



SOCIAL SCIENCES FOR BEGINNERS

VOL. I

Geography and Economics

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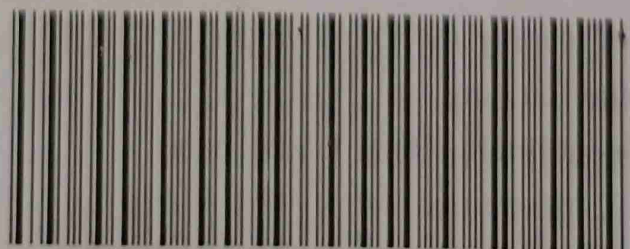
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FORWARD

The Book "Social Sciences for Beginners" is a series of books envisioned by the visionary leadership of the Faculty of Social Sciences, University of Ilorin. Volume 1 is focused on Geography and Economics, perhaps because of the traditional relationship between the two subjects. The good leadership provided by the Prof.I.P. Ifabiyi, the current Dean of the Faculty may also have been influenced by his experience as the Sub-Dean of the Faculty when both Geography and Economics were resident in the Faculty of Business and Social Sciences. It is therefore a book borne out of the necessity to truly create a series of reading materials for social scientists, especially now in Nigeria, where it has been suggested that social scientist have to demonstrate their relevance to society. The environment and the economic opportunities that abound in Nigeria demands that undergraduates be introduced to such opportunities early enough in their career development. This book has been designed to fill this gap.

The book consists of twenty six chapters; 18 and 8 of which is devoted to Geography and Economics, respectively. The authors are experienced lecturers drawn from the Faculty. This being the first volume and edition, it may not have satisfied all the requirements of undergraduates, but certainly it addressed and contained the requirements of new students that require to know a little of many of the different areas of interest in Geography and Economics.

The first part of the book contains the Geography section. The different areas of geography were spelt out in details (chapter one); basis and fundamental issues such as composition and structure of the earth; ocean circulation and ocean currents as well as its impact on the environment; field-work techniques ; energy in ecosystem and energy consumption in relation to population; relief, and soil processes; man-environment and sustainable agriculture and earth system; spatial interaction models and economic activities, including the management of wastes are contained in chapters 2-18.

Part II of the book, (Chapters 19-26) is made up of the nature and scope of economics (chapter nineteen); the theoretical aspects of production, national income accounting, the elementary models of income and employment are found in chapters twenty to twenty- five. Money as an acceptable, durable, stable, medium of exchange, that is usually kept in financial institutions is contained in the last chapter of the book. This by no means underestimated the importance of money to mankind.

This book is therefore a very bold step taken by the Dean of the Faculty in the first leg of his tenure. We look forward to other volumes as well as new ideas and initiatives. It is my pleasure and honour to present the Book "Social Science for Beginners" to the students and the general public so that the basic principles guiding the use of the environment as well as how we impact same as we use our resources can be better understood and appreciated.

Prof. J.F. Olorunfemi

SOCIAL SCIENCES FOR BEGINNERS VOLUME 1

GEOGRAPHY AND ECONOMICS

WASTE MANAGEMENT IN NIGERIA: ISSUES, PERSPECTIVE AND IMPACT ON DEVELOPMENT

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INTRODUCTION AND BACKGROUND

A substantial increase in volume of wastes generation began in the sixteenth century when people began to move from rural areas to cities as a result of industrial revolution (Wilson, 2007). This migration of people to cities led to population explosion that in turn led to a surge in the volume and variety in composition of wastes generated in cities. It was then that materials such as metals and glass began to appear in large quantities in municipal waste stream (Williams, 2005). The large population of people in cities and communities gave rise to indiscriminate littering and open dumps. These dumps in turn formed breeding grounds for rats and other vermin, posing significant risks to public health. The unhealthy waste management practices resulted in several outbreaks of epidemics with high death tolls (Tchobanoglous et al, 1993). Consequently, in the nineteenth century public officials began to dispose waste in a controlled manner in order to safeguard public health. Solid waste management is a local issue with global implications. As the world's population continues to grow, so does the amount of waste being produced. In 2015, the world generated 2 billion metric tons of solid waste. This number is expected to grow to 3.4 billion metric tons by 2050. In low-income countries, the amount of waste is expected to increase by more than three times by 2050 (Kaza et al. 2018). As waste generation increases, so does the importance of having an effective solid waste management system in place. However, cities and local governments face many challenges when it comes to properly managing their solid waste. As a result, it is estimated that at least 2 billion people live in areas that lack waste collection and rely on uncontrolled dumpsites (UNEP & ISWA, 2015). Inadequate solid waste management systems present serious risks to human health, the environment, and livelihoods in many cities.

The ever increasing global concern over environmental health demands that wastes be properly managed and disposed of in the most eco-friendly and acceptable way (Afun, 2010). Solid waste has become an important issue in Nigeria. Piles of wastes are often found by roads, rivers and many other open spaces in cities, and this is causing significant health and environmental problems (Imam, et al., 2008). The Nigerian population is increasing by about 2.8% per annum; with the rate of urban growth at 5.5% per annum (UDBN, 1998). This is increasing the difficulties associated with providing an effective solid waste management system. As cities grow, land use becomes increasingly complex and the wastes generated increase in volume and variety (Imam, et al., 2008). The ensuing refuse generated has assumed a scale of a major environmental challenge, and constitutes an embarrassment to Nigerians. Nigerian regulations and legislation concerning solid waste management have not been adequately enforced, nor are they well understood and accepted by Nigerians (Ogwueleka, 2009). More than 80% of Nigerians don't understand what sustainable waste management is, nor do they know the penalties linked to inadequate refuse disposal (Afun, 2010). Municipal Solid Waste Management (MSWM) systems in developing countries can

display an array of problems, including low waste collection coverage and irregular collection services, as well as improper disposal methods (Ogboi & Kperegbe, 2009). This ineffectiveness of contemporary MSWM practices constitutes a number of health and environmental problems (Songsore, 1992). This unacceptable situation is not unique to Nigeria, but also exists in many African cities. For example, in Accra, Ghana only 11% of the 1.4 million residents benefit from home collection (Songsore, 1992), while the remaining 89% dispose of their waste at community dumps, in open spaces, in water bodies, and in storm drainage channels. Kulaba (1989) observed that on average, city authorities in Tanzania collect only 24% of the refuse created. Ogbonna, et al., (2007) pointed out that household waste collection and street clearing were restricted to wealthy neighbourhoods, while in the remaining area household wastes were dumped along roads, in illegal dumps and in storm water drains or buried in open pits or landfills. According to the Nigerian Environment and Study/Action Team (NEST) in the national profile of the Nigerian environment, the problem of solid waste disposal in the country's cities has become one of the most intractable environmental problems (NEST, 1991), that: "...in many Nigerian cities, the volume of solid wastes has overwhelmed urban administrators' capacity to plan for their collection and disposal. Thus, it is not uncommon to find urban streets and roads practically blocked by solid wastes..."

The annual per capita solid waste generated in Nigeria is 20kg, which amounts to about 3 million tonnes a year if we use an approximate national population of 150 million (Imam, et al., 2008). According to Morris and Dickey (1991) Many communities/countries throughout the world are battling with the problem of how to safely and effectively manage their municipal solid waste. Solid waste recycling is now a common practice in the developed countries as people become more conscious of pollution problems caused by uncontrolled waste generation and disposal

What is a waste?

Waste is the useless by product of human activities which physically contains the same substance that are available in the useful product (White et al, 1995). Wastes have also been defined as any product or material which is useless to the producer (Basu, 2009). Dijkema et al, (2000) pointed out that, wastes are materials that people would want to dispose of even when payments are required for their disposal. Although, waste is an essential product of human activities, it is also the result of inefficient production processes whose continuous generation is a loss of vital resources (Cheremisinoff, 2003).

A substance regarded as a waste to one individual, may be a resource to another. Therefore, a material can only be regarded as a waste when the owner labels it as such (Dijkema et al, 2000). Despite this subjective nature of wastes, it is important to describe clearly, what constitutes a waste because. This is because the classification of a material as a waste will form the foundation for the regulations required to safeguard the populace and the environment where the wastes are being processed or disposed of (DEFRA 2009). Saving our earth planet from the contamination became a giant challenge for us. To conserve our natural resources, wastes should be maintained properly. So that all living beings on this earth can live safely and get benefits from it. The process of managing waste is referred to as waste management. Waste management consists of a series of steps such as collection of the waste, segregating it on the basis of its nature, transporting carefully and labelling them,

undergoing various types of treatment in order to reduce the its hazardous effect and disposing it by burning, burying and recycling methods, etc (see Figure 1).

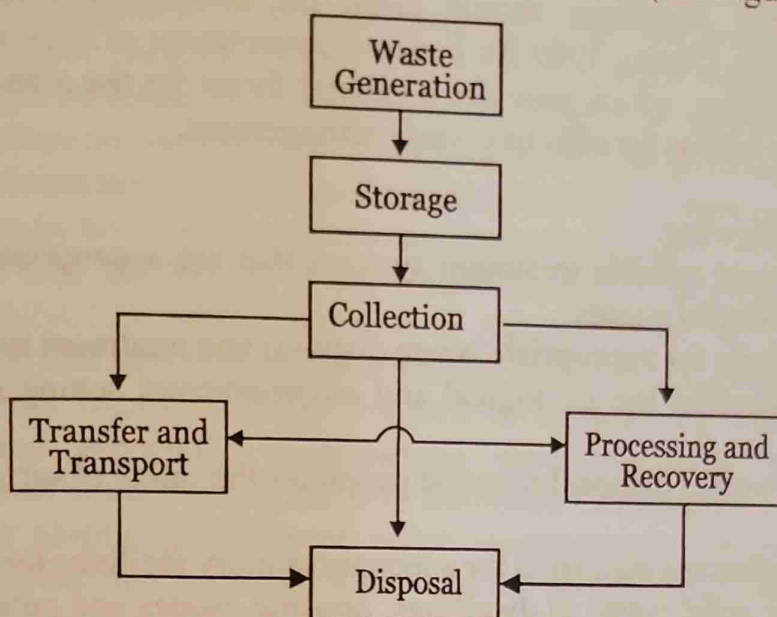


Figure1. Waste Management Steps Source: (Karim and John (2020))

These steps prevent the spread of pollution, reduces the hazardous effects and keeps the environment clean. So, the environment became a good habitat for all living creatures.

Waste Management in Nigeria: An Overview

In Nigeria, solid waste collection and disposal is the responsibility of local government. Paragraph (h) of the fourth schedule to the Nigerian 1999 Constitution gives the function of provision and maintenance of public convenience, sewage and refuse disposal to the local governments. In some states, the state government has, in addition to this provision, made further edicts or laws that are at variance with the constitution. These laws either attempt to give wholly this function to the state government or create particular areas of jurisdiction that derogate the powers of the local government (Ayotamuno, 2004). The discovery of toxic waste dumped by a foreign company at Koko town near Warri in Delta State, Nigeria in 1987 led to the establishment of the Federal Environmental Protection Agency (FEPA) during 1988.

In June, 1999, the Federal Government of Nigeria created the Ministry of Environment and, as a result, FEPA's function was absorbed by the new ministry. The Federal Ministry of Environment has the following instruments of intervention in place to tackle the problem of environmental degradation, including waste management as outlined in 1) the revised policy on environment, 1999, and 2) The National Agenda 21 (1999). These instruments complement what existed as guidelines and standards for environmental pollution control in Nigeria and other regulation that deals with effluents, industrial pollution, waste management and environmental impact assessment (Federal Ministry of Environment, 2003). Among FEPA's instructions in combating environmental degradation are the waste management regulation S.1.9 of 1991 and the Environmental Impact Assessment (EIA) Decree No. 86 of 1992 (FEPA, 2003). FEPA policies regulate the collection, treatment, and disposal of solid and hazardous waste from municipal and industrial sources and makes Environmental Impact Assessment (EIA) mandatory for any major development project likely to have an adverse impact on the environment (FEPA, 2003).

There is also, in existence, an environmental sanitation edict of 1997 that declared the last Saturday of every month Nigerians should clean the environment for three hours (7am–10am) (FEPA, 2003). During 1989 the Federal Government of Nigeria formulated a national environmental policy, which provides a general thrust for the management of the Nigerian environment, as well as for effective waste management.

The policy requires the following:

- I. A study of the most reliable treatment systems that are appropriate for our local domestic and industrial wastes;
- ii. Engineering designs for appropriate waste disposal and treatment systems that will take into consideration the geological and environmental setting and encourage recycling;
- iii. Specification of wastes disposal sites that guarantee the safety of surface and ground water systems;
- iv. Setting up and enforcing standards for adequate sanitary facilities for the disposal of human and other solid waste in dwellings, housing estates and public facilities in both urban and rural areas;
- v. Establishment of monitoring stations for the control of the disposal of leachates into surface and ground water systems;
- vi. Establishment of safe water limits for the location of water wells, boreholes and dams in the vicinity of major sanitary landfill, sites;
- vii. Establishment of early warning system for identification of potential waste disposal hazards;
- viii. Provision of information on appropriate methods and technologies for the treatment and disposal of wastes;
- ix. Regulation, registration and licensing of all major land based disposal sites and systems; and Solid waste management
- x. Establishment of a mechanism for identification and clean-up of abandoned land based hazardous dumps.

Waste Management and Sustainable Development in Nigeria.

Today, with a world population approaching seven billion that produces more than ten million metric tons of waste per day, questions of the impact of waste and how to manage it all, have emerged once again. Offered as the ultimate solution, 'zero waste' goals have been adopted by communities in New Zealand, Japan, the United Kingdom, North America and beyond. While the term 'zero waste' is used widely and enthusiastically applauded as a positive, yet often deemed impossible goal, no definite definition of the term exists. Examination of the concept reveals significant and opposing differences between theoretical and practical interpretations. The practical implementation of zero waste bears little relation to the foundational elements of zero waste theory and serves more to reinforce the status quo of unsustainable waste production and facilitate the 'throwaway society' than working towards waste elimination. Waste management is the collective process of sorting, storing, collecting, transporting, processing, resource recovering, recycling and disposal of waste. In Nigeria, wastes are usually dumped on roadsides, available open pits, flowing gully water and drainage channels. The indiscriminate disposal of waste is increasingly a prominent habit in most urban cities of Nigeria. Unlike urban cities, in rural communities municipal solid waste quantity are less and managed in household backyards by burning, composting,

as feeds to animals and occasionally disposed at dump sites. In Nigeria, the processes involved in the management of waste are, storage, collection, transportation and disposal at dumpsites. Moreover, recycling which is an environmentally friendly option is not yet fully adopted. There are no formal recycling sectors in Nigeria. Wastes are recycled informally by scavengers who buy un-use valuables from People and also go to legal and illegal dumpsites in search of materials that can be re-used and recycled. Since there is a continuous increase of waste production by households, educational institutions, commercial institutions etc.

That is why the Report of the United Nations Conference on Environment and Development (UNCED, 1992), and also in Agenda 21 of the United Nations General Assembly which affirmed that environmentally sound management of wastes was among the environmental issues of major concern in maintaining the quality of the Earth's environment and especially in achieving environmentally sound and sustainable development in all countries." In the fifth European Community environment programme towards sustain ability, problems of waste management - in particular the increasing amounts of domestic and industrial waste and the non-optimal use of recycling and reuse options - are referred to as being at the same level of urgency as climatic changes and aquatic pollution are in being basic environmental problems that need to be solved if a sustainable development is to be achieved.

However, during recent years' interest in industrial waste as an important source of energy use and material recovery has increased considerably. Today, most factories are in need of a detailed analysis of their waste management at all stages of production. Factory owners who have already studied waste streams within the company and the possibilities of recovery and resource saving usually find that there are large economic as well as environmental benefits if adequate waste management is implemented (IEA Bioenergy, 1996). The benefits of successful industrial waste management programs aiming at minimization of wastes frequently result in significant reductions in manufacturing and production costs, more efficient use of valuable resources, improvements in process and product quality and reductions in waste generation, treatment and disposal costs. Additional benefits of industrial waste minimization programs may include a reduction in a generator's long-term liability for any hazardous wastes produced and the potential for positive publicity for being proactive and doing the right thin.

A commonly suggested way to cope with the pollution aspect of the waste problem is to let the polluter carry all the costs of preventing and controlling any pollution that he originates. This principle, the Polluter-Pays Principle, (PPP) GECD 1992L is however not without Problem either. Nevertheless, it is commonly regarded that the Polluter-Pays Principle instrument represents the common view of today regarding how to finance environmental societal policy. Effective management of waste enhances the competitiveness of a firm as well as the material welfare of the members of the society. Waste management is to prevent waste from causing harm to human health and the environment and promote resource use optimization. Timely and effective waste management is one of the most critical challenges of sustainable development that needs to meet "the needs of the present without compromising the ability of future generations to meet their own needs WCED (1987). In the U.S, 80% of the population, 81 % of firms and 85% of employment is located in metropolitan regions (U.S. Census, 2002). Urban regions are the "keys to the delivery of sustainable development due to the considerable opportunity for increased quality of life through economic, political and social progress" (Walton, 2005).

The significant and growing fraction of population, material and energy flows are associated with the use and disposal of products and materials worldwide. A city cannot be sustainable if it generates more waste than it can assimilate; waste reduction is more critical than waste disposal management as the end problem. Hart (1997) added that the achievement of sustainability would require a blending of product stewardship, green technology and pollution prevention.

Importance of Solid waste Management

Inadequate solid waste management can impact cities and their residents in myriad ways. These impacts can generally be categorized into three categories:

- i. **Human health.** The improper handling of waste can impact human health (e.g., decomposing organic waste attracts rodents, insects, and stray animals). In some cities, human faecal matter and urine are not separated from solid waste, which attract insects and germs that spread disease (e.g., typhoid, cholera). Mosquitos also pose a concern when they breed in solid waste (e.g., used tires); mosquitos can be vectors for diseases such as malaria, dengue, and the Zika virus. Mismanaged solid waste and open dumpsites can lead to environmental contamination of surface and groundwater, which are common sources of drinking water. Uncontrolled burning of waste may result in emissions of air pollutants including dioxins, furans, black carbon, heavy metals, and particulate matter, many of which can be toxic for human health (ISWA, 2015). For populations living in direct contact with or close proximity to waste disposal sites, these health effects can be particularly severe.
- ii. **Environmental.** Inadequate control of leachate, water that filters through waste and draws out chemicals, at disposal sites can lead to environmental contamination of soils and waterbodies, impacting local ecosystems (U.S. EPA 2018d). Mismanaged waste is also a threat to stray animals and wildlife as animals may try to consume waste that contains food residue or
- iii. **scraps.** Open burning of waste produces emissions of black carbon, a component of particulate matter that has a significant impact on regional air quality and global climate. Waste disposal sites release methane, which contributes to the formation of ground-level ozone. In addition, methane is a greenhouse gas that contributes to climate change.
- iv. **Socioeconomic.** Inadequate solid waste management can be costly, both in terms of direct expenses and indirect costs. Mismanaged solid waste systems are a missed opportunity for economic growth, including increased property values and tourism benefits from having clean streets and beaches. Programs reducing waste can lead to cost savings in transportation and fuel costs, and cost recovery if implemented correctly. Improved solid waste management can especially benefit highly vulnerable populations through cost savings on public health systems by preventing respiratory issues, skin diseases, and other health care concerns associated with inadequate solid waste management (ISWA 2015). Taking action to improve solid waste management can help mitigate these impacts.

Types and Sources of Waste

Wastes are classified into three types. They are basis of physical state, basis of biodegradability and basis of effects on human health (see figure 2). On the basis of physical state, it is further classified into Solid (seen by naked eye), liquid (home and industrial effluents) and gaseous (not seen by naked eye).

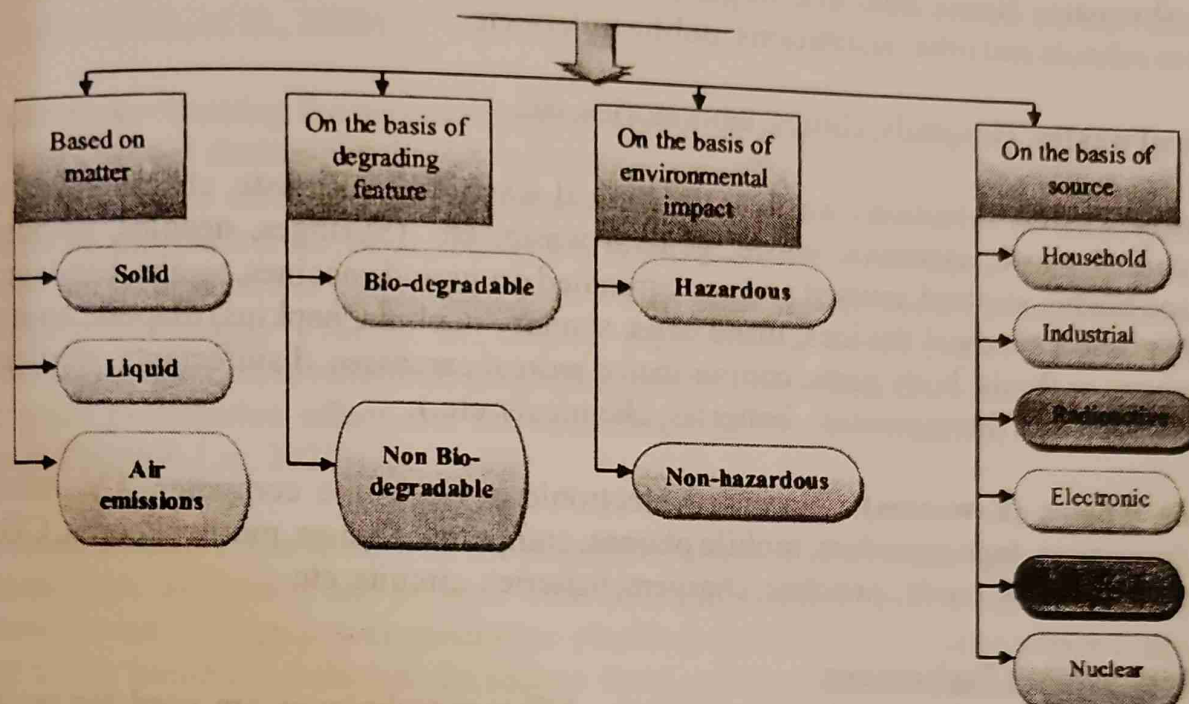


Figure 2: Types and sources of waste

On the basis of bio-degradability, it is further classified into biodegradable (organic) and non-biodegradable (metals, plastics, paper and glasses). On the basis of effects on human health, it is classified into hazardous (dangerous) and non-hazardous (non-dangerous).

Sources of wastes

Domestic wastes: Household waste, food wastes, garbage (kitchen waste), rubbish (paper, polythene, plastics, glass pieces), old toys, old clothes, old mattresses, etc. **Community wastes:** Educational institutions waste, government offices, markets, public cleansing, bulky wastes, hospitals, construction works, etc.

Commercial wastes: Bulky wastes from shops, offices, hotels, non-government markets, stores, tyres, electronics, plastic bags, bottles, buckets, packaging materials, paper fibres, thermocol, discarded electric waste, etc. **Industrial wastes:** Paper and pulp wastes, oil refineries, tanneries, distilleries, thermal power plants, chemical industries, metal smelters, coal, ash, acids, chemicals, textiles, plastics, nuclear wastes, unused metal sheets, metal scraps, rubber, leather, toxic effluents, fibres (residues), heavy metals, solvents, resins, sludge, abrasive, etc. **Agricultural wastes:** Farm waste, livestock yards, crop residues, bagasse from sugarcane, outdated pesticides and fertilizers, manure, weedicides, fungicides, slaughter waste, plastics and containers, organics, etc. **Mining wastes:** Waste rock, tailings, mine water, chemicals and others, etc.

Radioactive wastes: Nuclear explosions, nuclear testing, use of radioactive substances in medical and scientific research, products contaminated by radionuclides including

radioactive diagnostic material or radio therapeutic materials, etc. Construction wastes: Demolition, excavation, renovation works, road works, site clearance, wood, glass, metal, plastic, concrete, etc

Municipal wastes: House hold discharge, street sweeping, sewage treatment plant waste, waste from schools and other institutions, public toilets, etc.

Biomedical wastes: Hospitals, clinics, laboratories, etc.

Health-care wastes: Infectious waste, pathological waste, sharps waste, chemical waste, pharmaceutical waste, cytotoxic waste, general waste, etc. (Syringes, needles, disposal scalpels and blades, expired, unused and contaminated drugs and vaccines, swabs, bandages, gloves, disposable medical devices, urine bags, sanitary napkins, napkins, diapers, human tissues, organs or fluids, body parts, contaminated animal carcasses, disinfectants, sterilant, heavy metals, broken thermometers, batteries, chemicals, etc.).

Electronic wastes (E-wastes): Discarded electronic devices like computer, TV, music systems, transistors, tape recorders, mobile phones, computer cabinets, mother boards, CDs, cassettes, mouse, wires, cords, switches, chargers, batteries, circuits, etc.

Waste Management Techniques

According to the deposition and type of waste, different techniques are used for waste management. They may vary from person to person, place to place, time to time and nation to nation. *They are:*

Recycling:- Collecting the wastes from different places and segregating them according to the nature of products and used for recycling process. Robots are used in America for collecting the wastes in Baltimore River. In Malaysia and Hong Kong, recycling process is practiced for controlling the construction wastes (Wahi, et.al., 2016). Recycled the municipal and construction solid waste and used it for manufacturing highly environmentally friendly geopolymer composite (Tang, Tam & Xue, 2020).

Composting:- Organic wastes are separated from the wastes and allow decomposing by microbes for a long period of time in a pit. Then this becomes nutrient rich compost and used as a manure for the plants. Soil fertility is enriched by these manures. Composting through biological technique progresses the fertility of the soil. Vermicomposting method reduces environmental impact and enhances the nutrient content of the soil (Bhat, et. al., 2020). Vermicomposting is the effective process for sustainable organic agriculture and for also to maintain a balanced ecosystem (Kaur, 2020). For high level of organic waste reduction and rapid composting time, Black Soldier Fly (Larvae) was used. Then the residues were further treated with *E. Eugeniae* which results in the production of best quality of vermicompost (Bagastyo & Soesanto, 2020). Vermicomposting of onion waste with cow dump produces a valuable agricultural enriched nutrient circle (Pallejero, et.al. 2020).

Landfilling:- Dumping the wastes in the soil is called as Landfilling. Proper procedure should be adopted for landfilling such as lining the base with protective layer, selecting low

groundwater level area, etc. Skilled manpower is needed for this process. In China, construction of horizontal wells reduces leachate level in landfills containing municipal solid waste (Hu, et. al., 2020). Physical, chemical and biological processes-based model controls the Hg emission from landfills (Tao, Deng, Li & Chai, 2020). The results of co-incineration of sewage sludge and municipal solid waste showed more gaseous Hg⁰ to be oxidized to Hg²⁺ during the cooling process. It leads to cause less environmental risk to the atmosphere (Sun, et. al., 2020).

Incineration:- Burning the wastes at high temperature is called as Incineration. To avoid air pollution (caused during burning of wastes), proper filters are used. For handling sludge, direct incineration method without anaerobic digestion was found to be more preferred sustainable approach (Hao, et. al., 2020). For fossil fuel conservation and waste disposal, the technology of coal power plant along with waste incineration method was considered as a promising technology (Ye, et. al., 2020). Degradation technologies such as plasma, mechanochemistry, hydrothermal, photocatalytic and biodegradation had proved that they have good purification effect and are considered as the best resource of MSWI fly ash (Zhang, Zhang & Liu, 2020).

Bioremediation:- It has to do with the process of using microbes and bacteria for removing the impurities, pollutants and poisons from soil, water and other environments is called as bioremediation. Energy power generation plants emit radioactive wastes which is the major threat to the human population. To reduce these wastes, bioremediation strategy is used. Bioremediation technologies rectifies the heavy metal pollution problem and helps to regain the natural condition of soil (Saini & Dhanial, 2020). Bioremediation is an eco-friendly, inexpensive, and effective technology which is encouraged for the safe discharge of water from industrial activities (Coelho, 2020). Waste-to-energy Waste-to-energy is the process of creating energy in the form of electricity or heat from the primary treatment of waste.

In China, anaerobic digestion technology is used for energy recovery and also has been identified as an effective approach to minimize the degree of harm of GHG emissions which are related to FW treatment (Zhang, et. al., 2020). Waste-to-energy (WtE) technologies such as pyrolysis, gasification, incineration, and bio-methanation can convert MSW, as an appropriate source of renewable energy, into useful energy (electricity and heat) in safe and eco-friendly ways (Malav, et al., 2020).

Remote Sensing & GIS

Remote sensing is the art of obtaining information about objects or areas from a distance, typically from aircraft or satellites. In Coimbatore landfill sites, 75% of municipal solid waste were dumped without treatment and it was found out by using vector data and remote sensing (RS) (Gautam, Brema & Dhasarathan, 2020). Remote sensing is an avenue to quantify process-level emissions from waste management facilities (Cusworth, et al., 2020). Use of remote sensing and GIS for distinguishable proof of the sensible objectives of solid waste dumped depends on the overlaying of datasets and spots that fulfil the site suitability criteria. The datasets and spots join the spatial examination devices given by GIS to arrange and survey in order to choose possible waste areas (Vishnuvardhan & Elangovan, 2020).

Challenges of Solid waste management in Nigerian Cities

Nigeria states and cities recognize the many health, environmental, and other concerns associated with inadequate solid waste management; however, they face many challenges in properly managing this waste.

Common challenges include:

- i. **Limited financial resources and capacity.** Many cities have limited capacity for sustainably funding infrastructure or operations. Cities are often responsible for implementation but do not have the finances or financial expertise and struggle with investment costs, the upkeep of facilities, establishing a sufficient budget for solid waste projects, or rising costs and inadequate revenues as the volume of waste continues to increase. Prioritizing solid waste management, researching cost-cutting strategies, incorporating pay-as-you throw programs or taxes, and partnering with international investment organizations are all options for funding a viable solid waste program. Although some programs, taxes, or fees will face resistance when introduced, finding a sustained source of funding for solid waste management is an integral part of a successful program often needs to be imported, and operators may not have the technical knowledge or resources for proper and consistent maintenance. If the equipment is not designed for local conditions, this incompatibility can add further challenges because frequent repairs may be needed, and spare parts may be difficult to find. In tropical areas, local conditions such as humidity and heat can negatively affect equipment, leading to frequent repairs. In many cases, there are multiple equipment options, some of which may be better suited to local conditions.
- ii. **Limited technical expertise and awareness of best practices.** Local governments often lack the expertise needed to evaluate technologies or solutions in order to identify the most appropriate ones for their situation. Difficult situations can arise when private companies contract with cities to provide a technology or implement a project but abandon the project if the city cannot meet the terms of the contract. For example, many waste treatment project contracts include requirements that the city guarantee a clean or consistent feedstock. Private companies can and will abandon the work if the city fails to meet these requirements. Cities do not always anticipate these challenges, and projects can fail as a result. Decision-makers and staff at the local level are often not aware of best practices that other cities in similar situations have implemented successfully. Technical knowledge and awareness of best practices can be improved by participating in domestic and international exchanges such as conferences and webinars organized by the International Solid Waste Association. Centers of excellence – such as those identified in the text box to the right – can also be valuable resources for disseminating lessons and experiences.
- iii. **Limited staff capacity.** Many cities lack sufficient staff who are dedicated to addressing solid waste management issues. These staff are often focused on addressing immediate waste emergencies and have limited time or capacity to engage in longer term planning and strategy development.
- iv. **Political turnover.** Changes in administrations can result in projects being shut

down or radically altered by incoming officials and key staff reassignments on large capital projects, including solid waste management projects. As a result, many project champions who possess considerable technical expertise are not available to see projects through to completion. Solid waste management legislation, either national or subnational, which establishes long-term, sustainable systems that continue across administrations, can help overcome this barrier. Maintaining staff continuity on solid waste management projects and operations can also help minimize these disruptions.

- v. **Lack of planning and evaluation at both national and municipal levels** can negatively affect the success of a solid waste management system. National frameworks or regulations are important to facilitate long-term planning; establish national standards; and provide incentives for programs to reduce, recycle, or compost their waste. Planning at the municipal level where implementation occurs is often overlooked and can create challenges later. This is especially prevalent when there are unplanned disruptions such as natural disasters. Creating a national and local plan, which includes a monitoring and verification system, will help create a stable solid waste management system.
- vi. **Limited or lack of vertical and horizontal government coordination.** Solid waste management usually falls under the jurisdiction of multiple ministries or agencies at various levels of government. For example, the government agencies responsible for the environment, urban and housing development, or agriculture may all be involved at different parts of the solid waste management system, but may not have formal frameworks for collaboration. In addition, local governments are responsible for the implementation of national regulations, and national governments can play a significant role in creating enabling environments for successful local projects. A mechanism that enables coordination between agencies or departments and between the layers of government can assist in creating a holistic system.
- vii. **Difficult working conditions.** Solid waste management workers in developing countries may be underpaid and undertrained (UNEP 2005a). Without proper training and personal protective equipment, these workers are at risk of injury or disease. Studies show that a high percentage of workers who handle waste, and individuals who live near disposal sites, are at risk of being infected with worms or parasites (UNEP 2005a). Difficult working conditions also result in a lack of motivation for workers and low employee retention rates.
- viii. **Limited or lack of communications with relevant stakeholders,** including residents, can lead to illegal dumping, misuse and damage of containers, resistance to service fees, improper waste segregation, among other things. Coordinated communications and outreach campaigns can help ensure that relevant stakeholder groups are informed and equipped to comply with local solid waste management requirements.
- ix. **Limited available land.** As urban areas and populations continue to grow, the

amount of available space for solid waste facilities, local collection locations, and transfer stations decreases. There may not be space, the available parcels may be too expensive, or local residents may prevent facilities from being developed due to fears of smell depreciating their living conditions or property prices. However, siting these facilities at a distance from cities, where land is more available and less expensive, creates a new set of challenges because hauling waste long distances can be time-consuming and expensive. Solid waste managers can work with local and regional leaders to create a solid waste management plan that emphasizes the importance of route and city planning. Diversion or separation programs will also play a large role in reducing the amount of waste that needs to be collected at one time.

- x. **Climatologic, geographic, and topographic** conditions all influence the availability and cost of equipment, the feasibility of technologies, operating costs, and other aspects of solid waste management. For instance, cities in tropical zones might adapt solid waste management strategies to account for higher temperatures and faster organic waste decomposition rates than cities in cooler climates. Geographic and topographic features can pose challenges for solid waste management as well. Islands, in particular, face significant challenges due to limited space for waste disposal, as well as limited access to and capacity for recycling. Cities in hilly areas may need to design disposal sites that are resilient to slope failure.
- xi. **Cultural norms.** Cultural preferences and tendencies can complicate solid waste management efforts. For example, increasing wealth and lower prices for goods have led to a dramatic growth in material consumption and waste generation worldwide. Solid waste managers are faced with the implications of these trends. Addressing cultural norms during solid waste management planning requires a coordinated stakeholder engagement approach.

CONCLUSION

Waste management is a critical issue confronting practically every state in Nigeria because of its human and environmental sustainability implications. As human beings naturally depend on the environment to sustain their lives, proactive measures have to be taken into cognizance towards managing waste in order to achieve economic, social and environmental protection which form the basic components of sustainability development. This aspect of environmental management is as important as other public amenities or infrastructures without which the life of contemporary man would be extremely difficult. This is because studies have shown a direct link between air, water and land pollution and diseases such as lung cancer, heart disease, cholera and hepatitis. In addition, climate change and eutrophication are a direct result of water and air pollution. To live a healthier life proper waste management technique is essential. Through Reduce, Reuse and Recycle, we can conserve the natural resources and saves energy. Composting enriches nutrients to the soil, decreases the landfill wastes, keeps more microorganisms to be present in the soil and makes pollution free environment. In Landfills, latest technologies are used and helps in energy production such as methane in large amount. Incineration decreases the amount of solid waste, helps in the production of heat and energy, reduces pollution and makes the place

environment friendly. Bioremediation is a natural process, minimum equipment and little energy is needed, without harmful side effects, quickly makes soil and water more useful, etc. Waste-to-energy minimizes greenhouse gases, produces clean energy and reuses metals. Remote sensing helps to collect information about the large spatial areas and to characterize the natural features of the objects. This information helps to make decision about physical objects. GIS provides detailed information about the location and helps to make decision about it. Waste management techniques keeps the environment free from pollution, increases the fertility of the soil and groundwater level and saves the earth and energy sources. These waste management techniques are considered as the best methods to safeguard our environment. Clean and green environment is the greatest assets for our forthcoming generation. To achieve this, environmental guiding principles, values, policies and legislations should be framed properly and followed strictly for eco-friendly sustainability

Recommendation and Policy Implications

For effective sustainable waste management in Nigeria. *The following recommendations are put forward:*

1. Government should establish stringent legal and regulatory framework that will enhance efficient and appropriate collection and disposal of waste in Nigeria. This will ensure environmentally sound waste management system that prevents damage to the Earth's ecosystems and maintain a high quality of life for the inhabitants of the State.
2. Government should set up a formal recycling sector where wastes of all kinds will be recycling instead of informal recycling which scavengers adopt who buy unused valuables from people and go to legal and illegal dump sites in search of materials that can be reused and recycled. The implication is that formal recycling of waste will ensure friendly environment as well as effective waste management practice. However, formal recycling of waste will generate wealth to different Nigeria's state. This will contribute significantly to sustainable development in the country.
3. Government should effectively and sincerely provide incentives for waste collectors and those involve in public waste management, this will boost their morale, increase their level of commitment and productivity towards their duties.
4. Government should pump sufficient funds into public waste management agency to enable them dispose waste generated appropriately since hygiene and health of the citizens are very essential. This is pivotal because improperly stored waste can cause health, safety and economic problems.

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