Turkish Journal of Agriculture - Food Science and Technology, 10(10): 2016-2020, 2022
DOI: https://doi.org/10.24925/turjaf.v10i10.2016-2020.5252

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology Publishing (TURSTEP)

Facilitating Solid Waste Handling System in Port Harcourt Cosmopolis

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ARTICLE INFO

Research Article

Received : 04/05/2022
Accepted : 01/09/2022

Keywords:
Municipal Solid Waste
Constituents
Valuation
Depiction
Port Harcourt Cosmopolis

ABSTRACT

Port Harcourt cosmopolis grappled with a continual rise in municipal solid waste (MSW) generation. The increase is a consequence of an advance in population rise and consumption pattern. The paper reports an approximate valuation and depiction of municipal solid waste with emphasis from questionnaire survey on socio-economic status of the inhabitants in the zones that make up the cosmopolis. The methodology and procedure for this investigation obtained using vehicle selection approach centered on ASTM D5321 standard test method for ascertaining the constituents of municipal solid waste. Specimens were sorted into fourteen waste classifications of paper; 6.22%, pasteboard; 2%, plastic film; 9.05%, dense plastic; 2.73%, glass; 2.3%, iron-based metal; 3.03%, non-iron based metal; 1.13%, putrescibles; 56.3%, textiles; 1.85%, misc-ignitable; 2.83%, non-misc ignitable; 3.35%, E-waste; 2.33%, household waste; 4.88% and fine elements; 2.03%. The outcome shows an average 56.3% of municipal solid waste specimens discovered to be biodegradable. This is suitable for composting activities. Aside biodegradables, there exist, paper glass, dense plastics, and iron-based metals, which are recyclables. This is significant for providing gainful employments to the inhabitants of the cosmopolis. On the contrary, there were about 2.83% of misc-ignitable. This is suitable for energy recovery. There was a variation in specimens of MSW in all the zones that make up the cosmopolis, attributing it to changes in disparity in incomes. It is necessary for government to legalize, recycling and composting activities, which based on the waste management hierarchy process in a manner that ensures environmental sustainability, economic sustainability, and global acceptance.

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Introduction

Solid waste encompasses all solid materials, but not limited to those that the system no more considers of any adequate value to retain (Tchobanoglous et al., 1993). It includes commercial and industrial, construction and hazardous waste. The production of solid waste caused by human activities. Rapid advancement in Port Harcourt (PHC) cosmopolis have resulted in thousands of tons of solid waste produced daily. As at 2006, the projected waste load in Port Harcourt cosmopolis estimated to be around 2000 tons daily with a population of 1,754,175 persons at a yearly gradual integrant of 2 percent (Igoni et al., 2007**)**.

The urban expansion in Nigeria, like Port Harcourt cosmopolis whilst having brought great benefits to its resentment as employment and economic progress has caused environmental hitches. An upsurge in the standard of lifestyle is proceeded by hike in resources, consumption and large amount of solid waste produced from the cosmopolis daily. The high volume of solid waste results in propound strain in government, which led to the establishment of Rivers State Waste Management Agency. The agency tasked with managing waste in Port Harcourt cosmopolis. Unfortunately, handling waste is still a huge menace in the State. However, the focus here is on municipal solid waste (MSW), as it portrays the people's daily dilemma as well as a close relation to human health and well-being. MSW is grouped into non-synthetic and synthetic waste; the non-synthetic waste includes putrescibles and fermentable waste, while the synthetic

waste includes metals, plastic, and other non-biodegradable. It is evident that 80% of MSW washed off in dumpsites without being recycled, reflecting material and energy losses in the community (Ayotamuno and Gobo, 2004). The paper aims to identify solid waste constituents over the wet season with a view to establish any contrast in waste constituents from the four local government areas that make up the cosmopolis, employing the demographic status of inferior, medium and superior-income earners and utilize the outcomes from the investigation and make recommendations to government that could assist in designing a justifiable solid waste management plan for the cosmopolis and other similar urban habitation.

Materials and Methodology

Illustration of Investigation Area

The area of investigation was Port Harcourt cosmopolis in the Niger Delta region of Nigeria, recognized as the hub of oil and gas activities. The current cosmopolis is in Southern Nigeria and lies between longitude 6°55′ and 7°10′ east of Greenwich meridian and latitude of 4°47′ north of the equator housing an area of about 2600km with a population of 1,850,020 (NPC, 2007). The cosmopolis comprises of four local government areas, namely Port Harcourt, Obio/Akpor, Eleme and Okrika local government area (LGA). The area of investigation is shown in Figure 1.

Materials and Equipment

These include 40 samples of MSW, 2 sets of personal protective equipment comprising of overall wears, safety boots, mask, hand gloves, a markup scale of 150kg, 80 pieces of black bin bags, wash hand facilities, portable water, and a pickup van.

Methods

A solid waste assessment and visualization approach that meets an acknowledged worldwide standard (Dahlen and Lagerkvist, 2008). Examining several approaches with the goal of advising the best course of action for PortHarcourt cosmopolis established on social, economic and environmental aspects. The vehicle selection approach centered on ASTM 5321 Standard was utilized for this investigation. The method has been successfully applied in literature (Adeniran et al., 2017; Chee and Sumiani, 2014). The approach comprises the following procedures: waste specimen collection, sampling and sorting, classification of MSW, weighing of the sorted waste.

Waste Sample Collection

The specimen for waste content analysis were randomly collected from households within the investigation area, in accordance with international standard ASTM D5321.

Selection and Sorting

Vehicle waste loads were designated for selection and sorting. Specimens were gathered from the investigation study vehicle load. The specimens were manually sorted into the waste fractions. The selection and sorting took into consideration, the following: socio demographic elements of sampling area, climate conditions of selection period, temperature analysis, rainfall analysis and relative humidity analysis.

- *Socio Demographic Statistics of Selection Area*

  Table 1 represents an outline of the socio-demographic features of the selection area. Low population density in Okrika and Eleme zones and high population density in Obio / Akpor and PortHarcourt zones Earning levels of inhabitants also changed extensively inside and beyond the selection zones vested on questionnaire survey of the inhabitants of the cosmopolis.

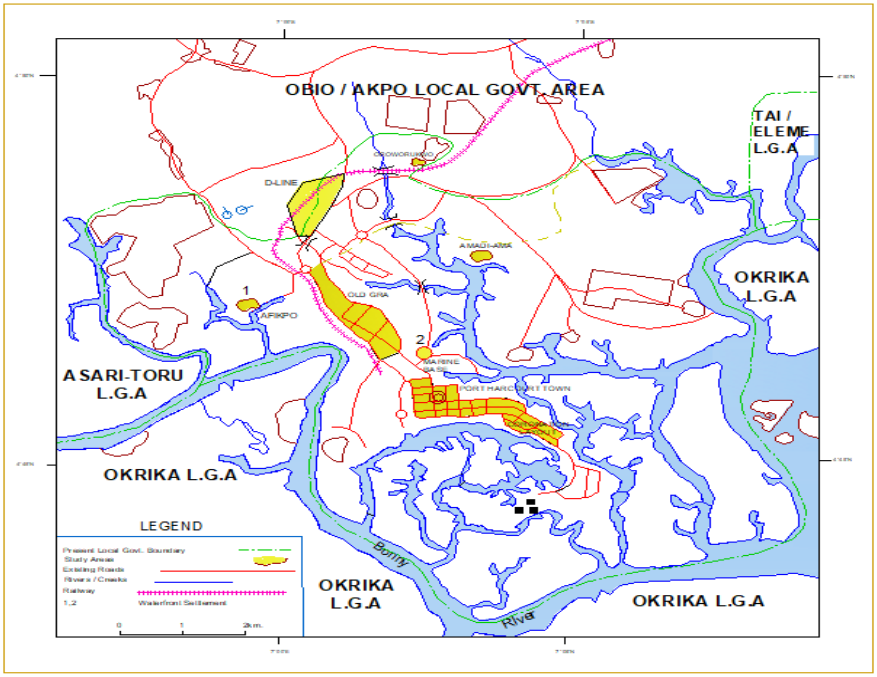

Figure 1. Map of Investigation Area

Table 1. Illustration of Socio-Demographic Features of Selection Area

Sampling Zone	No. of Samples	Geographic Description	Demographic Classification	Average Household	Income Classification
1	10	Port Harcourt LGA	High Density	5-7	High
2	10	Obio/Akpor LGA	High Density	5-7	High
3	10	Eleme LGA	Medium Density	5-7	Medium
4	10	Okrika LGA	Low Density	5-7	Low

- *Climate Characterization*
  The Nigerian weather is influenced essentially by the interaction amidst the dry north – easterly and moist south – westerly winds. Maximum temperature for Port Harcourt cosmopolis obtained from the Nigerian Meteorological Agency Station in Port Harcourt, Rivers State during this investigation was 30.3℃ while minimum temperature was 22.5°C (NIMET, 2020). The wet season stretches from March to October. Generally climate conditions throughout the investigation period were steady and typical for the area.
- *Rainfall Analysis*
  The period of the investigation coincided with period for yearly maximum rainfall. Records from the Nigerian Meteorological agency showed that Port Harcourt cosmopolis recorded an annual rainfall averaging 293.9m.
- *Relative Humidity*
  Relative humidity affects the rate of moisture content of waste samples (NIMET, 2020). Relative humidity in Port Harcourt cosmopolis was minimum at 63.3% and peak at 95.8% (NIMET, 2020).

Classification of Municipal Solid Waste

The specimens were sorted into fourteen categories pursuant to ASTM D5321. The categories were paper, paste board, plastic film, dense plastic, glass, iron base metal, non-iron based metal, putrescibles, textiles, misc-ignitable, non-misc ignitable, E-waste, HHW, fine elements.

Weighing of the Sorted Waste

The sorted waste were weighed using the pan balancing of 150kg. Plastics were placed on the floor to make the procedure easier, preceding with segregation and weighing. The waste was separated into fourteen various fractions by their weights as well as the percentage composition as described by ASTM D5321. The outcome was analyzed using SPSS. The percentage composite of waste fraction is

$$\%=\frac{\text{weight of separted waste}}{\text{total of merged waste sample}}\times 100 \quad (1)$$

Error Check

To avoid errors, the team in the investigation were given a PEP talk before commencement of the work.

Results and Discussions

This section outlines the results of solid waste composition analysis conducted between August and October 2020 to quantify municipal samples from the case study area and to establish any variation among samples taken from the four zones that make up the cosmopolis.

The major components of the municipal solid waste in wet season from the four zones that make up the cosmopolis are represented in Figures 2 to 5, while Table 2 shows a summary of the waste composition of the entire cosmopolis with respect to the population density. The putrescibles materials represented the largest component of municipal solid waste from all the four zones in the cosmopolis totaling to an average of 56.3 followed by 9.05, HHW; 6.22;plastic film;4.88, Misc – non ignitable;3.35, Iron based metal;3.03, misc ignitable;2.83, Dense plastic 2.73;E-waste and glass ;2.33 each, fine elements; 2.03, paste board; 2.08, textile; 1.85 and non-Iron based metal; 1.13.

Table 2. Overview of Results for Waste Fraction in the Study area in (Percentage; % by Weight in Kilograms)

Waste Category	Superior Socio-Economic Category		Medium Socio-Economic Category	Inferior Socio-Economic Category	Average
	Zone 1 (%)	Zone 2 (%)	Zone 3 (%)	Zone 4 (%)	
Paper	8.3	7.5	5.2	3.9	6.22
Paste board	3.4	2.6	1.5	0.5	2.00
Plastic Film	1.8	1.4	15.3	17.7	9.05
Dense Plastic	1.5	2.0	2.6	4.8	2.73
Glass	2.6	3.6	1.8	1.2	2.30
Iron based metals	3.1	1.1	2.2	5.7	3.03
Non-iron based metals	1.3	0.9	0.6	1.7	1.13
Putrescibles	61.9	68.7	54	40.6	56.3
Textiles	2.2	3.1	1.3	0.8	1.85
Misc-ignitable	3.2	2.1	1.9	4.1	2.83
Misc-non ignitable	2.0	1.8	4.0	5.6	3.35
E-waste	5.9	2.1	0.9	0.4	2.33
HHW	1.8	2.3	6.5	8.9	4.88
Fine Elements	1.0	0.8	2.2	4.1	2.03
	100	100	100	100	

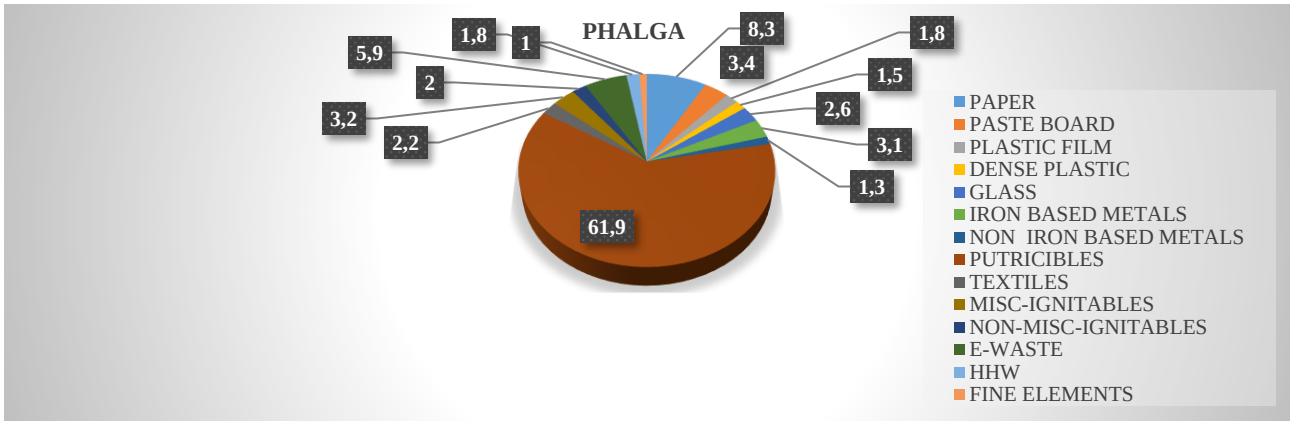

Figure 2. Results of Solid Waste Fractions for Zone One

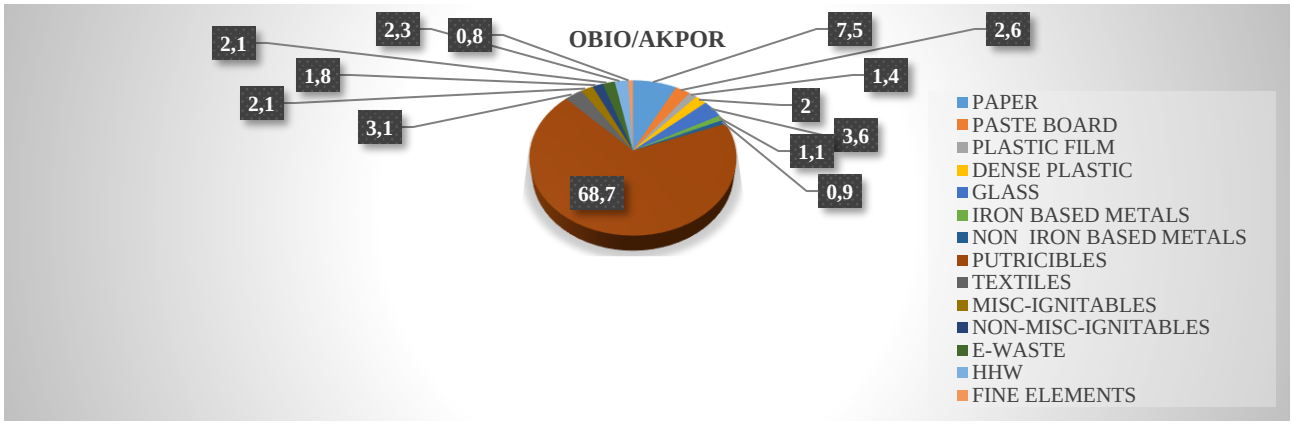

Figure 3. Results of Solid Waste Fractions for Zone Two

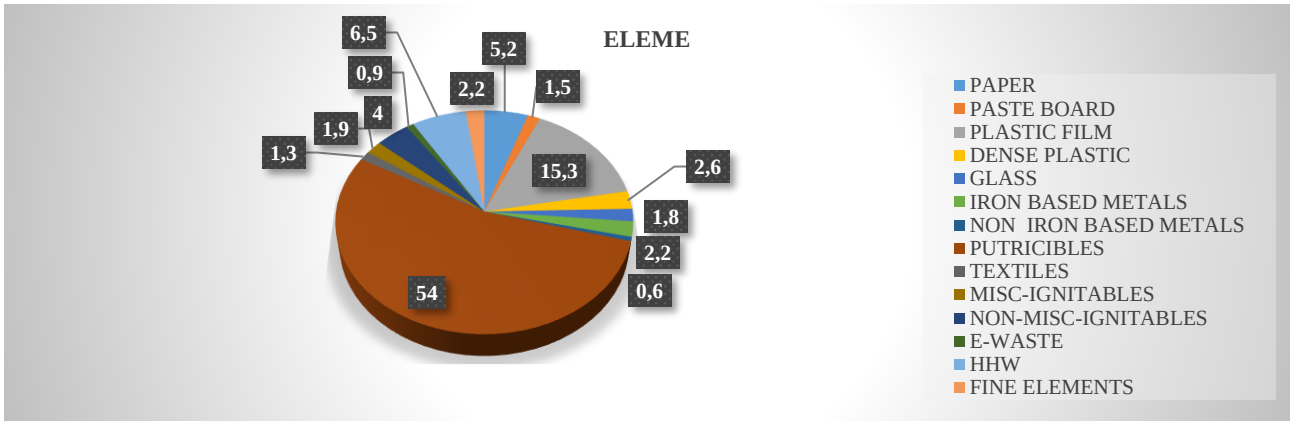

Figure 4. Results of Solid Waste Fractions for Zone Three

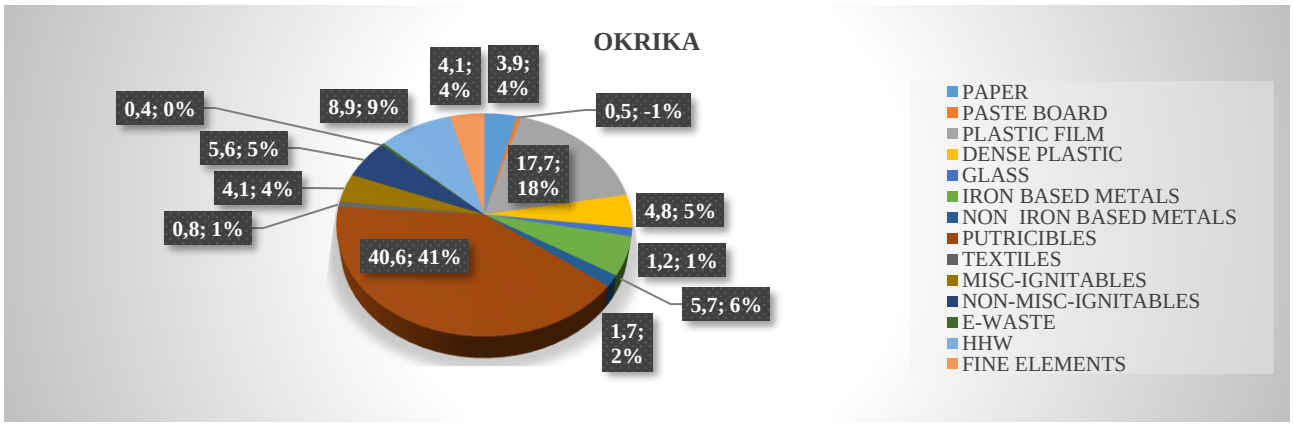

Figure 5. Results of Solid Waste Fractions for Zone Four

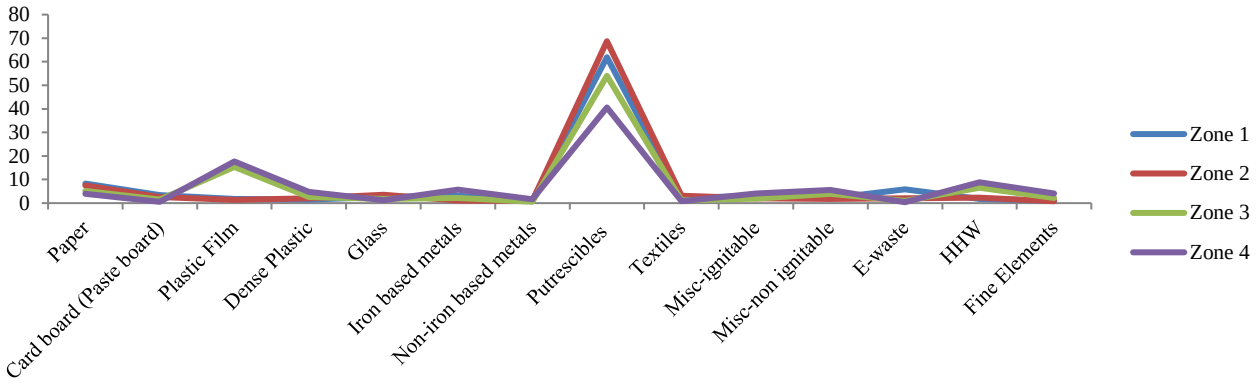

Figure 6. Solid Waste Comparisms in the Zones of the Cosmopolis

The outcome from the investigation area as shown in Table 2 and analyzed in Figure 6 reveals that municipal solid waste generation varied in composition for the four selection zones that made up the cosmopolis. Several agents can impact on the quantification of its composition, amongst them are geographical, climatic, cultural, socio-economic status. Thus, from this investigation emphasis were on socio-economic status of the inhabitants of the zones as shown in Table 2.

In line with the findings, there was a clear trend for putrescibles, paste board and paper suggesting increasing fractions with uptrend in socio-economic status. This variation is attributed in consumption habit from disparity in earnings in the inferior, medium and superior socio-economic status. while dense plastics, HHW and misc – non ignitable exhibited the reverse style.

The reverse pattern for dense plastic, HHW and misc non-ignitable can be deduced to its reuse and segregation property. Similarly, the iron based, and non-iron based metals did not show any correlation in pattern among the various socio-economic status.

The limitation of this investigation is that waste streams from the four zones that make up the cosmopolis have shown to be heterogenous. This implies that for a sustainable solid waste management in the cosmopolis to be achieved, solutions to waste management problems should be specific to each locality, an opinion shared by Igoni et al. (2007).

Conclusion

The goal of conducting the waste composition study using the vehicle sampling method based on ASTM D5321 Standard was achieved. The essence of assessing the socio-economic status was to find out its impact on the waste composition study that was used to identify and establish any variation in waste composition from the study area. The outcome shows an average 56.3% of municipal solid waste specimens were discovered to be biodegradable. This is suitable for composting activities. Aside biodegradables, there exist, paper, glass, dense plastics and iron-based metals which are recyclables. This is significant for providing gainful employments to the inhabitants of the cosmopolis. On the contrary there were about 2.83% of misc-ignitable. This is suitable for energy recovery. There was a variation in specimens of MSW in all the zones that makes up the cosmopolis, attributing it to changes in income disparities. Finally, the results clearly suggest a pragmatic management policy for solid waste in the state. For this to be achieved, it is necessary for government to legalize, recycling and composting activities, which should be based on the waste management hierarchy process in a manner that ensures environmental sustainability, economic sustainability, and global acceptance.

References

Adeniran AE, Nubi AT, Adelopo AO. 2017. Solid waste generation and characterization in the University of Lagos for a sustainable waste management: Waste management, 67, 3-10.

Ayotamuno JM, Gobo AE. 2004. Municipal solid waste management in Port Harcourt, Nigeria. Management of Environmental Quality: An International Journal, 15, 389-398.

Chee G, Sumiani Y. 2014. Municipal Solid Waste Characterization for a university Campus. University of Malaysia: Journal of waste Management, 12-30.NIMET, 2020a. Nigerian Meteorological Agency. Quarterly Weather Report, 001: 2-7.

Dahlén L, Lagerkvist A. 2008. Methods for household waste composition studies: Waste management, 28(7), 1100-1112.

Igoni AH, Ayotamuno MJ, Ogaji SOT, Probert SD. 2007. Municipal Solid-Waste in Port Harcourt, Nigeria: Applied Energy, 84, 664-670.

NPC, 2007. National Population Commission, NPC Population census figures, Abuja. Available from: http://www.population.gov.ng, 2008 [Accessed 1 March 2020]

Tchobanoglous G, Theisen H, Vigil SA. 1993. Integrated Solid Waste Management: Engineering Principles and Management Issues.