:

The Uttar Pradesh Municipal Corporation Act, 1959

Section 114 The watering, scavenging and cleaning of all public streets and places in the cities and the removal of all sweeping there from

Section 115 Making arrangement for preparation of compost manure from night soil and rubbish

Section 385 Mukhya Nagar Adhikari to provide for cleaning of streets and removal of refuse

Section 440 License required for dealing in dairy produce

The Karnataka Municipal Corporation Act, 1976

Section 58 The watering and cleaning of all public streets and public places in the city and removal of all the sweepings

Section 255 Provision for removal of filth

Section 256 Public notice ordering removal of the deposit of rubbish and filth

Section 258 Provision for daily cleaning of streets and removal of rubbish and filth

Section 261 Maintenance of establishment for removal or rubbish and filth

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LITIGATIONS :

In view of the Public Interest Litigations (PIL), various courts have viewed the matter of sanitation seriously. Some of the important decisions delivered by the courts are:

In Municipal Corporation Ratlam Vs Vardhichand (Air 1980 SC 1622), the Supreme Court issued direction to the municipal council to abate environmental pollution. The court categorically fixed responsibility on the municipal council to abate nuisance as it is one of the obligatory functions of the council.

In L.K. Koolwal Vs State of Rajasthan (AIR 1988 Raj 2), THE high Court held that it was not the duty of the court to see whether funds were available or not and whether the staff was available or not, it was for municipality to see how to perform its primary duties. The court also held that when every citizen owes a constitutional duty to protect environment under Article 51-A, the citizen must also be entitled to enlist the courts aid in enforcing that duty against recalcitrant state agencies, including municipalities.

In Rampal Vs State of Rajasthan (AIR 1981 Raj 121), the court held that municipal boards were primarily responsible for maintaining sanitation and for taking proper steps for creating and maintaining a healthy environment within municipal area.

In a writ petition © No.286 of 1994, Dr. B.L. Wadhera Vs Union of India, Hon'ble Supreme Court of India delivered a judgment on 1st March 1996. A 29-page judgment touched garbage affairs of Delhi and issued several directions to the local municipal authorities to perform upto satisfaction of public, which are their statutory obligations.

The Supreme Court directed CPCB and the Delhi Pollution Control Committee (DPCC) to inspect different areas of Delhi and New Delhi to ascertain that the collection, transportation and disposal of garbage/waste is carried out satisfactorily. The court further directed CPCB and DPCC to file the reports by way of an affidavit after every two months for a period of two years. Since then, CPCB and DPCC have filed six affidavits and inspection reports which represented in-depth analysis of garbage management in Delhi and made several recommendations for consideration of MCD and NDMC to improve the existing situation.

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PUBLIC OPINION :

CPCB attempted to collect public opinion in Delhi by issuing advertisements in newspapers on garbage management. The response was overwhelming and numbers of suggestions were received. Some of the public opinion was as follows::

- Present design of waste receptacles are not acceptable due to their poor maintenance.
- The availability of waste collection centers is inadequate and people are disposing garbage in a haphazard manner.
- Garbage is being deposited in drains, manholes, parks, streets and back-lanes.
- Sitting of dustbins is not proper.
- Dumping of debris or construction materials is to be regulated.
- Street sweepings should be regular.
- Garbage is burnt on streets and in colonies.
- Sludge, after cleaning of drains is dumped on streets and lanes, and not removed.
- Dead animals are not removed for days.
- Trucks carrying garbage remain open and are a great public noisome.
- Inter-departmental formalities leads into in sanitary conditions.
- Stray animals around dustbins and on streets cause great danger to public.
- Dairy activities create unhygienic conditions.
- Insanitary conditions caused due to open defecation and by slums and squatter settlements.

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ROLE OF POLLUTION CONTROL BOARDS:

Since disposal of municipal soil wastes poses problems of the pollution and health hazards, the Pollution Control Boards are expected to take action for persuading the civic authorities in proper management of municipal solid wastes. Though, direct responsibility of management of solid wastes is on the local municipal authorities, the Pollution Control Boards need to have close linkage with local authorities in rendering assistance in terms of carrying out necessary surveys and providing technological back-up. CPCB and SPCBs at national and state levels are to disseminate information and create awareness among the concerned authorities and public at large.

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A TALE OF TRASH :

A film produced on the municipal solid waste management, A Tale of Trash highlights the important stages of garbage handling which includes collection, transportation and disposal. The difficulties faced by the local authorities and the initiatives taken by them have also been covered. An attempt had been made to depict some of the technologies adopted for the treatment and disposal of municipal solid wastes. The film also covers the initiatives taken by the NGOs like Exnora International of Chennai, Gandhi Sewa Ashram of Ahmedabad, Vatavaran, and Srishti of Delhi. The film serves an important purpose from educational point of view to the students, trainee, technologists, municipal authorities and for the public at large. The film has been telecast on national network of the Doordarshan.

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FINANCIAL ASPECTS :

Non-availability of adequate financial resources is one of the important constraint in improving better management of municipal solid wastes. However, local authorities may avail and even evolve some pattern of financing the municipal services within existing laws for improving solid waste management, The services rendered may be collected though levying charges and taxes.

The Ministry of Urban Affairs and Employments in its draft policy paper has projected financial requirement by of funds fore the solid waste management by the year 2025 AD as Rs.5,230 crores.

The Ministry of Agriculture and Ministry of Non-Conventional Energy Sources also provide catalytic support for adoption of suitable technology for processing of garbage.

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CPCB PUBLICATIONS DURING APRIL, 1996 - MAY, 1997 :

1. Ambient Noise level Survey in Delhi on the Occasion of Deepawali Festival.
2. Booklet on coastal Pollution.
3. Comprehensive Industry Document on Gas based Thermal power Plant.
4. Pollution Potential of Industries in Coastal Areas of India.
5. Comprehensive Industry Document on Natural Rubber Processing.
6. Groundwater Quality of Flood Affected Areas of Delhi: 1995
7. National Ambient Air Quality Statistics of India: 1993-1994.
8. Cleaner Technology - Issues and Options.
9. Proposal for the Ninth Plan.
10. Review of Environmental Statements.
11. Basin Sub-Basin Inventory of Water Pollution - Godavari Basin.
12. Rationale in Evolution of Standards for Industrial Effluents and Emissions.
13. Comprehensive Industry Document on Fruit and Vegetable Processing Industry.
14. Ecomark: A Scheme on Labeling of Environment Friendly Products.
15. Comprehensive Industry Document on Soft Drink manufacturing Units, Bakeries and Confectioneries.
16. Status of Ambient Air Quality Statistics of India (1987-1993)
17. Inventorisation of Hazardous Waste Generation in five Districts (Ahmedabad, Vadodara, Bharuch, Surat and Valsad) of Gujarat.
18. Zoning Atlas for Sitting of Industries (Based on Environmental Consideration): the conceptual Framework.
19. Comprehensive Industry Document with Standard Guidelines for Pollution Control in Brick Kilns.
20. Ambient Air Quality Status and Trends in Delhi.
21. Inventorisation of Hazardous Waste Generation in Jammu Province of J & K State.
22. Rationalization and Optimization of Monitoring Programme for River Cauvery.
23. National Ambient Air Quality Statistics of India: 1995.
24. Inventorisation and Management of Hazardous Waste in Medak District, Andhra Pradesh.

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Environmental Management Plan Kanpur Urban Area- May 2001
Bio-Monitoring of Water Quality in Problem Areas - April 2001
Environmental Management System- February 2001
Common Effluent Treatment Plants - November 2000
Polluting Industries
Clean Coal Initiatives - June 2000
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Auto Emissions - June 1999
Technologies for Pollution Control Industry - October 1999
Hazardous Waste Management - June 1998
Plastic Waste Management - September 1998
Municipal Solid Wastes - June 1997

Cleaner Production Options for Pulp & Paper Industry - Sept 1997
Zoning Atlas For Siting Industries - June 1996
Bio-Monitoring of Water - September, 1995
Assessment and Development Study of River Basin - March 1995
Depletion of Ozone Layer and Its Implications - September 1994
Agro - based Industries - December 1994