

## Evaluating Municipal Solid Waste Generation Rate and Its Composition between High and Low-income Groups in Maiduguri

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**Abstract:** This study investigated the municipal solid waste generation rate between high and income groups in Maiduguri, Borno State capital. Households were selected randomly across the studied areas with more emphasis given to location where high-income and low-income groups are generally residing. The study gives detail data on the volume of waste being generated and its corresponding composition/characteristics. polyethene bags were kept in each of the households to ensure proper collection of waste generated a day before the collection date. The results show that lifestyle and income highly influence the volume of municipal solid waste generation and its composition/characteristics. The waste generation average was found to be 0.57 and 1.35kg/h/d for low and high-income groups respectively. The data shows that, high income earners consume more of packaged and processed food, thus resulting in high percentage of can, bottles, rubber plastics, as well as food/fruit peels, and papers in their waste bins. High income earners are connected to either public or private source of water supply which encourages tree planting (gardening) than in low-income areas, resulting in high leaf contents in their waste stream. High income class also produces less volume of ashes, sand, dust and debris during house cleaning than the low-income earners. Therefore, data obtained, and observation made from the study may assist waste managers in implementation of waste management policies for the betterment of the society and the environment.

**Keywords:** Solid waste, income, generation rate and composition/characteristics

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### I. INTRODUCTION

One of the major challenge facing large cities in Sub-Saharan Africa today is how to cope with the increasing population and the corresponding deterioration in urban environmental health. It has been reported that more people lives in urban areas than in rural areas today and by 2050, 7 out of every 10 people would live in urban areas (WHO and UN-Habitat, 2010; Gretsche et al., 2016). Preserving a good natural environment is essential for improving human health and quality of life. At present, the environment is damaged all around the world by several factors, such as climate change, excessive resource extraction, persistent organic pollutant release and waste accumulation. This combination of natural and human factors has resulted in complex spatial variability (Lv and Liu, 2019). For example, Municipal Solid Waste (MSW) creates special concern among the general public due to close relationship with the daily life of the lay person (Milan, 2008). In Nigeria and Maiduguri in particular, with the coining of democratic government in 1999, rapid economic growth was witnessed with subsequent improvement of the standard of living of its residents. Thus, the amount of MSW being generated has increased significantly due to change in lifestyle. The quantity of MSW generated in urban areas in developed countries is higher than in developing countries, yet streets, parks, drainage systems, and many other important locations remains littered with refuse in the developing world. The situation is worrisome and remains one of the greatest challenges facing these countries especially in Maiduguri, Nigeria. There has been little documentation of the quantity and composition of solid waste generated in different areas of African cities, thus limiting the capacity to develop effective waste management (Afon, 2007). The elements which are considered as basic and fundamental are getting reliable and consistent data on the sources and types of solid waste along with the data on the composition and rate of generation (Hassan et al, 2001). The compositions of

solid waste generated from a place is severally affected by the socio-economic development of the area, degree of industrialization and the climate. Generally, the greater the economic prosperity and the higher percentage of urbanization, the greater the amount of solid waste produced (Hassan, 2000). Study has shown that waste generation rates ranged from 0.66kg/h/d in urban areas to 0.44kg/h/d in rural areas as opposed to 0.7-1.8kg/h/d in developed countries (Cointreau, 1982). In another study, it was reported that solid waste generation rate is average of 0.5kg/h/d (Okpala, 1984). The generation rates for some African's cities are estimated to range from 0.3 to 1.4kg/h/d with an average of 0.78kg (Achankeng, 2003). The density of solid waste in Nigeria ranged from 250kg/m<sup>3</sup> to 370kg/m<sup>3</sup> this being higher than solid waste densities found in developed countries. interestingly, the composition of waste stream characteristics differs between developed and developing countries of the world. The wastes are heavier, wetter, and more corrosive in developing cities than in developed cities (Ogwueleka, 2009). Waste authorities spend 77-95% of their revenue on collection and the balance on disposal (Ogwueleka, 2005). Yet they can only collect between 50 and 70% of MSW. In Maiduguri, Nigeria, solid waste problem is one of the most debatable environmental issues. The mere ugliness of the streets, parks and public places, untidiness of areas surrounding garbage bins, and indiscriminate dumping of wastes is linked to solid waste generation and management problems. These would constitute some health threat to the people. It could be due mainly to the inability and possibly linked to lack of awareness among the public on the volume of waste they generate and its characteristics which has greater damaging tendencies on their health. The paper aims to examine current solid waste generation rate and its characteristics between high and low-income earners in Maiduguri and proffer solution with the objective of reducing the volume of MSW generated which affect people health and well being.

## II. MATERIALS AND METHODS

The study was conducted in Maiduguri, the Borno state capital, Nigeria. The state capital has common borders with Chad, Niger and Cameroon republic. This makes the state capital one of the biggest commercial centers in North-Eastern Nigeria. This factor alone encourages migration from other places/towns and countries to Maiduguri. Base on the 2006 census Maiduguri Metropolitan and Jere Local Government have a population of 521,492 and 211,204 people respectively. Random sampling technique was used to interview 180 households, 90 each in high and low- income communities. Two sets of primary data were collected in the period. The first was drawn from a well-structured questionnaire from the two local government areas. Three wards each were selected to represent the high and low-income areas. The second set of the data was based on the measurement of the solid waste generated in the 180 households in the sampled areas. Several waste receptors were used by the residents, which includes basket, plastic containers, open metal drums and polythene bags. In this study, polythene bags were provided to the selected households because it is cheap and easily obtain, light in weight and also convenient to replace and carry. Eight of such bags were given to each household and then labeled according to the waste to be collected. The bags were meant to contain paper, nylon, polythene, plastics, cans and bottles, etc respectively. The contents of each bag were separated and subsequently measured. This was done once a week for four different days in each month. The data was then analysed for percentage composition and to reflect different level of income in these areas.

## III. RESULTS AND DISCUSSION

The percentage, volume and characteristics of solid waste generated in low and high-income areas of Maiduguri are presented in Tables 1 and II respectively. The result shows that, per capital waste generation rate in the low and high-income areas of Maiduguri ranges from 0.57 to 1.35kg/h/d respectively. This figure is within the range of the African average of 0.3 – 1.4kg/h/d as previously reported in some studies (Cointreau, 1982 and Achankeng, 2003). Leaf waste accounted for the greatest volume of waste in the high-income areas, with 35.2% when compared with 4.8% in the low-income areas. This is because most of residents in the high-income areas have a private borehole drilled in their houses and are connected to public water supplies too which are always functional. This is not the case with the low-income areas. This makes a clear difference between the two areas as they are always evergreen with hedges and flowers in all season while trees are sparse and hardly survives in the localized low-income areas due to lack of water supplies.

**Table I: Percentage composition of solid waste generated in some wards of low income areas, in Maiduguri.**

Waste composition	Wulari	Custom	Mairi	Average
Leaves	5.6	4.3	4.5	4.8
Paper	2.9	2.6	4.2	3.2
Food/Fruit peels	15.6	18.3	15.5	16.4
Cans and bottles	3.3	5.2	4.7	4.4
Rubber/Plastics	3.2	4.6	9.5	5.8

Textile/clothing	13.7	13.6	13.4	13.5
Nylon/Polythene	48.4	45.2	42.5	45.5
Others	48.4	45.2	42.5	45.5
Σ	100	100	100	100
Per capital (Kg/h/d)	0.66	0.50	0.56	0.57

**Table II: Percentage composition of solid waste generated in some wards of high income areas, in Maiduguri.**

Waste composition	Wulari	Custom	Mairi	Average
Leaves	31.7	31.6	42.3	35.2
Paper	2.8	1.7	6.4	3.6
Food/Fruit peels	24.3	26.7	22.2	24.4
Cans and bottles	14.3	6.8	7.4	9.5
Rubber/Plastics	7.7	7.6	4.7	6.6
Textile/clothing	5.8	4.4	4.4	4.9
Nylon/Polythene	7.6	2.0	9.8	6.5
Others	5.8	19.2	2.8	9.3
Σ	100	100	100	100
Per capital (Kg/h/d)	1.65	1.56	0.85	1.35

Another very important waste was paper, and its composition decreases from high to low income areas. The percentage composition was 3.6% and 3.2% for high and low-income areas respectively. This is an indication that the high-income earners are mostly literate and uses paper in most of their daily activities. Papers are being used in the low-income areas for food packaging mainly. The result also revealed that, food and fruit peels constitute the second highest proportion of waste amongst the high-income earners with a daily average of 24.4% as compared with 16.4% in low income areas. This could be as a result of their high purchasing power with the volume of waste produced in high income areas doubling those in low income earners and hence have more thrown away foods. The study also shows that the waste cans and bottle is higher amongst the high-income people. Such development shows that, the high-income earner consumes more of processed and packaged food than their low-income counterpart. Similarly, the proportion of rubber and plastics follow the same pattern of can/bottles, therefore, resulting in higher percentage of inorganic waste in the high-income communities. Textile/clothing material appears to be the only area where the high-income earners produce less proportion of waste as compared to low income areas. This is because they always buy high quality materials and some-times give them out to the low-income class, while the low-income class patronizes a low quality and fairly-used materials in a bit to survive. The proportion of waste classified as “Others” which is approximately 46% in the low-income area are the result from the use of wood for cooking. Similarly, the compounds which are surrounded by sand result in high volume of ash, dust and soil during house cleaning. This is not the case with the high-income class where kerosene and cooking gas are used for their cooking and in most cases have their compounds well-cemented with pre-cast interlocks. Another waste that distinguishes the residents of low and high-income class is the presence of nylon and polythene in the waste stream. High income earners buy most of their food stuffs in in large quantities from supermarkets (in cartons) while the low-income class mostly buys in nylon and polythene and hence resulting in a higher percentage of this packaging material. The residents who indicated that they sometimes sort for recyclables were just 1.2% in high income area compared with 8.6% in the low-income class who sells to scavengers. This is a true picture of a low-income class in a developing society like Nigeria where many survive by either selling to or scavenged themselves.

#### IV. CONCLUSION

This study on waste components and proportion between low and high-income areas highlights some important issues. One is that, the quantity and characteristic of MSW waste generated is related to socio-economic status. Thus, the municipal solid waste generation rate is highly influenced by the population purchasing power or income. The per capita solid waste generation rate in the high-income class averaged at 1.35kg/h/d which is roughly double that of low income class. The study indicates that the size of the household does not really influence waste generation. The number of high income earners is lower than the number of low income class in the study, yet the volume of waste produced is higher amongst the high-income class than the low-income earners. The consumption trend reveals that high-income class consumes more of packaged and processed food than the low-income earners.’

## V. RECOMMENDATIONS

The high lighted proportion of organic waste in the waste stream can be composted to reduce the volume of waste generated. The data from the study can therefore, be used in the design of waste management facilities suitable for a particular area or locality. Waste management policies should be geared towards encouraging house sorting and recycling to reduce the volume of waste in the stream. Segregation of recyclables like waste papers, plastics, glass, metals will improve handling and disposal of waste generating in metropolitan settings.

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