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**SUSTAINABLE WASTE MANAGEMENT AND ECONOMIC DEVELOPMENT OF RIVERS STATE: A STUDY OF PORT HARCOURT METROPOLIS**

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**ABSTRACT**

The paper examined sustainable waste management and economic development in the Rivers state of Nigeria, with core focus on Port Harcourt metropolis. The paper adopted the descriptive survey design with the aid of an in-depth questionnaire to determine the nature and practice of waste management by households, Rivers State Waste Management Agency (RIWAMA) and waste collection/disposal service providers. Based on the Taro Yamani's statistical formula, 263 was determined as the sample size of the study with a 98 percent response rate. Simple percentages, mean, frequency distribution, Pearson Product Moment Correlation and ANOVA were utilized as the statistical instruments of data analysis. The paper revealed that waste disposal with water bodies is the highest practised method in waste management followed by open dump method. However, the respondents expressed no confidence in the sustainability of waste management in Rivers state; because it is found culpable of causing environmental degradation and pollution to the ecosystem. The study also discovered a positive and significant relationship between sustainable waste management and economic development in Rivers state. From the findings, the study recommends amongst others, that waste managers should pay adequate attention to the methods of waste disposal as it relates to the environment and human welfare.

**1.0 INTRODUCTION**

Waste generation is essentially part of day to day human activity brought about mostly by urbanization and development. As countries progress from low-income to middle- and high-income levels, their waste management situations also evolve (Emeribe, 1998). Thus, waste management is the application of techniques to ensure an orderly execution of the various functions of collection, transport, processing, treatment and disposal of waste (Ogovan, Lee & Kalmykov, 2019). Rapid urbanization and population growth create larger population centres, making the collection of all waste and the procuring of land for treatment and disposal more and more difficult (Ali, Cotton & Westlake, 2005).

Solid waste management is a universal issue affecting every single person in the world. Individuals and governments make decisions about consumption and waste management that affect the daily health, productivity, and cleanliness of communities. Poorly managed waste is contaminating the world's oceans, obstructing drains and causing flooding, transmitting diseases via breeding of vectors, increasing respiratory problems through airborne particles from burning of waste and affecting economic development through diminished tourism (Kaza, Yao, Tata, & Van Woerden, 2018).

For sustainable waste management to be effective, several strategies will be pursued different from the past to include industry participation, reaching out to the community and waste minimisation. Sustainable waste management thereby becomes an essential utility service that can be used to control and direct generation of waste for economic development. It' also aims to manage the process that works to establish infrastructure for recycling and reuse of waste to substantially reduce the amount of disposed waste while deriving utmost benefit for the society, economy, health, and environment (Hoorweg & Bhada-Tata, 2012). In other words, sustainable waste management has a far-reaching impact with economic, social and environmental implications.

From the collection, transfer, separation, treatment (composting), disposal, transportation, and remanufacturing sustainable waste management has challenges in its processing which are associated with high cost, health hazard, and quality of recycled products. It will, therefore, require concerted efforts on the parts of all stakeholders (government agencies, households and private sector) for any sustainable waste management strategy to succeed (World Bank, 2018).

Waste management is a major problem for many cities in Nigeria, especially Port Harcourt metropolis in Rivers State, where urbanization, industrialization and economic growth have resulted in increased municipal solid waste (MSW) generation (Ayotamuno & Gobo, 2004). According to their assessment, today solid wastes are seen littered all over the streets in Port Harcourt. Before now, Port Harcourt was known as the "Garden City of Nigeria" because of the neatness and overwhelming presence of vegetation and flowers all over the metropolis. This status has since changed, with the presence of refuse littered all over the city, one can say without a doubt that Port Harcourt is now assuming the status of a "garbage city". It is common to see left-over foods, spoilt fruits, plastic bottles and unwanted clothes, among others, haphazardly disposed within residential apartments, major roads and gutters. The blockage of drains with refuse has impeded the run-off of rain waters, leading to flooding and presenting suitable breeding ground for mosquitoes and unending malaria attacks (Ayotamuno, & Gobo, 2004). Rather than waste becoming a burden, it can be seen as an opportunity for economic development. A holistic approach to waste management embracing sustainable strategies can see to the effective resolution of the debilitating problems of waste management in the state by harnessing the opportunities provided by sustainable waste management.

### **1.1 Statement of the Problem**

Waste management is a major challenge in Rivers, especially in Port Harcourt metropolis, the rapidly growing capital. Port Harcourt generates approximately 2 million kg of solid waste daily (Igoni, Ayotamuno, Ogaji, & Probert, 2007). It has been reported that only a fraction of this amount is collected (Binafeigha & Enwin, 2017). The waste management system in the city mainly relies on open dumping. Here, generated wastes are gathered in bins or designated collection points but end up being dumped in none sanitary landfill.

In Port Harcourt metropolis, waste management is administered by the Rivers State Waste Management Agency (RIWAMA) who engages service providers to evacuate solid waste within the state. Service providers pose a challenge on occasions where they neglect to evacuate waste due to

breakdown of trucks and if they do, it is not neatly done. The impacts of poor waste management are dire and fall disproportionately on the poor, who are often unserved or have little influence on the waste being disposed of formally or informally near their homes. The problem is further compounded by the state's sometimes warm and humid climate. Refuse has to be removed and disposed of quickly, efficiently and safely before it gives rise to smell nuisance, infectious diseases and other public health hazards.

In addition, RIWAMA has to deal with costly and complex operations, limited resources and limited capacity planning, contract management, and operational monitoring. According to Obuah and Okon (2017), the Agency is saddled with the responsibility of conceptualizing policies and practices that will engender cleaner and safer environments in Rivers State. How far these have been achieved is doubtful: the agency *used* to organize a monthly sanitation exercise whose objective was to sustain the consciousness of cleanliness among the residents of Rivers State (Obuah and Okon, 2017), but this no longer takes place consistently (Needam, 2019). Another problem of waste management in Port Harcourt city is data gathering. Nevertheless, these factors and objectives make sustainable waste management a complicated proposition on the path of economic development as RIWAMA struggles to address the challenges, but which nevertheless presents greater opportunities for growth, if properly harnessed.

Given the absence of localized study based on sustainable waste management in relation to the economic development of the state, and given the benefits and feasibility in the implementation of an integrated and sustainable waste management system, it is imperative to conduct a study to determine sustainable waste management and economic development in Rivers State. Thus, the objectives of the study were to; determine the methods of municipal waste management in Port Harcourt Metropolis; examine sustainable waste management strategies in Port Harcourt Metropolis, and determine the impact of sustainable waste management on economic development in Port Harcourt Metropolis.

## **2.0 ISSUES IN SUSTAINABLE WASTE MANAGEMENT AND DEVELOPMENT**

### **2.1 Waste and Sustainable Waste Management**

The Basel Convention defines 'wastes' as 'substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law'. Also, Wright (2005), sees waste as the total of all the materials thrown away from homes and commercial establishments and collected by local governments. It encompasses food wastes, household waste, containers and product packaging, dirt, demolition and construction wastes and other kinds of inorganic wastes from residential, commercial and institutional sources, the collection and disposal of which are performed by local authorities and which may be in either solid or semi-solid form. According to Elenwo (2015), the subjective definition of solid waste is movable objects which the owner wishes to dispose of, while the objective definition of waste is any substance whose controlled disposal is necessary to ensure the well-being of the general public and in particular the protection of the environment. Solid wastes, as defined in this study include all domestic refuse and non-hazardous wastes such as commercial and institutional wastes, litters and construction debris. In some instances, the solid wastes management system also handles human wastes such as the evacuation of a septic tank and sewage treatment plants sludges.

Waste management comprises the collection, transport, segregation, recycling and disposal of wastes in an environmentally acceptable manner. Similarly, waste management is the collection, keeping, treatment and disposal of wastes in such a way as to render it harmless to human and animal life, the

ecology and the environment generally (Adewole, 2009). From the above definitions, it is clear that waste is unwanted or discarded materials.

Badly managed waste also has negative consequences in terms of greenhouse gas emissions. The waste sector was the third-largest contributor to global emissions of non-CO<sub>2</sub> greenhouse gases in 2005, accounting for 13 per cent of total emissions. In the waste sector, the two largest sources of emissions are landfilling of solid waste and wastewater, which together contributing 92-93 per cent of emissions throughout the 1990 to 2030 period. CH<sub>4</sub> from landfills accounted for an average of 58 per cent of waste emissions during this period. Increases in waste generation and population drive the quantity of these global waste emissions continuously upwards (US EPA, 2012).

Sustainable waste management is all about to reduce the number of natural resources consumed and to confirm that the materials taken from natural resources are reused as many time as possible as the waste created is kept to a minimum.

## **2.2 Waste Management in Rivers State**

The Rivers State Waste Management Agency (RIWAMA) is an agency of the Rivers State Government of Nigeria concerned with the responsibility of ensuring a clean and healthy environment. It was brought into existence in 2013 through an Act of Parliament. It was asserted by the state governor in July 2014. Prior to this, the agency had functioned as "Rivers State Environmental Sanitation Authority (RSESA)" which originally was formed in 1983 to tackle municipal waste and other related issues (Anosike, 2012). RIWAMA as a government body was saddled with the responsibility for the enhancement of the environment with the aim of achieving positive and substantial change in living conditions as well as reducing diseases or health problems in the state.

As part of its statutory responsibility of maintaining a clean environment, the agency organizes a monthly sanitation exercise which has not only instilled but also tries to sustain the consciousness of cleanliness among the residents of Rivers State. In terms of structure, the agency runs a highly centralized structure with a Sole Administrator at the helm of affairs. The operations of the agency are coordinated through a task force system. In sum, the agency is expected to:

- a. Develop the most suitable and effective means of building understanding and garner support in keeping Rivers State clean.
- b. Engage in environmental education and awareness among decision-makers geared towards ensuring better integration of environmental issues into development planning, budgeting and policy formulations.
- c. Sensitize the citizenry and, by extension, residents on waste management policies, procedures and practices.
- d. Ensure a mainstreaming of consciousness on best practices in terms of attitudinal conditioning and favourable dispositions.

The Government of Rivers state through the ministry of the environment is responsible for waste management in the city (Ogbonna, Amangabara & Ekere, 2007). Successive government in the state made very little effort in terms of waste management legislation and enforcement. However, in recent time, remarkable improvements have been noticed. In Port Harcourt today, wastes generated and gathered at source are disposed of in communal bins or communal collection points stipulated by the Government. These communal points are spread out at different location across the city. This system is patterned after the management system in developed countries, for example – the UK.

## **2.3 Waste Disposal Practice in Port Harcourt**

**Landfill:** Most of the landfill operations in Port Harcourt do not have the facilities for leachate

collection and treatment. The gases produced are not also captured; therefore most landfill sites in the city are major sources of pollution (Leton & Omotosho, 2004). Very little is done to minimize odour by the operators, the main activities on these sites involve - spreading of waste with tractors and then covering the surface with clay. The sites are not properly engineered, neither are they fitted with appropriate liners. Hence, they pose a major threat to the surrounding communities as a result of pollution and odour.

Some landfill sites in the city are located at Eneka village in the outskirts of Port Harcourt, Rumuokoro community along the East/West Road, Ada Gorge Road and several other locations.

The disadvantages of these ill-managed landfills sites are enormous. They pose serious threat to the populace. During the rainy season, leachates and other debris are carried by runoffs into nearby communities, causing pollution of open water bodies as well as underground water.

**Open Dumps:** Figure 2.2 and Figure 2.3 are pictures of dump sites in different locations in Port Harcourt and Obio/Akpor local government areas. Open dump sites are the most common waste disposal methods in the two local government areas and many cities in Nigeria. Open dump sites are found in several locations around the city, for example, Rumuokoro/Tank road, Ada George.



**Disposal to Water Bodies:** This is one of the oldest methods of waste disposal in Port Harcourt; it is not a very popular method of waste disposal in the city. Nevertheless, the practice continues unabated in some Riverine areas of the city. This method involves getting rid of waste by disposing them into

the surrounding rivers, lakes and other water bodies without prior treatment. Due to the Deltaic nature of Port Harcourt, there are several water bodies in some parts of the city. A notable example is the Nembe waterfront, which is host to a large market.

### 3.0 METHODOLOGY

This paper adopted the descriptive survey design to determine the nature and practice of waste management by households and the Rivers State Waste Management Agency (RIWAMA) with a view to trying it to economic development. The population of this study consists of all households in Port Harcourt City Local Government metropolis of Rivers state, Nigeria, staff of RIWAMA, and waste collection/disposal service providers in Port Harcourt as shown in Table 3.1 below.

The sampling method that was used for the study is stratified sampling with a sample size of 200 households, all 11 service providers with 3 staff participating in each, and 30 staff of RIWAMA Based on this the sample.

**Table 3.1: Population of service desk staff in study locations**

S/N	Sampling Frame	Sample size	Percentage (%)
1	Households	200	76.05%
2	RIWAMA	30	11.41%
3	Service Providers	33	12.55%
	Total	263	100.00%

*Source: Researcher's Field survey data, 2019*

#### Method of Data Analysis

The retrieved copies of questionnaires were analysed using simple percentages, mean, frequency distribution, Pearson product-moment correlation (PPMC) and analysis of variance (ANOVA). These statistical tools were selected because of their simplicity and relevance to the research work. The descriptive tools help to provide a central or typical view of the total responses. PPMC was used to determine the strength and nature of relationship between the independent variable, sustainable waste management, and the dependent variable, economic development. ANOVA was used to determine if there was significant difference between perceptions of waste management between households, service providers, and RIWAMA.

## 4.0 RESULTS AND DISCUSSION

### 4.1 Methods of Municipal Solid waste management

This segment highlights the methods of municipal solid waste management in Port Harcourt metropolitan city. In order to identify the methods of solid waste management prevalent in Rivers state, the households in Port Harcourt metropolitan city, Rivers State Waste Management Agency (RIWAMA) and registered service provider responded to various items about the methods of municipal solid waste management in Rivers state in a Likert scale. The Port Harcourt Households responded by ticking on options that best explain their position on the methods of municipal solid waste management in Port Harcourt. In the scale, 1=Strongly Disagree, 2= Disagree; 3=Moderate; 4=Agree; while 5=Strongly Agree. Below, we present the mean response with the equivalent standard deviations in Table 4.1

**Table 4.1: Methods of Municipal Solid waste management**

S/No.	Methods of Municipal Solid waste Management	Mean (M)	Standard Deviation ( $\delta$ )
1.	Landfill waste disposal practice	3.34	1.072
2.	Open dump waste disposal practice	3.66	0.745
3.	Waste disposal with water bodies	4.03	0.854
4.	Mass burning	3.39	1.001
	<b>Grand Mean</b>	<b>3.605</b>	

Source: Researchers' computation from Field Survey (2019)

As shown in Table 4.1, waste disposal with water bodies in Port Harcourt metropolis is strongly indicated as a major method of municipal solid waste management (Mean= 4.03,  $\delta$ = 0.854); this is followed by open dump waste disposal practice (with a Mean= 3.66,  $\delta$ =0.745); mass burning is another method of waste disposal that was indicated as a method of solid waste disposal management and landfill disposal practice. However, the least strongly indicated factor is landfill waste disposal practice with a mean score of 3.34 and standard deviation of 1.072. The grand mean of the variables is 3.605 signifying insignificant agreement that waste disposal with water bodies, open dump waste, mass burning and landfill waste disposal practices are the methods of municipal solid waste management practice in Port Harcourt metropolis of Rivers State.

#### 4.2 Sustainable Waste Management Strategies

This sub-section addresses the confidence interval of the sustainability of waste management practice adopted in Rivers State. To provide information about the level of confidence of sustainable waste management pattern in Port Harcourt metropolis of Rivers state, respondents were required to rate items regarding their level of confidence in the implementation strategies of achieving sustainability in waste management in a Percentage interval. The Percentage interval has 3 levels about the degree of the confidence reposed on the implementation strategies and practices of waste management. Households, RIWAMA staff and professionals as well as the service providers responded by ticking the percentage option that best reveals their position. The mean response and standard deviation are computed and presented in below Table 4.2.

**Table 4.2: Sustainable Waste Management Perception**

S/No.	Sustainable Waste management perception	Mean (M)	Standard Deviation ( $\delta$ )
1.	No confidence	3.82	1.010
2.	Moderate confidence	3.76	0.786
3.	Complete confidence	3.66	0.938
	<b>Grand Mean</b>	<b>3.75</b>	

Source: Researchers' computation from Field Survey (2019)

Indicate the degree of confidence you have in the sustainability of municipal waste management in Rivers state

As shown in Table 4.2 above, Households, RIWAMA staff and professionals as well as the service providers most strongly indicated no confidence in the sustainability of municipal waste management in Rivers State (M=3.82,  $\delta$ =1.010) and hold moderate confidence in their perception of sustainable waste management in Rivers State. However, the least strongly indicated complete confidence (M=3.66,  $\delta$ =0.938) in their perception of sustainability of the prevalent practice of waste management in Rivers state. The grand mean computed is 3.75 which reveals that Households, RIWAMA staff/professionals and service providers in Port Harcourt metropolis within the sample under review expressed no confidence in the sustainability of waste management practice in Rivers State.

### 4.3 Impact of Sustainable Waste Management on Economic Development of Port Harcourt metropolis

Households, RIWAMA staff and professionals as well as the service providers in Port Harcourt metropolis, were required to assess the impact of sustainable waste management strategies adopted in achieving economic development. In this regards, the computed mean score and standard deviation of their responses are presented below;

**Table 4.3 Means and Standard Deviation of the Impact of sustainable waste management on economic development**

Statement	Mean	S.D
To what extent does sustainable waste management affect the economic development of Rivers state	3.44	1.118
I am satisfied with the level of economic development in Rivers State because it accommodates for the sustainability of waste management	4.10	0.812
Sustainable development is linked to economic development objectives of Rivers State	3.98	0.802
Sustainable waste management method ensures that the objective of economic development is achieved	3.70	0.981
Sustainable waste management is accountable for achieving economic development goals	4.19	.875
<b>Total Mean and Standard Deviation</b>	<b>19.41</b>	<b>4.588</b>

**Source:** Researchers' computation from Field Survey (2019)

The study sought to assess the impact of sustainable waste management on economic development of Port Harcourt metropolis, the arithmetic mean was used to explore the respondent's perception of the impact of sustainable waste management practice in Rivers state on economic development; the standard deviation was used as dispersion measure of the answers from their mean. Table 4.3 shows the means and standard deviations for each of the 5 statements concerning the influence of sustainable waste management strategies on achieving economic development. It also shows mean and Standard deviations of total scores across all respondents. The highest mean scores (standard deviation) were 4.27 (0.875) sustainable waste management is accountable for achieving economic development goals; 4.10 (0.812) for level of satisfaction with the level of economic development in Rivers state due to the fact that it accommodates for the sustainability of waste management; 3.98 (0.802) or sustainable development is linked to economic development objectives of Rivers state; and 3.70 (0.981) for being satisfied that sustainable waste management method ensures that the objective of economic development is achieved. These results show therefore that the statements with the highest performance possible is that sustainable waste management is accountable for achieving economic development goals. The statement with least performance rating was. It's obvious with this result; that Households, RIWAMA staff and professionals as well as the service providers in Port Harcourt metropolis agree that the level of sustainable waste management is accountable for economic development.

#### 4.4 Discussion

The study established that sustainable waste management strategies contributed positively to the goal of achieving economic development in Rivers state.

The study also finds the methods of waste management practised in Rivers state to include waste disposal with water bodies, followed by open dump waste disposal practice. This practice is found culpable of causing environmental degradation and pollution to the ecosystem. Also, mass burning and then landfill disposal of waste is also practised in the regions under study. Consequently, the study revealed that the respondents expressed no confidence in the sustainability of municipal waste management in Rivers state. In addition, the study showed that sustainable waste management is accountable for achieving economic development goal. The findings supported the report of World Bank (2018) on methods and strategies of waste management.

Furthermore, the study found evidence that a positive and significant relationship exists between sustainable waste management and economic development in Rivers state. This infers that economic development, otherwise referred to as improvement in human welfare is largely a function of the level of sustainable of strategic waste management in Port Harcourt metropolis. The finding conforms to the empirical work of Kalmykov (2019), who pointed that there is a direct link between waste management and socioeconomic development.

#### 5.0 CONCLUDING REMARK

The issue of sustainable waste management on economic development in Port Harcourt metropolis is an important issue which has to be dealt with decisively. According to the findings on the course of the study, the necessary approach needs to be put in place to manage waste in Port Harcourt metropolis. The findings of the study suggest that waste disposal with water bodies is capable to damage the environment and ecosystem, hence the need for a sustainable method of waste management. Also, the extent of influence of sustainable waste management on economic is mainly hindered by poor coverage of the region, lack of worthy service delivery, paucity of funds, and lack of trained workers and lack of equipment, old vehicle and recurrent breakdown of equipment. Based on the positive relationship found between sustainable waste management and economic development, it infers that, policies ensuring the sustainability of waste management are geared towards achieving the goal of economic development within the region of study. Hence, the study brilliantly concludes that waste management is a critical aspect in the determination of economic development in Port Harcourt city metropolis.

Based on the findings, the following recommendations were made;

1. Waste Managers should pay adequate attention to the method of waste disposal adopted, in order to achieve economic development, as relates to the environment and human welfare.
2. There should be proactive analysis and implementation of waste management strategies, in order to eliminate the root causes of the paucity of funds and coverage.
3. Waste management agency or regulator should adopt a method of waste disposal that guarantees the sustenance of the ecosystem and human wellbeing.
4. The government should ensure the autonomy of the waste management Institution, in order to enable the agency decisively carry out its task.
5. The government through its appropriate agency should carry out a public enlightenment exercise on waste management, especially on the water bodies.

## REFERENCES

1. Adewole, A.T. (2009). Waste management towards sustainable development in Nigeria. *International NGO Journal* 4(4), 173-179. Retrieved on 12/10/2010. Available online at <http://www.academicjournals.org/INGOJ>.
2. Ali, M. A. Cotton and K. Westlake (2005). Waste Disposal in Developing Countries. WELL Factsheet. Available from <http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/waste.htm>.
3. Anosike, N. (2012). RSESA law to be repealed soon...as rsha gives waste management bill first reading. National Network. Retrieved 18 May 2015.
4. Ayotamuno, J.M. and Gobo, A.E. (2004). Municipal solid waste management in Port Harcourt, Nigeria Obstacles and prospects. *Management of Environmental Quality, International Journal of Management Studies*, 15(4), 389-398
5. Ayotamuno, J.M., and Gobo, A.E., (2004). Municipal solid waste management in Port Harcourt, Nigeria: Obstacles and prospects. *Manag. Environ. Qual. Int. J.* 15, 389-398.
6. Binafeigha, T.R. and Enwin, A. (2017). The state of solid waste management in Port Harcourt City, Nigeria. *American Journal of Civil Engineering and Architecture*. 5(4), 160-166
7. Elenwo, E.I. (2015). Solid Waste Management Practices in Port Harcourt Metropolis: Problems and Prospects. *Journal of Geographic Thought & Environmental Studies*, 13(1), 60 – 81.
8. Emeribe, A.C. (1998), The United Nations and environmental resources exploitation: Implications for sustainable development in Africa, paper presented at the annual summit of All-Nigeria United Nations students and Youth Association (ANUNSA), Abia State University Chapter, 10 June.
9. Hoornweg, D. and Bhada-Tata, P. (2012). What a Waste: A Global Review of Solid Waste Management. March 2012, No. 15. Urban Development & Local Government Unit World Bank.
10. Igoni AH, Ayotamuno MJ, Ogaji SOT, Probert SD. (2007). Municipal solid-waste in Port Harcourt, Nigeria. *Applied Energy*. 84, 664-670.
11. Kaza, S., Yao, L., Tata, P., and Van Woerden, F. (2018). What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050.
12. Leton, T., and Omotosho, O., (2004). Landfill operations in the Niger delta region of Nigeria [WWW Document]. URL <http://www.sciencedirect.com/science/arti> (accessed 2.27.14).
13. Needam, J. (2019). RIWAMA Cancels Sanitation Exercise For July, 2019. <https://www.nationalnetworkonline.com/en/metro/3076-riwama-cancels-sanitation-exercise-f-or-july-2019>
14. Obuah, P.F., Okon, G.B. (2017). Environmental communication strategies of the Rivers State Waste Management. Agency (RIWAMA): Implications for sustainable waste management in Nigeria. *International Journal of Development and Sustainability*, 6(11), 1541-1558.
15. Ogbonna, D.N., Amangabara, G.T., Ekere, T.O., (2007). Urban solid waste generation in Port Harcourt metropolis and its implications for waste management. *Manag. Environ. Qual. Int. J.* 18, 71-88.
16. Ogovan, M. I., Lee, W. E. and Kalmykov, S. N. (2019). *An Introduction to Nuclear Waste Immobilisation*, Elsevier Ltd.

17. US Environmental Protection Agency (US EPA) (2012). Summary Report: Global Anthropogenic Non-CO<sub>2</sub> Greenhouse Gas Emissions: 1990-2030. Office of Atmospheric Programs. Climate Change Division. EPA 430-S-12-002.
18. World Bank (2018). Municipal Solid Waste Management a Roadmap for Reform for Policy Makers. April 2018. World Bank Group Social, Urban, Rural and Resilience Global Practice Tokyo Development Learning Center (TDLC) Program Fukoku Seimei Bldg. 10F, 2-2-2 Uchisaiwai-cho, Chiyoda-ku, Tokyo 100-0011 Japan.
19. Wright, R.T. (2005): Environmental Sciences, 9th Ed. New Delhi, Prentice Hall.



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