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AN ANALYSIS OF URBAN SOLID WASTE MANAGEMENT OPERATION IN ERNAKULAM CITY: A CASE STUDY

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Abstract

Solid waste, often called as the third pollution after air and water pollution, is that material which arises from various human activities and which is normally discarded as useless or unwanted. The present studies made and attempt to analysis the urban solid waste management operation in Ernakulam city. Ernakulam city is the largest urban agglomeration and most densely populated cities in the state. The study focuses on generation, disposal and management of solid waste in Ernakulam city. It further explains its characteristics, management and its treatment practices.

Keywords: *Solid waste, Management, Disposal, Generation*

Introduction

Almost all processing and consumption activities of people, from agriculture, industry to commerce and health generate solid waste. Solid waste, often called as the third pollution after air and water pollution, is that material which arises from various human activities and which is normally discarded as useless or unwanted. It consists of the highly heterogeneous mass of discarded materials from the urban community as well as the more homogeneous accumulation of agricultural, industrial and mining wastes (Rana, 2007).

According to an estimate a single person generates 1600 kg of waste in one year in developed countries. Several components of these wastes can be recycled whereas others remain to be non-biodegradable (Rana, 2007).Humans have always produced trash and

have always disposed of it in some way, so municipal solid waste is not a new issue. What has changed are the types and amounts of waste produced, the methods of disposal and the human values are perceptions of what should be done with it (An introduction to Solid waste management and the environment, 2013). Waste pollution is considered a serious threat by many and can broadly be defined as any pollution associated with waste and waste management practices (Raju, 2009).

Solid waste management can be divided into two major areas: collection, including storage, transfer, and transport; and disposal, including any accompanying treatment. (Robert & James, 1975)

Study area

Ernakulam is a coastal city located in the central part of Kerala. Ernakulam city is the largest urban agglomeration and commercial capital of Kerala and it is classified as B-1 grade city by Government of India, which leads Ernakulam to become one of the most densely populated cities in the state. The civic body governing the Ernakulam city is the Corporation of Cochin.

Objectives

1. To assess the characteristics of urban solid waste generated in Ernakulam city
2. To assess the amount of urban solid waste in Ernakulam city
3. To assess the mode of disposal of solid waste in the city

Database and Methodology

The study is based on primary and secondary sources of data obtained from field survey and published and unpublished records from concerned agencies and institution like, Municipal Corporation of Cochin, Kerala State Pollution Control Board (KSPCB) Ernakulam, Town and Country Planning Office Ernakulam, Health Department Corporation of Cochin, Greater Cochin Development Authority (GCDA) Ernakulam, Jawaharlal Nehru National Urban Renewal Mission (JNNURM) Ernakulam, and Solid Waste Disposal Plant Brahmapuram.

The spatial analysis of urban solid waste management is based on the year 2011. The

temporal analysis of solid waste generation was done with the help of data during the period 2007-2012. The analysis of solid waste generation, collection, disposal and management is based on both qualitative and quantitative technique. The primary and secondary source of data has been collected through conducting field survey and empirical observation. For the analysis of data various statistical methods have been used i.e. growth rate, simple percentage method, Z-score and Composite Z-score (CS).

Temporal Analysis of Solid Waste Generation in Ernakulam City 2007-2012

The waste generation by big cities is really astonishing, consisting mostly of plastic bags, plastic bottles, metals, glass and paper (Manoharachary & Reddy, 2004, p.136). Table 1 shows the trend of solid waste generation Ernakulam city. It reveals that there was a rising trend in solid waste generation from 2002 -2012. It is to note that the solid waste generation has increased alarmingly from 2009-2012. It is attribute to rising population growth, the existing commercial and residential areas and the development of new residential areas. In 2007 the solid waste generation in

Table 1

Municipal Solid Waste Generation in Ernakulam City 2007-2012

Years	Solid Waste Generation in Metric Tonnes
2007	295.26
2008	315.5
2009	353.1
2010	392.9
2011	421.5
2012	433.8

Source JNNURM, Corporation of Kochi, 2011

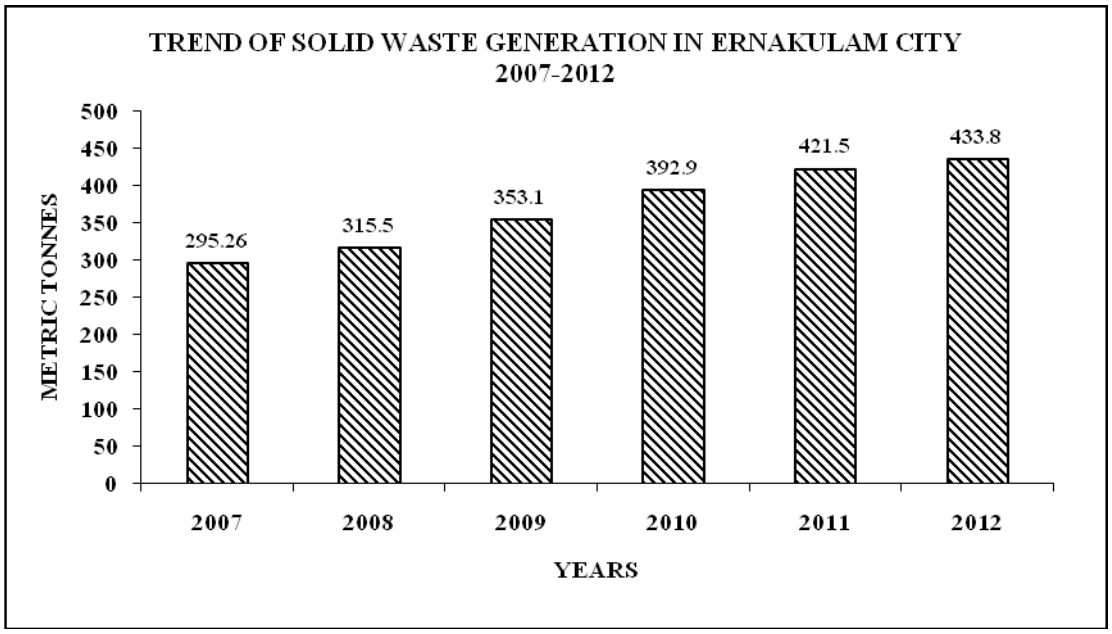

Fig. 1

Ernakulam city was only 295.26 metric tonnes, it reached to 315.5 metric tonnes in 2008. But the solid waste generation in Ernakulam increased steadily to 353.1 metric tonnes and 392.9 metric tonnes in 2009 and 2010 respectively. In 2011 the waste generation again increased to 421.5 metric tonnes and in recent year 2012, it reached the mark of 433.8 metric tonnes per day.

Source and Character of Solid Waste in Ernakulam City, 2011

Ernakulam city generates 421.50 metric tonnes of solid waste every day at an average waste generation of 707 grams per capita per day. Ernakulam city's administrative body Cochin Corporation collects and dumps the generated waste at Brahmapuram Solid Waste Disposal plant. The rest is dumped on road sides, drains and canals. But the collection network miserably lacks the solid support of community.

Table 2 indicates the source wise solid waste generation at the city level. Solid waste is generated by a variety of sources, ranging from household to commercial establishment, public and institutional areas. From the 421.50 metric tonnes of solid waste 66.22 percent of the waste is generated from the household 279.12 metric tonne. Commercial establishment contribute 21.15 percent (89.15 metric tonne) of the total

waste. Institutional waste constitutes 2.53 percent of the total waste generated in

Ernakulam city.

Table 2

Source of Municipal Solid Waste in Ernakulam City 2011

Source of Waste	Quantity TPD	%
Household	279.12	66.22
Commercial	89.15	21.15
Institutional	10.66	2.53
Road sweeping	18.63	4.42
Drain cleaning	7.97	1.89
Clinical	9.31	2.21
Construction and demolition	6.66	1.58
Total	**421.5**	**100**

Source: Draft City Sanitation Plan Executive Summary, August 2011

The contribution of road sweeping and drain cleaning is 4.42 percent and 1.89 percent, respectively. The percent share of waste from hospitals and clinics is 2.21, these health institutions produce 9.31 metric tonnes of waste per day. Construction and demolition activities contribute 1.58 percent of the waste in the city.

Physical Characteristics of Solid Waste in Ernakulam City

The physical characteristics of solid waste in Ernakulam city is given in the table 3. It shows that more than 79 per cent of the total waste generated in Ernakulam city constitute of vegetable waste or biodegradable waste. Paper, metal, glass, plastic and rubber constitute 12.61 per cent of the total waste production. The presents of inerts, ash and fine earth in the total waste was 3.42 per cent. About 0.28 per cent of the waste in Ernakulam city was domestic hazardous.

Table 3

Physical characteristics of Municipal Solid Waste in Ernakulam city 2011

Types of Solid Waste	Collection point (%)	Dump site (%)
Paper	4.87	4.42
Plastic	4.83	4.10
Metals	0.35	1.03
Glass	1.06	2.04
Rubber/Leather	1.50	1.42
Inerts	1.74	1.81
Ash and fine earth	1.68	3.68
Compostable organics	79.78	77.14
Domestic hazardous	0.28	0.74

Source: JNNURM, Corporation of Kochi, 2011

Chemical Characteristics of Solid Waste in Ernakulam City

Chemical characteristics of municipal solid waste in Ernakulam city showed that the level of moisture content in the solid waste was 55.29 per cent with a density of 267.81 kg/m^3.

Table 4

Chemical Characteristics of Municipal Solid Waste in Ernakulam city 2011

Chemical characteristics	**Value**
Density (kg/m^3)	267.81
Moisture content (%)	55.29
Calorific value (k.cal/kg)	1759
pH	7.46
C (%)	26.39
N (%)	1.25
C/N	21.11
P as P_2 0_5 (%)	129.25

Source: JNNURM, Corporation of Kochi, 2011

The calorific value of solid waste in Ernakulam city was 1759 cal/kg and showed alkaline in nature with a pH value of 7.46. It contains 26.39 per cent of carbon and nitrogen content of 1.25 percent and C/N content of 21.11. The content of P_2O_5 in the solid waste of Ernakulam city was 129.25 per cent.

Metal content of Solid Waste in Ernakulam city

Amount of metal content in the municipal solid waste in Ernakulam city is shown in the table below.

Table 5

Heavy Metal Content of Municipal Solid Waste in Ernakulam city 2011

Heavy metals	Value
Ar (mg/kg)	5.72
Mn (ppm)	-
Ni (ppm)	4.49
Cd (ppm)	0.38
Pb (ppm)	2.48
Cr (ppm)	-
Cu (ppm)	47.53
Zn (ppm)	98.98
Hg (mg/kg)	<0.1

Source: JNNURM, Corporation of Kochi, 2011

Table 5 showed the heavy metal content in the solid waste of Ernakulam city. It indicated that the presence of Mn and Cr are below the traceable level and the amount of Hg was less than 0.1 mg/kg. The amount of Cd in the solid waste was also very low with a value of 0.38 ppm. The solid waste in Ernakulam city had the Ar content of 5.72 mg/kg, Ni 4.49 ppm and Pb 2.48 ppm. From the table it is clear that the value of Cu and Zn is very high as compared to other metals. The amount of Cu and Zn in the solid waste was 49.52 ppm and 98.98 ppm respectively.

Spatial Analysis of Municipal Solid Waste Generation in Ernakulam city, 2011

The table 6 shows the ward wise generation of solid waste in Ernakulam city. On the basis of the quantity of solid waste generation the wards of Ernakulam city is divided into five categories. The analysis shows that among the 66 wards, two wards namely Ernakulam North and Pulleypady come under the category of very high. The quantity of waste generated by these wards is very high because they are located in the CBD, they constitute the central part of the city and they are the main commercial areas of the city. These wards are along the main markets of Broadway, M.G.Road, Banerjee Road, Ernakulam North, Kaloor, Shanmugam Road etc. Bus terminal, railway stations, vegetable markets, malls, hospitals, administrative offices, educational institutions and other institutions are located in this part of the city.

Table 6

Ernakulam city Ward Wise Municipal Solid Waste Generation 2011

Ward No.	Ward Name	Waste Generation	Z- Score
1	Fort Kochi	4.5	-0.01
2	Iraveli	8.75	0.92
3	Karipalam	4	-0.12
4	Mattancherry	6	0.32
5	Cheralai	9	0.98
6	Kochangadi	5	0.10
7	Panayappilly	7	0.54
8	Karuvelipady	13	1.86
9	Thoppumpadi	4	-0.12
10	Tharebagham	3	-0.34
11	Kadebagham	1.5	-0.67
12	Tazhuppu	3	-0.34
13	Edakochi North	1	-0.78
14	Edakochi South	1	-0.78
15	Perumpadappu	1	-0.78
16	Konam	2	-0.56
17	Kacheripadi	2.5	-0.45
18	Nampyapuram	2	-0.56
19	Pullardesham	2.5	-0.45

20	Mundamveli	2.5	-0.45
21	Manasserry/Beach	5	0.10
22	Moolamkuzhy	1.5	-0.67
23	Nazrat	5	0.10
24	Fort Kochi Veli	2.5	-0.45
25	Amaravathi	10	1.20
26	Island	5	0.10
27	Vaduthala West	2	-0.56
28	Vaduthala East	3	-0.34
29	Elamakkara North	1.15	-0.75
30	Puthukalavattam	1	-0.78
31	Ponekkara	1.2	-0.73
32	Kunnumpuram	1.1	-0.76
33	Edappily	1.65	-0.64
34	Devankulangara	5	0.10
35	Elamakkara South	1.1	-0.76
36	Karukappilly	6	0.32
37	Mamangalam	5	0.10
38	Vennala	6	0.32
39	Chakkaraparambu	5	0.10
40	Palarivattom	5	0.10
41	International Stadium	5	0.10
42	Thammanam	2	-0.56
43	Elamkulam	4	-0.12
44	Punnurunni	2	-0.56
45	Chalikkavattom	4	-0.12
46	Vaitla	2.2	-0.52
47	Poonithura	2.4	-0.47
48	Vaitla Janatha	2.3	-0.49
49	Girinagar	4	-0.12
50	Panampally Nagar	4.5	-0.01
51	Kadavanthra	3.5	-0.23
52	Konthuruthy	1.8	-0.60
53	Thevera	1.6	-0.65
54	Perumanoor	1.5	-0.67
55	Ravipuram	9.6	1.11
56	Gandhinagar	2.5	-0.45

57	Ernakulam Town South	8.5	0.87
58	Ernakulam Town North	33	6.26
59	Pulleppady	13.5	1.97
60	Kathrukadavu	7.5	0.65
61	Kaloor South	7.5	0.65
62	Kaloor North	7.5	0.65
63	Thrikkanarvattom	4	-0.12
64	Ayyappankavu	3	-0.34
65	Pachalam	3	-0.34
66	Thattazham	3	-0.34

Source: JNNURM, Corporation of Kochi, 2011

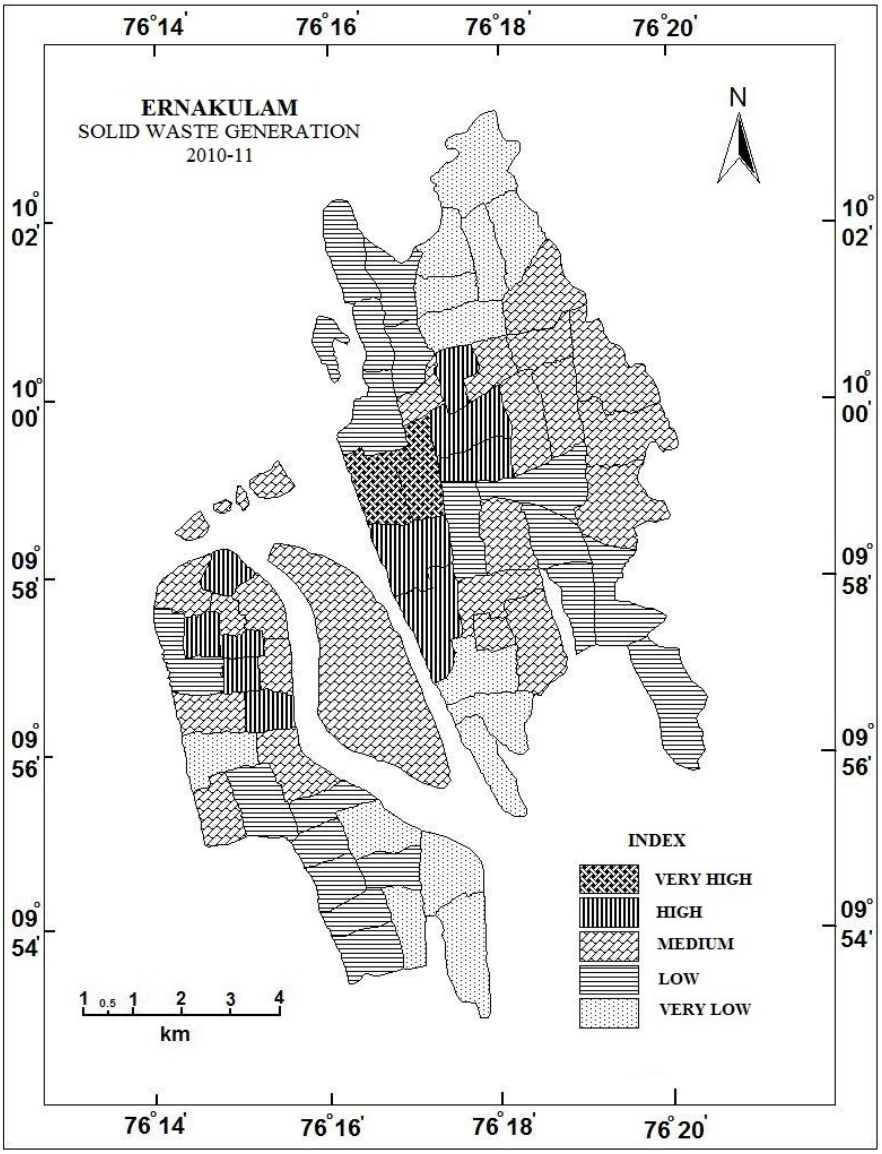

Fig. 2

Ten wards, for instance the peripheral wards of CBD and the wards along NH-47 towards Thrissur, come under the category of high solid waste generation. Some of the coastal wards of island also come under this category because they are thickly populated and are the main commercial cum residential area in the island.

Medium solid waste generation category has twenty one wards. Most of the wards in Ernakulam city come under this category. These wards are mainly residential areas of Ernakulam city

Low and Very low solid waste is generated by 19 and 14 wards, respectively. Low and very low category wards are located in the peripheral regions of the city. Here the commercial activities are less and they are completely residential areas. Some of the wards in the coastal areas of the island region come under very low category. Such wards are fishermen colonies and are regarded very backward wards of the city. As compared to all the other wards the development and infrastructure facilities in these wards are very poor.

Solid Waste Management in Ernakulam City

Solid waste management involves activities associated with generation, collection, transportation and disposal of solid waste in environmentally compatible manner, adopting principles of economy and aesthetics, energy and conservation.

Ernakulam city generates 421 tonnes of solid waste every day. About 60 percent of the waste generated is collected by the corporation. Before the commission of Brahmapuram plant, these wastes were dumped at selected dumpsite at Wellington Island, Cheranallor etc. But in response to the opposition from the public a new solid waste disposal plant was commissioned in Brahmapuram on 2008.

To curb the ever increasing menace of waste, the corporation sub-divide the scheme of waste management to two department viz. the Health Department and Engineering Department. While Health department manages the task of day to day waste collection and disposal, the Engineering department deals with setting up of plants for treating bio-degradable waste and annual contracts for large scale cleaning activities.

Household Collection

Currently, in Ernakulam city the municipal solid waste is collected at the household level in bins in segregated form (approximately 57000 pairs of refuse bins have been given to household for segregating their wastes, and another 75000 green bins for biodegradable material has also been supplied to the city under the KSUDP) at the household level by the waste collector. This collection of waste from households is carried out by workers belonging to different groups like self-help groups under the banner of Kudumbashree (self-help groups Govt. of Kerala program), Resident Welfare Associations and Kerala Builders Forum (KBF), Rotary Club, NGOs, etc. Kudumbashree covers 15 of 66 wards of the city with the help of its 200 workers. The remaining 51 wards are served by contracted workers of RWAs, KBF, Rotary Club or NGOs. The City corporation has provided 2 coloured bins, a green one with a 15-litre capacity, for biodegradable waste, and a white one with a 10-litre capacity, for dry waste) to all households (Draft city sanitation plan, 2001)

Collections from Commercial Establishments

Waste that is not collected from small hotels and commercial establishments by the Hotels Association is collected by either Kudumbashree or RWA workers serving that ward. The large hotels have their own systems and mostly produce biogas from their kitchen waste. The City corporation is in charge of the main road sweeping and drain cleaning for all drains across the city. The collection and transportation of this waste is also done by the corporation. However, the by-lanes are not swept by the corporation, and these become problem areas in terms of accumulation of solid wastes, which also enter the drainage systems including the storm water drains and canals.

Ernakulam city has launched an initiative called the “CREDAI Clean City Movement”, as part of the social responsibility in keeping the city clean and healthy. The implementation of the project is also linked with poverty alleviation programme, whereby women from economically weaker section of the society are given employment. The initiative is an eco-friendly Solid Waste Management system. The

eco-friendly waste management technique uses the aerobic microbial composting system for SWM .

Tariff and charges

There is a solid waste charge, which is two per cent of the property tax and is collected along with the property tax. There are also user charges that are collected ₹ 30 per household and ₹ 50 per commercial establishment. These user charges are collected directly by the door-to-door waste collectors and are used for funding the salary and insurance charges of the workers and also for maintenance and diesel charges of the vehicles used for collection of waste. However, there are currently no records maintained by the RWAs for the fees collected and as to how these are used. For areas served by Kudumbashree, there are approximately 13- 14 workers per ward and the user charges collected by these workers are deposited in an individual account for each ward. These micro accounts are operated and maintained by each self-help group and are used for salary disbursal, maintenance of vehicles, taking loans for groups' activities, etc (Draft city sanitation plan, 2001).

Transportation

Segregated waste is collected by workers in two separate dustbins and brought to the secondary collection points. The primary collection vehicle is either an auto rickshaw or a cycle rickshaws that belong to the Corporation and has been given to the various groups for collection of waste. On the vehicle 4 bins are provided in which pre-segregated waste at the household level is collected. Some of the workers also collect wet waste in the cart and dry waste in bags. After primary collection the waste is brought to the secondary collection points (each administrative circle comprising 2-3 wards has one such secondary collection point) where the garbage is further segregated on the floor, before it is transferred to the Corporation truck. These transfer points have been pre-determined by the Corporation and the time when the vehicle reaches this spot is also defined. In some places the pre-segregated waste from households is directly

transferred to the trucks from the large bins. The transportation system consists of 40 large open trucks at the corporation, 2 covered trucks (supplied under KSUDP), 30 three wheelers, 35 small 4 wheelers, and 264 hand-carts/wheel barrows.

Processing and Disposal

Processing of solid waste was not done in the Ernakulam city area at all, until recently, due to the scarcity of available land, and Cheranalloor was used as a dumping site, but this was discontinued due to protests from local residents in that area. Some disposal was also done at Willingdon Island, however since the disposal site falls within the 'air funnel', the Indian Navy ceased the disposal on 2006. Today, all the solid waste from the secondary collection points is transported to the Brahmapuram site, a 100 acre parcel of land, which has a solid waste treatment plant, at a distance of approximately 20 km from the city centre. The plant is currently run by an NGO, CED, under a contract from the city corporation. The site has the capacity to process 200 tonnes of mixed waste via mechanical composting and 50 tonnes of organic waste via vermicomposting daily. In April 2010, the refuse-derived fuel (RDF) plant was inaugurated at the Brahmapuram plant. At this plant, recyclable material from combustible non-biodegradable waste material can be recovered to create a high calorie uniform material, which can be used as a substitute for fuel at cement kilns and incinerators. However, various environmental concerns have been expressed about the suitability of the Brahmapuram site, which is a low-lying and water logged area, in close proximity of the Kadambria River (Draft city sanitation plan, 2001).

Conclusion

The data regarding the solid waste generation in the city indicate that the major share of the solid waste is from household and commercial and the remaining is from institutional, road sweeping, drain cleaning, clinical, construction etc… The spatial analysis of solid waste generation in Ernakulam city during 2011-2012 shows that the wards that are located in CBD and near to CBD are came under the category of very high and high. Because these wards are the main commercial hub and market area of the

city. The analysis of the mode of disposal of solid waste showed that 82 per cent of the population is depending on corporation dumps for the disposal of solid waste, 10 per cent disposed their solid waste around their house and the remaining 8 per cent dump it on the road side, on vacant land, water bodies.

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