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Characterization of Household Solid Wastes in the Niger Delta: A Case Study of 100-Domestic Units in Yenagoa Metropolis, Nigeria

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Abstract: Household solid waste (HSW) stream is becoming problematic due to the threat they posed to the environment and public health. Application of inefficient and insufficient management strategies results in unsegregated HSW which are burnt, or left to undergo biological or physicochemical transformation which affects the atmospheric ambient air quality of the environment. In this study, waste streams were characterized in a block multi-stage and stratified randomized post-monthly study, comprising of 100-domestic unit. Comparatively, the mass composition of garbage (food) waste streams was 211.50kg (40.82%) in dry season, and 285.70kg (42.81%) in wet season. Plastic/rubber wastes, had values of 127.00kg (24.51%) and 138.01kg (20.68%) in dry and wet seasons respectively. Similarly, paper waste stream was 70.30kg (13.56%) in dry season and 98.41kg (1476.68%) in wet season. Furthermore, glass/ceramic waste had seasonal values of 56.20kg (10.85%) for dry season and 62.59kg (9.37%) for wet season. Furthermore, the composition of metal and wood waste streams per 100 domestic units in dry/wet season were reported as; 29.50kg (5.70%)/39.40 (5.90%) for metals; and 12.70kg (2.45%)/24.23 (3.63%) for wood. Other unclassified and special wastes streams which includes but not limited to ashes, sand, stones, clothes were reported to have values of 10.90kg (2.10%) in dry season and 19.00kg (2.85%) in wet season. Disposal of uncharacterized HSW is hazardous and pose grave consequences to the environment, we therefore urge the populace to desist from reckless disposal of HSWs and also urge Government to formulate policies the will enhance safe disposal of wastes for the effective reuse and recycling.

Keywords: Waste Stream, Anthropogenic Activity, Municipal Solid Waste, Yenagoa Metropolis

1. Introduction

The problems posed by improper and ineffective management of Municipal Solid Wastes/Household Solid Wastes (HSW/MSWs) has become an issue of global concern over the past decades. The magnitude of waste stream has acquired some abrupt dimensions [1, 2], with corresponding ineffective and inadequate management strategies [3, 4], including insufficient funding on the part of Government [5, 6]. The incidence of poor waste handling that has infringed on vital environmental components; including but not limited to soil, water and to air quality. Also, the magnitude of commercialization, industrialization and population expansion of most cities all over the world has also had its attendant adverse effects on the environment due to poor ameliorative strategies [7, 8].

A previous study on MSWs streams in Nigeria, showed that waste stream densities ranges from ranges from 280 - 370 kg/m^3 [9], with daily rates of about 0.44 - 0.66 kg/capital/day, resulting to an annual generation of 25 million tons [10]. Furthermore, Nigerian urban population density has witnessed an abrupt rise due to rural-urban migration, largely necessitated by yearning of the populace to keep abreast or understand contemporary technological

applications [11]. Unfortunately, high population density is implicated the generation of large waste streams, with inadequate facilities and consequently results to environmental pollution. As such industrialization and population expansion seems to have resulted in the generation of large waste streams [12]. In most developing countries, anthropogenic activities associated with the precarious disposal of MSWs poses more grave consequences to the ecosystem, besides being threat to public health [13].

In most developing country waste streams are generated with inadequate funding of the sector by Government coupled with poor sensitization of the populace on the dangers posed by precarious handling of MSWs, as well as weak legislation to deter erring persons. When waste is dumped precariously recklessly, they undergo certain transformation over time produce to foul odour and toxic leachates that impair air quality and other fragile components of the ecosystem including water and soil [14], as well as other aquatic and terrestrial biota by the process of bioaccumulation [8]. Another aspect of environmental pollution arising from Solid Wastes is the practice of *in-situ* combustion of unsegregated waste stream (especially in the dry season), which produce toxic pollutant gases with envisaged greenhouse effects. Consequent upon the danger posed by these anthropogenic activities; the Characterization of HSWs and it seasonal impact is hereby investigated.

2. Method

Study Area

The study area is Yenagoa Metropolis which is the capital city in Bayelsa State, Nigeria. Bayelsa state lies central and southernmost on the Nigerian Map. Yenagoa is located on latitude 4^o 49N and 5^o 23'N and longitude 6^o 10'E and 6^o 33'E with a population estimate of over 300,000 [15]. Since attaining the status of a state capital in 1996 its urbanization and population density have since accelerated appreciably. Yenagoa forms part of the wetland characterized by shallow aquifer and several networks of creeklets linked to a parent creek called Epie Creek. Consequently, the major river which connects all Municipal runoffs is the Epie Creek, which basically empties into the Nun River, which lies central and flanked to the west and East by Rivers Focardos (Delta State) and Orashi (Rivers State) respectively.

Waste Characterization

Multi-stage stratified random sampling was used with slight modification [16]. A total of 100 domestic units consisting of a four-block area of 25 unit each (Edepie, Opolo, Biogbolo and Amarata), were randomly selected for the survey. Each selected domestic unit was visited bi-weekly in a post-monthly manner in order to assess the mass and volume of waste stream generated, with core reference to season (November-March for dry season and April – October for wet season).

Prior to the survey, field assistants/volunteers were trained, recognisance and consent visits were ensured in order to sensitize the volunteers of the study units. About A 50 litres of cylindrical plastic container with waterproof bags inserted was provided to each study units for the collection of HSWs streams, volume of the waste was determined based on the shape of the waste container ($V = \pi r^2 h$). The wastes stream were weighed before sorting them out to their various components (i.e. garbage, plastic/rubber, metal, glass/ceramics, wood and other which includes but not limited to special waste like ashes).

Statistical Analysis

All data were expressed as mean using version 20 of SPSS statistical package. Microsoft excel was used to plot graph from derived mean values.

3. Results

As presented in Figure 1, the seasonal mass composition of waste streams in study area indicated that garbage (food) waste streams (479.20kg), are composed of 211.50kg (40.82%) in dry season, and 285.70kg (42.81%) in wet season per 100 domestic unit. Plastic/rubber wastes, with total mass of 265.01kg per 100 domestic unit had individual seasonal values of 127.00kg (24.51%) and 138.01kg (20.68%) in both dry and wet seasons respectively. The mass of paper waste stream per 100 domestic unit was 168.81kg, with seasonal values of 70.30kg (13.56%) and 98.41kg (1476.68%) in dry and wet season respectively. Furthermore, glass/ceramic waste streams having total mass of 118.76kg per 100 domestic unit, had seasonal values of 56.20kg (10.85%) for dry season and 62.59kg (9.37%) for wet season. Furthermore, the seasonal composition of metal and wood waste streams per 100 domestic units in dry/wet season were reported as; 29.50kg (5.70%)/39.40(5.90%) for metals; and 12.70kg (2.45%)/24.23(3.63%) for wood. Other unclassified and special wastes streams which includes but not limited to ashes, sand, stones, clothes were reported to have values of 10.90kg (2.10%) in dry season and 19.00kg (2.85%) in wet season.

In this 100-domestic unit, bi-weekly and post-monthly investigation, the seasonal net value of waste streams in wet season was 518.10kg (43.71%) having a volume of 290.50m^3, compared to a higher value for wet season with 667.30kg (56.29%) and a volume of 329.80m^3. Furthermore, the cumulative net mass of waste stream per 100 domestic unit was 1185.40kg with volume of 620.30m^3. Furthermore, the net mass of organic waste streams in the study area was 931.03kg per 100 domestic unit with individual seasonal values of 408.80kg in dry season compared to 522.22kg in wet season. Comparatively, the inorganic waste stream had net weight of 254.52kg, with seasonal values of 109.30 and 145.22kg in dry and wet seasons per 100 domestic unit, respectively. Furthermore, it can be estimated that Yenagoa metropolis generates an annual waste stream with net mass of 4741.60kg with volume of 2481.20m^3 per 100 domestic unit.

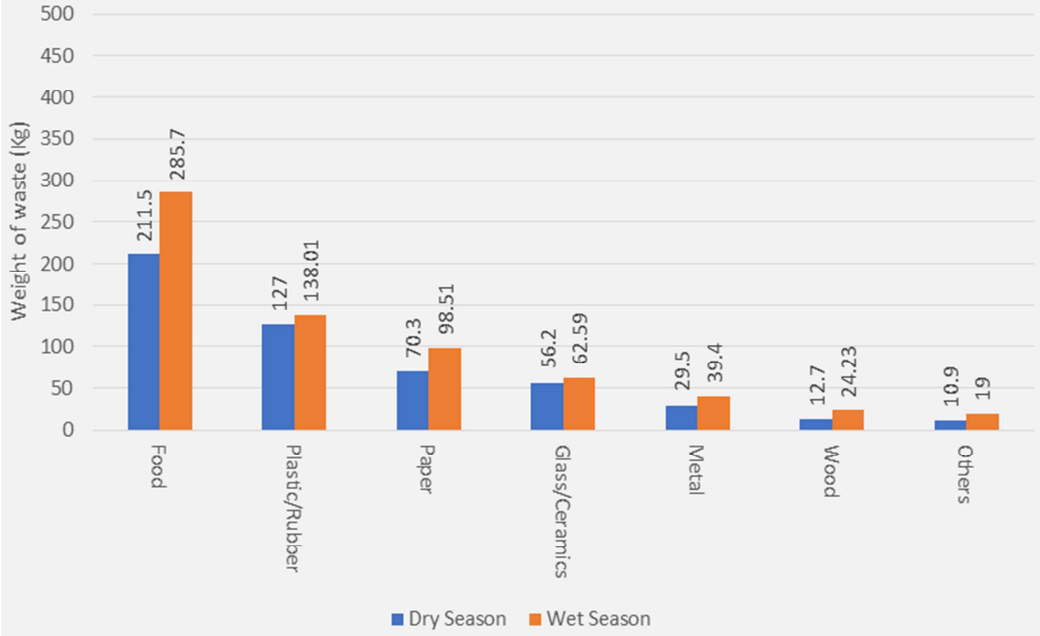

Figure 1. *Characterization of Municipal Solid Waste in Yenagoa Metropolis.*

4. Discussions

An investigation on the characterization of MSWs in Abuja metropolis recorded the following; Garbage (56.20% dry season and 52.0% wet season), of the solid waste generated in the area rubber (dry season10.20% and wet season 3.56%); paper (wet season 10.00% and dry season 12.46%), glass/ceramics (dry season 7.60% and wet season 1.42%) plastics (7.4% and 2.85%), metals (2.60% and 0.71%) and other forms of MSW which includes dust particle, ash, stones was 5.60% in dry season and 25.62% in wet season [7].

Another study on characterization of MSWs in Benin metropolis recorded a total waste stream of 2323.93kg; with individual component, as: 44.96% garbage, 25.43% plastic, 14.27% paper, 3.21% metal, 3.89% glass, and 8.24% for other wastes which includes but not limited to ceramics, foam, clothes. Waste stream like nylon was reported to be high due to commercial activities in Benin metropolis [16]. Furthermore, our recent finding is also comparable to the investigation of Musa *et al*., [17], in Kazaure LGA of Jigawa state with daily generation per capita volume as 0.85 x 10^{-3} and 0.88 x 10^{-3} m^3/person/day in dry and wet seasons. Meanwhile percentages compositions of organic wastes were 53.18% in dry season and 62.75% in wet season, compared to inorganic waste of 46.82% and 37.25% in dry and wet seasons respectively. Study of MSW in Nsukka of the South-East region of Nigeria showed that a total waste stream of 161112 Kg of waste was generated with 42 % as biodegradable waste, while 58 % was reported as non-biodegradable components [18]. In Uyo, Akwa Ibom state, it is indicated that waste streams ranging from 0.49 – 0.60 kg/capital/day. It comprises of 65% of compostable materials including; 10% plastics, 8% paper, 4% metal, 3% textile, 3% glass and other unclassified waste which makes up 7% (Okey et al., 2013).

Characterization of HSW/MSW is very intrinsic if waste streams are to be effectively and safely managed in terms of waste recycling. In addition, this will help Government to formulate a policy that will effectively mitigate the adverse effects posed by HSW/MSW [7], especially in the area of waste legislation, treatment and recycling. Unfortunately, this aspect of waste management has been ignored as most municipalities do not know the volume of waste streams generated. It has been documented in literature that in most cases, Government only care for the logistic of gathering and transportation of unsegregated waste which are unsafely dumped outside the municipality, and sometimes burnt to emit toxic gases [16]. Effective recycling, reuse and reduction of waste stream begins from the domestic units and is pictured in proper waste segregation or characterization

5. Conclusion

This research investigated the seasonal of characterization and impacts of HSWs on the air quality in Yenagoa metropolis. Consequent upon poor handling of HSW/MSW, they undergo diverse biogeochemical transformation that infringes on sensitive media like ambient air quality. Most landfill systems are composed of unsegregated/characterized wastes streams, which could have been recycled or treated and reused appropriately. Regrettably, most of these uncharacterized wastes are burnt in open air thereby posing grave consequences on the ecosystem, including its biodiversity and greenhouse effects. Unfortunately, our results indicated waste streams in Yenagoa are neither characterized, or treated and even burnt off in open air. This

study will provide succor to Government and all stakeholders policy in terms of formulating policies for waste inventorization, legislation and sustainable development. Results also showed significant emissions of suspended particulate matter, greenhouse gases like carbon monoxide, hydrogen sulphide and oxides nitrogen.

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