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## MAJOR CHARACTERISTICS ASSOCIATED WITH THE PROBLEM OF SOLID WASTE MANAGEMENT IN THE CITY OF COLOMBO

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### Abstract

Urbanization has given rise to several environmental problems in Sri Lanka, particularly in the city of Colombo. The gradual increase of city population and the expansion of its economic activities have influenced the generation rate of solid waste in the city of Colombo. In 1987 the average generation rate of solid waste in the city was 450 tons per day. It has been projected that the average generation rate of solid waste would increase to 470 tons per day by 1997. The volume and character of solid waste have changed in response to the rising standard of living and the expansion of service facilities in the city.

However, today the city encounters several problems that have arisen due to inadequate management of solid waste. The poor quality of urban environment and several health hazards bear evidence to the inefficiencies in the management systems.

Factors giving rise to the present situation can broadly be categorised into the following groups. (i) climate and weather conditions, (ii) lack of equipment and vehicles, (iii) poor co-ordination in the administrative framework, (iv) lack of waste recovery techniques (v) lack of co-operation from the public, and (vi) problems related to the labour force.

An immediate solution to several problems would be the provision of adequate funds. However, it is vital to provide a long term solution by evaluating multidimensional facets of solid waste generation, disposal and management problem in the city of Colombo.

### Introduction

The collection, disposal and recycling of solid waste is a common problem in many countries especially in developing countries. In Sri Lanka, particularly in the city of Colombo, it is an acute problem as the inefficient management of solid waste is reflected by unclean, unhealthy urban environments. The responsibility of maintaining a clean city, rests largely with the Colombo Municipal Council. The inefficient nature of the management system is caused by several factors. In this connection it is relevant to evaluate the factors causing inefficiencies in the collection, disposal and management of urban solid waste.

The objective of the study is to pay attention to the following aspects of the solid waste management problem in the city of Colombo.

- (1) The impact of urbanization process on the solid waste generation rate in the city of Colombo.

- (2) Constraints on improving the present system of collection, transportation and disposal of solid waste in the city of Colombo.
- (3) Suggestions for efficient management in the light of future waste generation rates in the city.

### Research Methodology

This report is based primarily on the information collected from the Colombo Municipal Council during the years 1986 and 1987. Several discussions were held with the officials who are responsible for Planning and Management of solid waste in the city of Colombo. Reports and published data, pertaining to the subject that were available at the Colombo Municipal Council were made use of.

Additional information were extracted from the research reports based on field surveys done by the Author in the years 1984, 1985 and 1986, in the city of Colombo. The different aspects covered by the research surveys were on (i) The environmental problems in the city of Colombo, and (ii) Sub-standard housing units and their impact on environmental pollution in the city of Colombo. (De Silva, J. 1988)

#### 1 — THE IMPACT OF URBANIZATION PROCESS ON THE SOLID WASTE GENERATION RATES IN THE CITY OF COLOMBO:

##### 1 — (a) Definition of Urban Solid Waste:

A waste is a material which is thrown away or put aside as worthless. "Urban solid waste is defined as material for which the primary generator or user abandoning the material within the urban area, requires no compensation upon abandonments. In addition it qualifies as an urban solid waste, if it is generally perceived by society as being within the responsibilities of the Municipality to collect and dispose of." (Cointreau, Sandra Johnson, 1982, p. 4.)

##### 1 — (b) Major Characteristics of the Urbanization process in the city of Colombo.

Sri Lanka is primarily an agricultural country which has a 22 per cent urban population. Approximately 50 percent of the total urban population is found in the Colombo District, whereas 19 percent of the

total urban population is concentrated in the city of Colombo. The major characteristics of urbanization are depicted in Tables I and II.

Table I shows that from 1881–1981 the area of Colombo city has grown by 53 percent while the city population has increased by 430 percent. Table II presents two vital aspects of the growth of urban population after 1946 in the city of Colombo. Firstly, the average growth of population in the city has been increasing at a decreasing rate. Secondly, the average growth rate of city population has been comparatively lower, than that of the national population in Sri Lanka. The increase of city population, particularly during the last two decades has undoubtedly contributed to the increasing volume of solid waste.

1 — (c) Major Categories of Solid waste in the city of Colombo

Categories of solid waste viewed as the responsibility of the Colombo Municipal Council are as follows :

- (i) household garbage and ashes
- (ii) Commercial refuse
- (iii) Institutional refuse
- (iv) Construction and demolition debris
- (v) Street sweepings and drain cleaning wastes
- (vi) dead animals
- (vii) abandoned vehicles and tyres. (Annexure 1)

In addition to the above categories, the management of industrial waste, particularly from the small scale units has become the responsibility of the Colombo Municipal Council. However, some large scale industries either have private waste disposal methods or a payment is made to the Municipality for the special services provided to them.

1 — (d) General Characteristics of Solid Waste in the City of Colombo.

The city of Colombo cannot claim a satisfactory sanitation system covering the entire city. This is particularly true in regard to the slum and shanty housing units where there is a dearth of toilet facilities. It is inevitable therefore that the street refuse contains a lot of human faecal matter. This problem is worse in locations where beggars shelter in the night.

Although stray cattle is not a serious problem in the city of Colombo, bullock carts are used for the transportation of goods.

TABLE 1

## AREA, POPULATION AND DENSITY OF COLOMBO CITY, 1881-1981

Census Year	Area (in Sq. Km.)	Population	Density (per Sq. Km.)
1881	24.47	110,502	4,516
1891	24.47	126,825	5,183
1901	25.90	154,691	5,973
1911	30.92	211,274	6,833
1921	33.51	244,163	7,287
1931	33.67	284,155	8,439
1946	34.39	362,074	10,529
1953	34.65	426,127	12,298
1963	34.70	511,644	14,745
1971	37.29	562,160	15,075
1981	37.29	587,647	15,759

Source — Sri Lanka Census of Population and Housing 1981, General Report — Volume 3, p. 69, 1986.

**TABLE 2**  
**POPULATION GROWTH IN COLOMBO**

Name of Town	Census Year	Population	Total Increase	Percentage	Inter - Censal Increase	
					Average Annual Growth Rate (%)	National Population (%)
COLOMBO	1946	362074	—	—	—	—
	1953	426127	64053	17.9	2.5	3.1
	1963	511644	85517	20.0	2.0	3.1
	1971	562420	50776	9.9	1.2	2.5
	1981	585776	23356	4.1	0.4	1.7

Sources — Statistical Abstract of Ceylon, Census of Population — 1971 and Census of Population & Housing 1981, Department of Census & Statistics, Colombo.

Cattle dung is a component found with street refuse. Therefore, techniques such as methane generation and composting are often technically viable because of the high organic content of the refuse.

The high moisture content of the refuse depends largely on two factors. Firstly, the monsoonal rainfall, particularly from May to September soaks through garbage, awaiting collection. Secondly, unsatisfactory methods of garbage disposal are common in the city of Colombo. For instance, when garbage is not collected in polythene bags, it collects rainwater and attracts roaming cattle and dogs. Therefore, extra animal manure may be added thereby increasing the organic matter and moisture content. Incineration would generally not be self sustaining because of the high moisture content of the waste.

Another characteristic of the waste in the city of Colombo is the low recyclable nature of paper, glass and plastics. Nevertheless, human scavengers redeem plastic, polythene and textile from collecting sites.

The small scale industrial enterprises are likely to make use of the Municipal waste disposal system. Therefore the city garbage contains a proportion of hazardous industrial waste.

## 2. CONSTRAINTS IN IMPROVING THE PRESENT SYSTEM OF COLLECTION, TRANSPORTATION AND DISPOSAL OF SOLID WASTE IN THE CITY OF COLOMBO

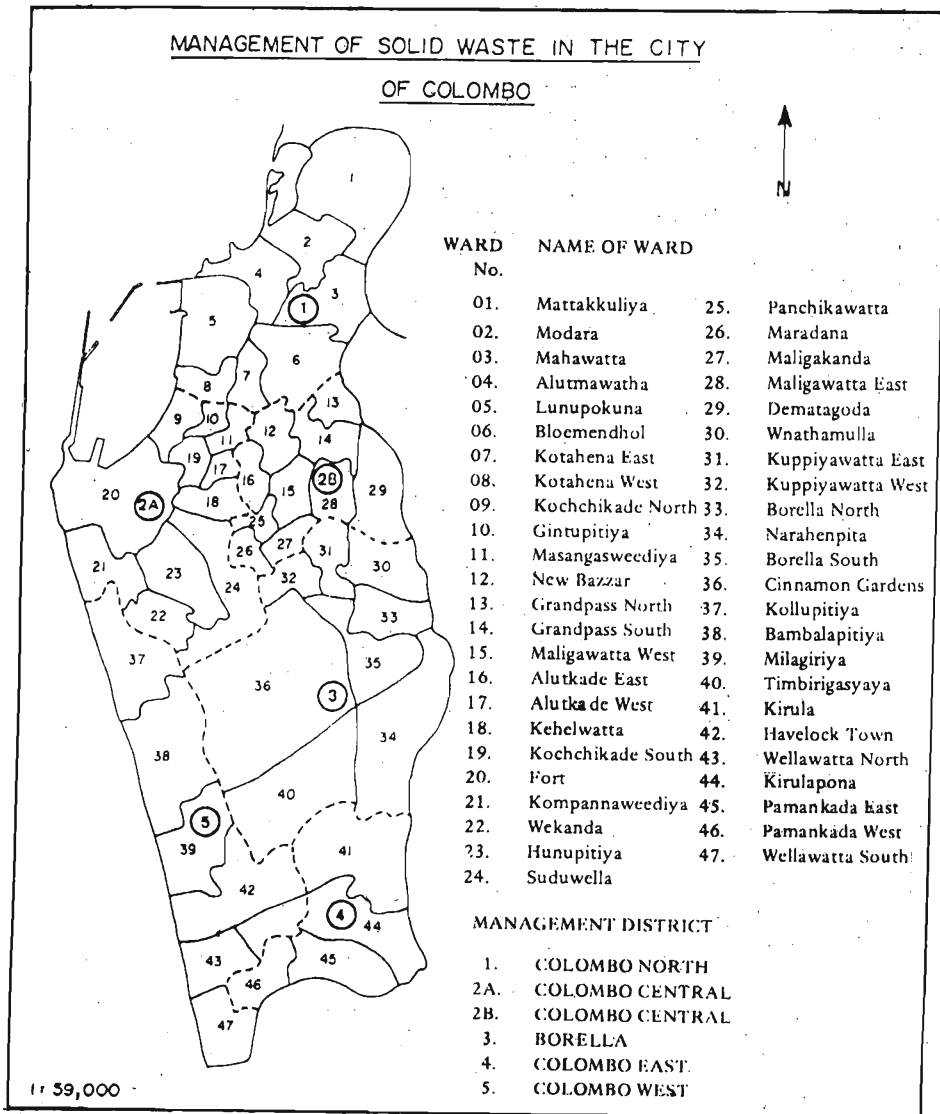
- 2 - (a) The General characteristics of the present system available for solid waste management in the city.

The city of Colombo consists of 47 wards. These wards are grouped into 6 districts for the purpose of garbage collection (Map 1).

During the last two decades tremendous changes have taken place in the system available for garbage collection. Prior to 1973 the use of bullock carts for garbage collection was a common feature. During this period the Colombo Municipality had only 12 lorries and they were 25 years old. Dumping of garbage was done within the city limits in low lying areas viz. Maligawatte, Bloemendhal Road, Mahawatte, Wanathamulla, Destructor Road, Kirillapona, Balapokuna Road and Parakumba Place.

It became clear that these facilities were insufficient to meet the rising demand within the city. By 1981 the city population had increased to 587,647 and solid waste generation escalated up to 400 tons per

MAP I



SOURCE — COLOMBO MUNICIPAL COUNCIL — BUDGET SPEECH REPORT 1987 (BASIC MAP HAS BEEN MODIFIED)

day. Table III shows the technical improvements introduced to garbage collection by the Colombo Municipal Council.

The introduction of polythene bags to the residents of the Colombo city in 1985 is a worthy step taken in waste management. The Colombo Municipal Council has taken several additional steps to keep the city clean. Garbage collection has been made compulsory twice a week in the city. Table IV shows the labour force engaged in the six garbage management districts in the city. Table IV (a) depicts the availability of equipment in a selected district i.e. district 04.

- 2 — (b) Constraints associated with the present garbage management system in the City of Colombo.
- 2 — (b)—i— Constraints associated with climatic conditions.

The city of Colombo falls within the hot-wet climatic zone which is characterised with temperatures ranging from 27.8°C to 29.4°C. During the months from May to September the Southwest monsoons bring 43 percent of annual rainfall of the city. The convectional thunderstorms are dominant during the two Intermonsoonal seasons. 16 percent of annual rainfall is received during the first Intermonsoonal season (March to April) and 28 percent during the second Intermonsoonal season (October to November). The Northeast monsoon winds which are active from December to February account for 13 percent of the annual rainfall of the city. (Table V)

The risk of flooding is naturally greater in the low lying valley sites in the city. The occurrence of continuous rain is a common phenomenon during the South-West monsoon season. The collection and transportation of garbage is severely hampered for several days during the occurrence of floods and heavy rains. (Vide Table VI and Table VII) Floods and rains are likely to cause several additional problems, such as the clogging of drains, dispersion of garbage in a larger area, and pollution of water.

- 2 — (b)—ii— Poor access to sub-standard housing units.

The city of Colombo is dotted with shanty and slum units. 45 percent of the city population dwell in sub-standard housing units. A large number of these housing units are accessible only by narrow walkways which are invariably unpaved. The problem of inaccessibility prevent garbage disposing handcarts and mini-tractors approaching

TABLE 3

## 1982-1987 PURCHASE OF GARBAGE DISPOSAL VEHICLES

TYPE OF VEHICLE	NUMBER OF VEHICLES PURCHASED
Rear loading compactor type garbage lorries	30
Tractors and Trailors	20
Smaller capacity type garbage lorries	06
Mini tractors to be used in by-lanes	20
Bulldozers for Sanitary land fill sites	02

Source — Colombo Municipal Council, Budget Speech — 1987.

TABLE 4

## THE CITY OF COLOMBO – LABOUR FORCE ENGAGED IN THE DISPOSAL OF SOLID WASTE – 1987

DISTRICT	NUMBER OF WARDS	PERMANENT		CASUAL		TOTAL
		MALE	FEMALE	MALE	FEMALE	
1	8	170	45	68	29	312
2A	11	306	36	127	37	506
2B	10	240	36	142	31	449
3	8	268	130	130	133	661
4	4	110	10	180	25	325
5	6	185	18	105	15	323
Total	47	1279	275	752	270	2576

TABLE 4(a)

## THE AVAILABILITY OF EQUIPMENT IN WASTE MANAGEMENT IN THE CITY OF COLOMBO (DISTRICT NO.4)

BIN CARTS	HAND CARTS	RAKES	SHOVELS	MAMMOTIES	FORK SHOVELS	EKEL BROOMS
17	19	12	63	50	02	16

Source – (TABLE 4 &amp; 4a) Colombo Municipal Council – Engineering Division – 1987.

TABLE 5

## CITY OF COLOMBO

## (DISTRIBUTION OF RAINFALL DURING THE FOUR SEASONS)

SEASON	PERIOD	RAINFALL (Millimetres)
(i) First Intermonsoon Season	March–April	122.8 – 285.3
(ii) South West Monsoon Season	May–September	98.2 – 388.3
(iii) Second Intermonsoon Season	October–November	330.5 – 388.9
(iv) North East Monsoon Season	December–February	68.1 – 192.2

Source – Department of Meteorology – Colombo 7, 1987.

TABLE 6

(RAINFALL DATA — AVERAGE VALUES FROM 1951—1980)

	MONTHLY RAINFALL (Millimetres)	NUMBER OF RAINY DAYS
January	87.9	8
February	96.0	7
March	117.6	11
April	259.8	18
May	352.6	23
June	211.6	22
July	139.7	15
August	123.7	15
September	153.4	17
October	354.1	21
November	324.4	19
December	174.8	12

Source — Meteorology Department, Colombo 7, 1987.

them. Moreover, many housing units do not have yard space even to place a storage garbage bin. Haphazard garbage disposal has become an inevitable phenomenon.

2 — (b)—iii—Difficulties in protecting garbage from animals.

Garbage placed along roads is collected by the Municipal services, and frequently dumped in communal masonry bins or designated neighbourhood dumping grounds. In these temporary storages and transfer places, wastes are being eaten or dishevelled by cattle, dogs, goats and pigs. Waste is also being picked up by birds and deposited in neighbouring lands and water bodies. Human scavengers also grab items that are of use to them. The above activities lead to dispersion of waste in a larger area, and create an unpleasant sight in the city.

2 — (b)—iv— Scarcity of land for garbage collection within the city limits.

The former collecting grounds viz: Maligawatte, Bloemendhal Road, Mahawatte, Wanathamulla, Destructor Road, Kirillapone, Balapokuna Road, and Parakumba Place have been completely filled by 1980. Therefore, new sites are required that are located out of the city limits. Today, some of the low lying filling areas are available in the outskirts of Colombo, such as Kolonnawa, and Urugodawatte. The frequent traffic blockages and slow moving traffic are likely to pose problems in transporting garbage to locations which are away from the city limits.

Although marshy, waterlogged lands are available as garbage collecting centres, there are several physical problems associated with them. Transportation of garbage by heavy vehicles would not be possible in such waterlogged areas and special road-ways will be required. At the same time any stagnant water should be removed by dewatering processes.

Solid waste management has a large transportation component. It is important to minimize the travel time and distances, of the collection and transfer vehicles with a view to minimizing costs. If there is recoverable material or energy value in the waste, it is important that the transport distances to the potential market area be limited, in order to make the best use of the waste.

TABLE 7

**THE IMPACT OF KELANI RIVER FLOODS ON THE LOWLYING AREAS  
OF THE CITY OF COLOMBO**

**(FLOOD LEVELS AT NAGALAGAM STREET\*)**

WATER YEAR	WATER LEVELS (METRES)	MONTH	DURATION (NUMBER OF DAYS)
1970/71	2.23	September	1 to 6 days
1971/72	1.62	May	1 to 6 days
1972/73	0.92	August	1 to 2 days
1973/74	1.62	July	1 to 6 days
1974/75	2.00	May	1 to 6 days
1975/76	1.42	November	1 to 5 days
1976/77	1.28	June	1 to 5 days
1977/78	1.60	October	1 to 4 days
1978/79	1.49	November	1 to 4 days
1979/80	0.73	June	1 to 2 days
1980/81	1.34	September	1 to 4 days
1981/82	1.43	June	1 to 5 days
1982/83	1.06	November	1 to 3 days
1983/84	1.58	July	1 to 5 days

- \* Minor flood level = 1.5 metres (Mean sea level)  
 Major flood level = 2.4 metres ( „ „ „ )  
 Dangerous flood level = 3.0 metres ( „ „ „ )  
 Critical flood level = 3.6 metres ( „ „ „ )

Source — Irrigation Department — Hydrology Division, Colombo 7 — 1988.

- 2 — (b)—v Lack of adequate cover material for garbage collecting sites.

Once garbage is dumped and levelled in the collecting sites, cover material such as earth has to be spread over it, and large volumes of cover material would be required as this has to be applied on each layer of garbage. However, the scarcity of cover material within the vicinity of the city of Colombo has become a problem.

- 2 — (b)—vi— Frequent interruptions to Garbage Collecting schedules in the City.

Primarily the collection of garbage rests on the availability of labour. Sweeping, collecting and loading into lorries are all labour intensive activities. The Colombo Municipal Council has to collect garbage twice a week. These plans are interrupted by intervening public holidays, labour strikes, and such rare instances as a 24 hour curfew in the city. Frequent collection of garbage is vital, particularly in the densely populated areas, as the households do not have adequate space to store garbage for a few days. On the otherhand waste with high content of organic matter lead to rapid decay in a warm temperature resulting in insect propagation.

- 2 — (b)—vii— Institutional problems such as lack of planning and poor co-ordination in the institutional Framework.

The Colombo Municipal Council is conscious of maintaining a clean city. But, a special unit exclusively for solid waste planning and management does not exist in the administrative system in the Municipal Council. As a result, data pertaining to the following aspects of solid waste management are not available.

- (a) Changes of per capita waste generation rates in the city of Colombo.
- (b) Health hazards encountered by the labour force.
- (c) Research and technologies adopted for recycling of solid waste.

The present records available on collection, disposal and management of waste are scapy in the institutional framework.

2 — (b)—viii— Inadequate supervision of field work by field Supervisors.

The field officers are not provided with transport facilities such as scooters, motor bicycles to travel in their respective fields. Thus, the Officers are unable to have a close supervision of labourers.

2 — (b)—ix— Lack of vehicles, equipment and poor maintenance.

One of the acute problems is the lack of vehicles for collection and transportation of garbage. The limited number of bulldozers are insufficient to work simultaneously at the refilling centres. The problem could be eased to some extent, if the non-working vehicles are repaired and made use of. There is a severe dearth of basic equipment such as ekel brooms, push carts, collecting baskets etc.

2 — (b)—x— Lack of Co-operation from the residents in the City of Colombo.

The plans and programmes for waste management could be jeopardized if there is no public co-operation. Despite the fact that the residents have been informed of the proper steps in waste management, the following methods of waste disposal are still in use.

- (a) Haphazard dumping of waste along road sides
- (b) Dumping in canals and waterways.

These methods are adopted particularly by 68 percent of shanty dwellers in the wards of Pamankade and San Sebastian. On the other hand 70 percent of the residents in the wards of Cinnamon Gardens and Thimbirigasyaya, use polythene bags to dispose garbage. The polluted waters in the Dehiwela canal, San Sebastian Canal and Kelani river are largely used for the dumping of waste. ((De Silva, J. 1988)

2 — (b) — xi — Problems encountered by labourers attached to the Colombo Municipal Council.

The wages given to labourers are woefully inadequate and they are compelled to work in private houses to earn extra money. Approximately 40 percent of the labourers are suffering from various forms of diseases, for which they are not provided with medical treatment. The Colombo Municipal Council has not provided them with suitable protective measures such as hand-gloves, boots, raincoats etc. which are

essential during work.

2 — (b) — xii — Lack of proper legislation.

The legislation pertaining to waste management, date back to 1905. Certain amendments have been introduced to these regulations in 1935.

There are several examples to show that the division of responsibilities is one of the major constraints, in efficient management. The proper management of waste comes under the engineering division of the Colombo Municipal Council. On the other hand, when regulations are violated by the city dwellers only the Sanitary Inspectors are authorized to take necessary action.

The Colombo Municipal Council has the right to collect a sum of Rs. 100/= per  $\frac{1}{2}$  barrel of garbage from each industrial establishment. Of the 47 wards, only 6 percent of the wards were able to implement the regulation. Likewise the Municipal Council, also has the power to charge Rs. 100/= from each house-hold when demolished building particles, and felled trees are disposed by the Council. As these regulations are not implemented properly the due revenues are not received by the Council.

3. SUGGESTIONS FOR EFFICIENT MANAGEMENT IN THE LIGHT OF FUTURE WASTE GENERATION RATES IN THE CITY.

Waste management by the Colombo Municipal Council could be improved by adopting the following methods.

3. — (a) Increasing public awareness of waste management and the possible health hazards.

It is possible to conduct educational programmes through mass media to increase public awareness of possible health hazards of haphazard waste disposal.

Posters, Television, radio and News papers are suitable means of conveying the message.

3 — (b) Attention should be paid by the Colombo Municipal Council to satisfy workers' demands.

Waste management is highly a labour intensive activity. Priority should be given to improve their health facilities in order to prevent them from contracting diseases. Provision of hand-gloves, boots, medical facilities are essential. It would be beneficial if the workers are made to undergo compulsory medical tests at least once in every six months.

3 — (c) Provision of adequate equipment and vehicles.

Immediate steps should be taken to overcome shortages pertaining to equipment.

It would be economical to increase the number of dual purpose lorries which are capable of crushing garbage whilst being able to load large volumes of garbage.

When land filling areas are widely dispersed, it is important to have a large number of bulldozers for garbage levelling purposes. The general shortage of equipment and vehicles could be partly overcome if they are properly maintained. It was reported that 25–50 percent of the fleet of vehicles are invariably at repair stage.

3 — (b) Provision of close Supervision.

The extent of the area under each Supervisor should be smaller than the present extent, which would enable them to have close supervision of workers. The field supervisor should be provided with transport facilities for easy travel within the designated areas.

3 — (e) Good Planning and effective management is required.

There should be a proper planning unit based on regular data collection. Record keeping in regard to different aspects of waste disposal activities should be made compulsory. It is important to have close co-ordination among the different sections in the administrative framework.

3 — (f) Introducing amendments to existing regulations.

Although there are regulations to prosecute offenders, these regulations are not properly implemented. The regulations should be revised with a view to overcoming present problems. If such steps are taken, the Colombo Municipal Council would be able to increase earn-

ings due from erring industrial organizations disposing industrial waste.

3 — (g) Protection of tipping sites from rainwater.

The use of bunds and peripheral drainage channels are necessary to keep off surface water. Infiltration of rainwater could be minimized by having drainage to make water to flow to adjacent ground water resources. Dewatering processes in tipping sites are needed to prevent ground water getting contaminated.

Additional steps should be taken to maximize surface runoff and minimize infiltration. Bunds are needed to prevent water entering from adjacent areas to tipping sites.

3 — (h) Steps should be taken to prevent leaking of gases from garbage collecting centres.

Garbage collecting centres produce noxious gases such as methane, which could percolate to adjacent areas. The accumulation of gases and their ill effects could be minimized by adopting corrective measures. The re-circulation of gases should prevent its outflow during land filling. Technological measures should be taken to remove accumulated gases.

3 — (i) Technological innovations should be adopted to treat garbage as a potential asset.

In a resource scarce country like Sri Lanka, with the appropriate technology garbage can be used as a potential resource.

Research should be made to study the feasibility of producing compost. Government or private owned companies should be established to use Municipal waste to produce compost. A feasibility study reveals that the moisture content, and the carbon to Nitrogen ratio of urban solid waste are optimum for the preparation of compost. The study shows that there will be a high demand for compost from coconut plantations. Research should be directed to evaluate the feasibility of producing solid fuel from king-coconut husks. It has been shown that there is a high possibility of producing fuel by adopting the air-drying method of king-coconut husks. (The World Bank — Environmental Resources Ltd. 1987)

In some of the developing countries land fill gas is extracted as an energy source. The Colombo Municipal Council should explore the

possibilities of producing energy and providing it to industrial units.

- 3 — (j) Priority should be given to 'Bulk—haulage' (via transfer stations) over 'direct haulage'

Waste should be collected to transfer stations and subsequently transported to landfill sites. The advantages of this method are:

- (a) Time spent by collectors on delivering refuse to distant landfill sites will be saved.
  - (b) All collector vehicles are unable to go on rough, unpaved roads leading to landfill sites.
  - (c) Bulk haulage will be more efficient on transferring garbage from transfer stations.
- 3 — (k) Steps should be taken to prevent bad odour emitting from tipping sites.

In some of the developed countries chemical sprays are used to minimize bad odour emitting from tipping sites. Another method that could be adopted in Sri Lanka is the increasing cover thickness or using different cover material to suppress the odour. Some of the efficient methods in minimizing the impact of bad odour are provision of a adequate cover material, good compaction and correct gradient to prevent water ingress.

- 3 — (l) Exploration of suitable land to be used as land fill sites.

A feasibility study done on this aspect has suggested the following locations as land fill sites. (The World Bank, Environmental Resources Ltd., 1987)

- (i) Welisara Quarry
- (ii) Mahara harbour work Quarry
- (iii) Mahara railway Quarry
- (iv) Hokandera Quarry

Additional land fill sites are vital as the daily waste generation rates are likely to escalate in the near future. The present waste generation rate which is 450 tons per day (1987) will increase to 470 tons per day in 1992 and 490 tons per day in 1997. In addition to the above

rates, 200 tons of industrial waste will be added daily to the waste load in the city of Colombo. (The World Bank — Environmental Resources Ltd. 1987)

These deep extensive Quarries provide land space for disposal of garbage. There are risks of having fractures in the quarry walls, and potential environmental damage from leakages of gas should not be overlooked. The impermeable bedrock may encourage seepage. In many developed countries the trend is to select lands with standing water as tipping sites, as there are two main advantages attached to such sites;

- (a) It promotes anaerobic decomposition of waste and
- (b) The risk of methane gas production will be reduced.

### Conclusion

The management of solid waste is a highly labour intensive service. The co-operation of the residents is vital for a waste management programme to be successful. Most of the equipment used for refuse collection and disposal are generally short lived. Thus, annual budget allocations should be made particularly for the maintenance and purchase of equipment. A solid waste management unit requires well planned programmes based on reliable data, co-ordination among institutional sectors, and research methods on possible recycling of waste.

## ANNEXURE I

### CATEGORIES OF SOLID WASTE

- (i) Household garbage and Ashes:

Waste generated from household activities, such as food preparation, sweeping, cleaning, fuel burning, gardening etc.

- (ii) Commercial refuse:

Waste from stores, hotels, restaurants, ware houses, garages and fuel service stations.

- (iii) Institutional refuse:

Waste from schools, government offices, hospitals, Banks, police barracks, and religious places.

## (iv) Construction and Demolition debris:

Large heaps of soil, old bricks, and planks are piled along road sides in construction and demolition sites. Particularly in the demolition sites unwanted material are dumped along the road with the assumption that the Municipal Council has the responsibility to collect them.

## (v) Street Sweepings and drainage cleaning waste:

This category consists of a large portion of kitchen waste, human faecal matter, animal manure and waste matter deposited in drains. In some parts of the city where sanitary facilities are inadequate, open drains and road sides have been used to dump human faecal matter and droppings of household animals. Drains contain highly decomposed street sweepings, as they are in constant contact with water.

## (vi) Dead Animals:

Cats, dogs, rats, and crows are the common species found in urban environments. In localities, where housing density is high and land is scarce animal carcasses are dumped along the road side to be disposed by the Municipal Council.

## (vii) Abandoned vehicles and Tyres:

Delapidated or burnt vehicles that are abandoned along road sides are a rare occurrence in urban areas. However, abandoned tyres and delapidated spare motor parts are generally piled up along the road side where there are garages and service centres.

## BIBLIOGRAPHY

- Cointreau, Sandra J. 1982 *Environmental Management of Urban Solid Wastes in Developing Countries — A Project Guide—* Urban Development Technical Paper No. 5. The International Bank for Reconstruction and Development/The World Bank, Washington D.C.

- De Silva J. 1988 *The Environmental Problems in the City of Colombo.* (Paper presented at the Regional Workshop on "Tropical Urban Ecosystem Studies", University of Kebansaan, Malaysia, January 1988).
- De Silva J. 1988 *Sub-Standard Housing Units, and their impact on environmental pollution in the City of Colombo.* (Unpublished Research Report, Central Library, University of Colombo.)
- Mendis, M. W. J. G. 1982 *Sri Lanka—Urbanization and Urban Development.* Office of Housing and Urban Development USAID/Colombo.
- Thanh, N. C.  
Lohani, B. N.  
Tharun, Gunther 1978 *Waste Disposal and Resource Recovery.* Proceedings of the Seminar on Solid Waste Management. Asian Institute of Technology, Bangkok, Thailand.
- Wijayadasa, K. H. J.  
and Ailapperuma W. D. 1986 *Survey of Environmental Legislation and Institutions in the SACEP Countries,* Sri Lanka, Central Environmental Authority of the Ministry of Local Government, Housing and Construction.
- 1984 *Sri Lanka Census of Population & Housing 1981 Colombo District Report, Volume 1 — Part 1,* Department of Census & Statistics, Ministry of Plan Implementation.
- 1986 *Sri Lanka Census of Population and Housing 1981 General Report,* Volume 3 Department of Census and Statistics, Ministry of Plan Implementation.

- 1976 *Population of Sri Lanka—ESCAP Country Monograph Series No. 4, Economic & Social Commission for Asia and the Pacific— Bangkok, Thailand.*
- 1982 *Case Studies — Urban Survey Colombo —Sri Lanka, International Institute for Aerial Survey and Earth Sciences, Enschede, The Netherlands.*
- 1985 *Industrial Pollution in the Kelani River— Preliminary Survey and Interim Report, Vol. II, Central Environmental Authority of Sri Lanka.*
- 1973 *Wellawatte Canal Pollution Control, Report of the Special Committee appointed by the Minister of Irrigation, Power & Highways.*
- 1986 *Water Pollution Survey with An Ultra Light Aircraft, Colombo — Phase II, Final Report, Ministry of Housing, Physical Planning and Environment, The Netherlands — Central Environmental Authority, Sri Lanka.*
- UNDP 1987 *Study of Landfill and Resource Recovery in Metropolitan Colombo. Draft Report — Prepared for a Swiss Corporation. The World Bank by Environmental Resources Ltd.*
- 1979 *Policy Paper — Slum and Shanty Upgrading in Colombo Municipal Council. Ministry of Local Government, Housing and Construction — Urban Development Authority.*