SEWAGE DISPOSAL SYSTEM AND HUMAN HEALTH IN DENSELY POPULATED CITY SQALORS OF OBIAGU AND ABAKPA IN ENUGU METROPOLIS IN ENUGU STATE

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Abstract

The study investigated the relationship between disposal system and human health in densely populated squalors of Obiagu and Abakpa areas of Enugu Metropolis of Enugu State. The study used both primary and secondary data to get information from two agencies of Enugu State government – the Enugu State Waste Management Authority (ENSWAMA) and Enugu State Ministry of Health. A sample size of 228 staff was generated from the two agencies. The research adopted simple random sampling technique which did not discriminate any respondent the result of the hypothesis using sample mean difference statistics of Z = x-μ ÷ s for the two formulated hypothesis showed that onsite sewage disposal system negatively affects human health in the study area (Z cal 1.70 > Z tab 1.65) and that lagoon sewage disposal system positively correlate with human health in the study area (Z cal of 1.66 > Z tab of 1.65). Based on this, the study recommended among others that onsite disposal system should be made compulsory in the study area as a starting point.

Key words – Sewage, disposal, human health, city squalors

Introduction

Every community should have a way of disposing of sewage so that people, animals and flies cannot touch it. This is called a sewage system. Sewage disposal states *World Health Organization (2016),* is the process in which sewage is transported through cities and inhabited areas to sewage treatment plants, where it is then treated to remove contaminants to produce environmentally-safe waste. Disposal of sewage waste protects public health and prevents disease as well as water pollution from sewage contaminants. Many modern cities have sewage disposal systems, and advancing technology has allowed for more environmentally friendly and healthy solutions to disposing and treating sewage. Sewage systems are part of modern infrastructure and urban utilities, which also include gas, electric, and water supply. A system for disposing of sewage, whether by means of a cesspool, septic tank, or by mechanical treatment, all of which is designed to serve a single building or group of buildings, independently of the public sewer. As Water and Environmental Health at London and Loughborough (2018),would define , "Sewage disposal system" means any system, plant, disposal field, lagoon, pumping station, constructed drainage ditch or surface water intercepting ditch, incinerator, area devoted to sanitary landfills, or other works, installed for the purpose of treating, neutralizing, stabilizing or disposing of sewage, industrial waste or other wastes, "sewage disposal system" or "facilities," used in relation to a commission as explains Walker, James D. and Welles Products Corporation (2016), means the sewers, conduits, pipelines pumping and ventilating stations, treatment plants and works, and other plants, structures, boats, conveyances and other real and personal property operated by the commission for the purposes of the commission. As *Tchobanoglous, George; Burton, Franklin L.; Stensel and David (2013),* would define, sewage system is the process of removing and destroying or converting the noxious substances of sewage especially by ammonification and nitrification through bacterial action.

The term sewage is nowadays regarded as an older term and is being more and more replaced by “wastewater”. In general American English usage, the terms “sewage” and “sewerage” mean the same thing. In common British usage, and in American technical and professional English usage, “sewerage” refers to the infrastructure that conveys sewage. Illustrating further *Randall, Clifford W. and Dipankar (2016),* notes that sewage (or domestic wastewater or municipal wastewater) is a type of wastewater that is produced by a community of people. It is characterized by volume or rate of flow, physical condition, chemical and toxic constituents, and its bacteriologic status (which organisms it contains and in what quantities).

It consists mostly of grey water (from sinks, tubs, showers, dishwashers, and clothes washers), black water (the water used to flush toilets, combined with the human waste that it flushes away); soaps and detergents; and toilet paper (less so in regions where bidets are widely used instead of paper). Before the 20th century, sewers usually discharged into a body of water such as a stream, river, lake, bay, or ocean. There was no treatment, so the breakdown of the human waste was left to the ecosystem. Today, the goal is that sewers route their contents to a wastewater treatment plant rather than directly to a body of water. In many countries, this is the norm; in many developing countries like Nigeria, it may be a yet-unrealized goal. Current approaches to sewage management may include handling surface runoff separately from sewage, handling grey water separately from black water (flush toilets), and coping better with abnormal events (such as peaks storm water volumes from extreme weather).

The disposal of sewage by discharging it into watercourses such as streams, rivers or large body of water such as a lake, sea is called dilution. This methods of disposal are only possible when the natural water in required quantity is available near the town. While discharging the sewage in this way care should be taken that the sewage may not pollute the natural water and render it unfit for any other purpose such as bathing, drinking, fish culture, rough industrial use and irrigation. When the sewage is evenly spread on the surface of land methods is called land treatment the water of sewage percolates in the ground and the organic suspended solids remain at the surface of the ground the organic suspended solids are partly acted upon by the bacteria are partly oxidized by exposure to atmospheric action of heat light and air. In the words of *Margot (2013),* proper collection and safe, nuisance-free disposal of the liquid wastes of a community are legally recognized as a necessity in an urbanized, industrialized society. In developed countries like Nigeria, sewage collection and treatment is typically subject to local and national regulations and standards. Raw sewage is also disposed of rivers, streams, and the sea in many parts of the world city squalors. Doing so can lead to serious pollution of the receiving water. This is common in developing countries and may still occur in some developed countries, for various reasons - usually related to costs.

There are different types of sewage systems which can be described as On-Site Systems and Sewage or Effluent Systems. As could be explained by Logan *and Regan (2016),* an on-site system is one which treats the sewage in a septic tank so that most of the sewage becomes effluent and is disposed of in an area close to the house or buildings. An example of an on-site disposal system consists of a septic tank and leach drains. A sewage or wastewater system disposes of the effluent from a community at a central place usually called a sewage lagoon or effluent pond. The sewage can be treated: in a septic tank at each building, just before the lagoon in a large septic tank or macerator system, or in the lagoon itself. This research looked at sewage disposal system and human health in densely populated city squalors like Obiagu and Abakpa in Enugu Metropolis.

Sewage disposal is a serious matter anywhere in the world because of the heavy impact on human and environmental health. The problem of the study, therefore, is that on-site sewage disposal system usually in use in our cities are often abused and not taken of neatly which most times, results into serious health hazards. We see most septic tanks punctured and slush oozing out , causing serious damage to the environment. Also, the sewage lagoon system as a centralized sewage disposal system is not popularized as too many people still stick to the on-site system. Besides, the laid pipes connecting many homes to the central sewage lagoon are usually damaged without routine repairs, which makes sewage slush gulp out with offensive or dour too hazadous to health. The extent these problems affect sewage disposal system in Enugu City squalors like Obiagu and Abakpa, is the reason for this study.

Objectives of the Study

The main objective of the study is to evaluate how sewage disposal system affects human health in densely populated city squalors like Obiagu and Abakpa in Enugu City. Specific objectives include:

1. To examine how on-site sewage disposal system affects human health in densely populated city squalors like Obiagu and Abakpa in Enugu Metropolis.
2. To study how lagoon sewage disposal system affects human health in densely populated city squalors like Obiagu and Abakpa in the study area.

Research Questions

1. How does on-site sewage disposal system affect human health in densely populated city squalors like Obiagu and Abakpa in the study area?
2. To what extent does lagoon sewage disposal system affect human health in densely populated city squalors like Obiagu and Abakpa in the study area?

Hypotheses Formulation

HO_1: On-site sewage disposal system does not negatively affect human health in densely populated city squalors like Obiagu and Abakpa in the study are.

HO_2 : Lagoon sewage disposal system does not positively correlate with human health in densely populated city squalors like Obiagu and Abakpa in the study area.

Review of Related Literature

Conceptual Framework

The Concept of Sewage Disposal

Sewage is generated by residential, institutional, commercial and industrial establishments. It includes household waste liquid from toilets, baths, showers, kitchens, and sinks draining into sewers. In many areas, sewage also includes liquid waste from industry and commerce. The separation and draining of household waste into grey water and black water is becoming more common in the developed world, with treated grey water being permitted to be used for watering plants or recycled for flushing toilets. Sewage usually travels from a building's plumbing either into a sewer, which will carry it elsewhere, or into an onsite sewage facility (of which there are many kinds). Whether it is combined with surface runoff in the sewer depends on the sewer design (sanitary sewer or combined sewer).

The reality is, however, that most wastewater produced globally remains untreated causing widespread water pollution, especially in low-income developing countries. A global estimate by UNDP (2017) and UN-Habitat (2018) is that 90% of all wastewater generated is released into the environment untreated. In Nigeria, the bulk of domestic and industrial wastewater is discharged without any treatment or after primary treatment only. Sewer pipe note *Lienert; Burki and Escher (2017),* must be strong enough to withstand the structural stresses to which it is subjected by being buried in the ground. In addition, the pipe itself and the joints between sections of pipe must be capable of withstanding at least moderate water pressure without significant leakage of sewage into the environment. Materials used for sewer pipe include plastics, vitrified clay, cast iron and steel, corrugated iron, concrete, and asbestos cement. Although usually circular, pipes are also made egg-shaped or semi-elliptical so that suspended solids do not accumulate even at a relatively low rate of flow, about 2 ft (.6 m) per second. Sewer pipes alleges *Khopkar (2014),* are usually inclined downward toward the central collection point so that sewage will flow to it naturally, although pumping stations may be required. Sewage is eventually discharged into underground or surface watercourses that naturally drain an area. In past centuries, the dilution produced by discharging sewage into large bodies of water was considered sufficient to render harmless any toxic substances contained in it. However, the volume of sewage is now so great that dilution is no longer considered an adequate safeguard.

Any home or building that is not connected to a municipal or city sewage system needs a method for getting rid of human waste (feces and urine). All buildings not serviced by a municipal (centralized) treatment plant need to have an onsite sewage disposal system that is properly designed and filed with the local public health authority. This is what is mostly obtainable in Nigeria, and Enugu. Only Trans Ekulu in Enugu City has central sewage system Huber and Berching (2012),explain that a typical sewage disposal system has two basic parts: septic tank - which may also be accompanied by a treatment plant and dispersal area - usually a series of underground pipes or chambers that evenly distribute the partially treated liquid into the ground for final treatment. A septic tank explains *Haughey (2018),,* is a watertight, underground container used for receiving, treating, and settling human waste. The solids settle to the bottom of the tank and become sludge, while oils and other light material float to the surface, forming a scum layer. Within the tank, anaerobic bacteria, which are bacteria that do not need oxygen, break down the solid waste. When the septic tank is working properly posit *Harshman, Vaughan; Barnette and Tony (2018),* these bacteria can reduce the solids by 50 to 60 per cent. The liquid between the sludge on the bottom of the tank and the scum on the top, flows out of the tank into the dispersal area. Further treatment occurs within the soil, prior to entering the ground water table, adding that the sludge and surface oils remaining in the septic tank need to be pumped out regularly (usually every 2 to 3 years). An authorized person who is a septic system pump-out contractor can do this maintenance.

Types of Sewage Disposal System

As *Harhangi,.; Le Roy ; Van Alen; Hu,.; Groen* ; *Kartal*; *Tringe,; Quan,; Jetten and Den-Camp* (2012J, would narrate, types of sewage disposal system include: the wastewater from residences and institutions, carrying bodily wastes (primarily feces and urine), washing water, food preparation wastes, laundry wastes, and other waste products of normal living, are classed as domestic or sanitary sewage; liquid-carried wastes from stores and service establishments serving the immediate community, termed commercial wastes, are included in the sanitary or domestic sewage category if their characteristics are similar to household flows. Wastes that result from industrial processes such as the production or manufacture of goods are classed as industrial wastewater, not as sewage and surface runoff, also known as storm flow or overland flow, is that portion of precipitation that runs rapidly over the ground surface to a defined channel. Precipitation absorbs gases and particulates from the atmosphere, dissolves and leaches materials from vegetation and soil, suspends matter from the land, washes spills and debris from urban streets and highways, and carries ail these pollutants as wastes in its flow to a collection point.

On-Site Sewage Disposal Systems

All the liquid waste from the toilet, bathroom, laundry and sink goes into pipes which carry it to a, septic tank. The effluent from the tank is then disposed of through effluent disposal drains often referred to as leach or French drains. Both of these methods of disposing of liquid waste are on-site disposal systems. They must be installed and maintained properly. Sewage treatment defines Edmondson (2012),, is the process of removing contaminants from municipal wastewater, containing mainly household sewage plus some industrial wastewater. Physical, chemical, and biological processes are used to remove contaminants and produce treated wastewater (or treated effluent) that is safe enough for release into the environment. A by-product of sewage treatment is a semi-solid waste or slurry, called sewage sludge. The sludge has to undergo further treatment before being suitable for disposal or application to land.

Sewage Pollutants

Sewage is a complex mixture of chemicals, with many distinctive chemical characteristics. As record Dos *and* Tapes *(2011),* these include high concentrations of ammonium, nitrate, nitrogen, phosphorus, high conductivity (due to high dissolved solids), high alkalinity, with pH typically ranging between 7 and 8. The organic matter of sewage is measured by determining its biological oxygen demand (BOD) or the chemical oxygen demand (COD). In the analysis of *Corcoran, Nellemann, Baker, Bos, Osborn and Savelli (2010),* sewage contains human faeces, and therefore often contains pathogens of one of the four types: bacteria (for example Salmonella, Shigella, Campylobacter, Vibrio cholerae), viruses (for example hepatitis A, rotavirus, enteroviruses), protozoa (for example Entamoeba histolytica, Giardia lamblia, Cryptosporidium parvum) and parasites such as helminths and their eggs (e.g. ascaris (roundworm), ancylostoma (hookworm), trichuris (whipworm). Sewage can be monitored for both disease-causing and benign organisms with a variety of techniques. Traditional techniques involve filtering, staining, and examining samples under a microscope. As *Corcoran, Nellemann, Baker, Bos, Osborn and Savelli (2010),* illustrate, much more sensitive and specific testing can be accomplished with DNA sequencing, such as when looking for rare organisms, attempting eradication, testing specifically for drug-resistant strains, or discovering new species. Sequencing DNA from an environmental sample is known as metagenomics. Sewage as examine Chowdhry and Kone (2012), also contains environmental persistent pharmaceutical pollutants. Trihalomethanes can also be present as a result of past disinfection. Sewage has also been analyzed to determine relative rates of use of prescription and illegal drugs among municipal populations.

Health and Environmental Aspects

All categories of sewage alleges Burrian and Steven (2018), are likely to carry pathogenic organisms that can transmit disease to humans and animals. Sewage also contains organic matter that can cause odor and attract flies, further adducing that sewage contains nutrients that may cause what is termed eutrophication of receiving water bodies and can as well lead to what is known as ecotoxicity.

Sewage Treatment

Sewage treatment explains *Barwal, Anjali; Chaudhary and Rubina (2014),* is the process of removing the contaminants from sewage to produce liquid and solid (sludge) suitable for discharge to the environment or for reuse. It is a form of waste management. A septic tank or other on-site wastewater treatment system such as biofilters or constructed wetlands can be used to treat sewage close to where it is created. Sewage treatment results in sewage sludge which requires sewage sludge treatment before safe disposal or reuse. Under certain circumstances, the treated sewage sludge might be termed "biosoiids" and can be used as a fertilizer. A typical treatment plant uses air to help break down and treat waste. The waste is treated in a septic tank before flowing into the treatment plant. In the words of *Ashton; Ubido and Janet (2011)* treatment plant treats liquid waste to a higher quality so it is cleaner and safer before it enters the dispersal area than the discharge from a regular septic tank. This also creates a smaller dispersal area.

Every owner who wants to construct a new sewage disposal system, or alter or repair an existing one, must do so according to the Public Health Act and the Sewerage System Regulation of the nation. An owner must use the services of an authorized professional engineer or a registered onsite wastewater practitioner (ROWP) to construct, alter or repair a sewage disposal system. As Anderson, Rosemarin, Lamizana, Kvarnstrom, McConville, Seidu, Dickin and Trimmer (2016),would explain, there are 3 categories of RQWPs: planner, installer and maintenance provider. A person may be registered in more than 1 category and provide several services. The authorized person assesses both the owner's needs and the capability of the land for sewage treatment and dispersal. They would then plan an onsite sewage system that meets those needs. Once the plan is filed with the health authority, an authorized person installs the system. When the installation is complete, the authorized person certifies that the system was installed according to the plan. They would then provide a maintenance plan and an 'as-constructed' drawing of the system components to the owner and the health authority.

For most cities, the sewer system will also carry a proportion of industrial effluent to the sewage treatment plant which has usually received pre-treatment at the factories themselves to reduce the pollutant load. As Andersson, Rosemarin, Lamizana, Kvarnstrom, McConville, Seidu, Dickin and Trimmer (2016), would note, if the sewer system is a combined sewer then it will also carry urban runoff (storm water) to the sewage treatment plant. Sewage water can travel towards treatment plants via piping and in a flow aided by gravity and pumps. The first part of filtration of sewage typically includes a bar screen to filter solids and large objects which are then collected in dumpsters and disposed of in landfills. Fat and grease is also removed before the primary treatment of sewage.

Reuse of Treated or Untreated Sewage

Increasingly, agriculture is using untreated wastewater for irrigation. Cities provide lucrative markets for fresh produce, so are attractive to farmers. However, because agriculture has to compete for increasingly scarce water resources with industry and municipal users, there is often no alternative for farmers but to use water polluted with urban waste, including sewage, directly to water their crops. There can be significant health hazards related to using water loaded with pathogens in this way, especially if people eat raw vegetables that have been irrigated with the polluted water. The words "sewage" and "sewer" came from Old French *essouier* "to drain", which came from Latin word *exaqudre.* Their formal Latin antecedents are *exaquaticum* and *exaquarium.* Both words are descended from Old French *assewer,* derived from the Latin *exaquare,* "to drain out (water)".

Servicing a Sewage Disposal System

Once the sewage system is working, it is the homeowner's responsibility to ensure that the maintenance plan is followed. Improper or insufficient (not enough) maintenance may result in system failure, and require costly repairs or replacement of the system. A failing sewage system can also contaminate local drinking water sources which can cause serious illness in people. In the words of *World Health Organization (2016), t* is important to have an accurate drawing that shows the location of all parts of the sewage system so you and your maintenance provider can find them. For sewage systems constructed under the Sewerage System Regulation, this 'as-constructed' drawing will be provided by the authorized person at the time it is installed. All sewage systems need ongoing and proper operation and maintenance.

Sewage Mixing with Rainwater

Sewage may include stormwater runoff or urban runoff. Sewerage systems capable of handling storm water are known as combined sewer systems. As explains Water and Environmental Health at London and Loughborough (2018),,this design was common when urban sewerage systems were first developed, in the late 19th and early 20th centuries. Combined sewers require much larger and more expensive treatment facilities than sanitary sewers. Heavy volumes of storm runoff hints Walker, James D. and Welles Products Corporation (2016), may overwhelm the sewage treatment system, causing a spill or overflow, adding that sanitary sewers are typically much smaller than combined sewers, and they are not designed to transport stormwater, further alleging that backups of raw sewage can occur if excessive infiltration/inflow (dilution by stormwater and/or groundwater) is allowed into a sanitary sewer system. In the words of *Tchobanoglous, George; Burton, Franklin L; Stensel and David* (2023J,communities that have urbanized in the mid-20th century or later generally have built separate systems for sewage (sanitary sewers) and stormwater, because precipitation causes widely varying flows, reducing sewage treatment plant efficiency. As rainfall travels over roofs and the ground, it may pick up various contaminants including soil particles and other sediment, heavy metals, organic compounds, animal waste, and oil and grease. Some jurisdictions require stormwater to receive some level of treatment before being discharged directly into waterways. Industrial wastewater may contain pollutants which cannot be removed by conventional sewage treatment Also, variable flow of industrial waste associated with production cycles may upset the population dynamics of biological treatment units, such as the activated sludge process.

Process Steps (Stages) in Sewage Treatment

Randall, Clifford W. and Dipankar (2016), asserts that sewage treatment generally involves three stages, called primary, secondary and tertiary treatment. *Primary treatment he notes,* consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment. Some sewage treatment plants that are connected to a combined sewer system have a bypass arrangement after the primary treatment unit. This means that during very heavy rainfall events, the secondary and tertiary treatment systems can be bypassed to protect them from hydraulic overloading, and the mixture of sewage and stormwater only receives primary treatment. *Secondary treatment alleges Margot (2 013),removes* dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water-borne micro-organisms in a managed habitat. Secondary treatment may require a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment. Secondary treatment further explain *Logan and Regan (2016) ,* is a treatment process for wastewater (or sewage) to achieve a certain degree of effluent quality by using a sewage treatment plant with physical phase separation to remove settleable solids and a ... biological process to remove dissolved and suspended organic compounds. After this kind of treatment, the wastewater may be called as secondary-treated wastewater. Secondary treatment is the portion of a sewage treatment sequence removing dissolved and colloidal compounds measured as biochemical oxygen demand (BOD). Secondary treatment is traditionally applied to the liquid portion of sewage after primary treatment has removed settleable solids and floating material. Secondary treatment is typically performed by indigenous, aquatic microorganisms in a managed aerobic habitat. Bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, and organic short-chain carbon molecules from human waste, food waste, soaps and detergent) while reproducing to form cells of biological solids. Biological oxidation processes are sensitive to temperature and, between 0 °C and 40 °C, the rate of biological reactions increase with temperature. Most surface aerated vessels operate at between 4 °C and 32 °C.

Tertiary treatment notes *Lienert; Burki and Escher (2017)* is sometimes defined as anything more than primary and secondary treatment in order to allow ejection into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers, coral reefs,...)- Treated water is sometimes disinfected chemically or physically (for example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes. The purpose of tertiary treatment {also called "advanced treatment") illustrates *Khopkar (2014),is* to provide a final treatment stage to further improve the effluent quality before it is discharged to the receiving environment (sea, river, lake, wet lands, ground, etc.). Tertiary treatment may include biological nutrient removal (alternatively, this can be classified as secondary treatment), disinfection and removal of micro pollutants, such as environmental persistent pharmaceutical pollutants.

Odour Control

Odors emitted by sewage treatment are typically an indication of an anaerobic or "septic" condition. As Huber and Berching (2012), would explain, early stages of processing will tend to produce foul-smelling gases, with hydrogen sulfide being most common in generating complaints. Large process plants in urban areas will often treat the odors with carbon reactors, a contact media with bio-slimes, small doses of chlorine, or circulating fluids to biologically capture and metabolize the noxious gases. Other methods of odor control exist, including addition of iron salts, hydrogen peroxide, calcium nitrate, etc. to manage hydrogen sulfide levels. High-density solids pumps are suitable for reducing odors by conveying sludge through hermetic closed pipe work.

Sludge Treatment and Disposal

The sludge accumulated in a wastewater treatment process explains *Haughey (2018),* must be treated and disposed of in a safe and effective manner. The purpose of digestion is to reduce the amount of organic matter and the number of disease-causing microorganisms present in the solids. The most common treatment options include anaerobic digestion, aerobic digestion, and composting. Incineration is also used, albeit to a much lesser degree. Sludge treatment note *Harshman, Vaughon; Barnette and Tony (2018),* depends on the amount of solids generated and other site-specific conditions. Composting is most often applied to small-scale plants with aerobic digestion for mid-sized operations, and anaerobic digestion for the larger-scale operations. The sludge is sometimes passed through a so-called pre-thickener which de-waters the sludge. Types of pre-thickeners note *Harhangi,.; Le Roy; Van Alen* ; *Hu,.; Groen; Kartal; Tringe,; Quan, ;Jetten and Den- Camp (2012),* include centrifugal sludge thickeners rotary drum sludge thickeners and belt filter presses. Dewatered sludge may be incinerated or transported offsite for disposal in a landfill or use as an agricultural soil amendment.

Population Density in City Squalors and Sewage Disposal

The rural poor may lack nutrition, health care, education, and infrastructure but they can farm still in settings that represent the condition of most of humanity for most of history. *As Kenny(2018), there are two reasons for choosing to live in urban slums:*

1- Because slums are better than the alternative

As Kenny would posit further, most people who have experienced both rural and urban poverty choose to stay in slums rather than move back to the countryside. That includes hundreds of millions of people in the developing world over the past few decades, including 130 million migrant workers in China alone. They follow a well-trodden path of seeking a better life in the bright lights of the city and in this new century, the probability of living a better life is better than ever. For some African countries that are currently experiencing a sustained economic growth like Nigeria, Kenny states, the story is the same.

2 - Start with the simple reason that most people leave the countryside: money

Moving to cities makes economic sense. Rich countries are urbanized countries, and rich people are predominantly town and city dwellers. According to the McKinsey Global Institute (2017), 600 cities worldwide account for 60% of global economic output . Slum dwellers may be at the bottom of the urban heap, but most are better off than their rural counterparts. As Edmondson (2012), would state Dos *and Tapas (2011), while about half the world's population is urban, only a quarter of those living on less than a dollar a day live in urban areas.*

Theoretical Framework

1. **Eva Pongracz, Paul Phillips and Riitta Keiski Theory of Waste Minimization (2014)**

The Theory of Waste Management is a unified body of knowledge about waste and waste management, and it is founded on the expectation that waste management is to prevent waste to cause harm to human health and the environment and promote resource use optimization. The Theory is constructed under the paradigm of Industrial Ecology as Industrial Ecology is equally adaptable to incorporate waste minimization and/or resource use optimization goals and values. The Theory is thought of as formulated within a lingustic framework of a clear specified logical structure, which determines, in particular, the rules of deductive inference. The first aspect of the theory belongs to the situation that places re-use, the application of the definition of waste to end-of- life vehicles. The second phase belongs to treated construction and demolition waste. The theory reminds that Re-use happens when a thing that has just performed its purpose and momentarily no new purpose is assigned to it, noting that a thing that has fulfilled its purpose is not necessarily useless. It is because usefulness is defined by structure and state, while re-use is subject of purpose. The theory asserts that as long as structure and state allow performance with respect to the assigned purpose, re-usable things shall not be considered wastes. An empty bottle for instance, whose Structure is undamaged is thus a useful non-waste. The Theory affirms that loss of performance can be attributable to the inability of one or several structural parts to perform their purpose. Repair or changing the faulty structural parts can extend useful life. The theory alleges that Reduction of waste by application of more efficient production technologies I ideal. The theory affirms also that every product should be designed so that it can be used to create other useful products at the end of its life. The theory notes that Waste minimization should use resources to optimize Prevention of waste creation.

2. Kharbanda and Stallworthy Theory of Zero Waste Tollerance (1990)

They defined waste as anything unusable, unwanted and unrecyclable adding that Zero waste is a visionary goal for everybody and city of people. Waste must be avoided, not minimized or reduced, they enthused, noting that waste is evidence of poor design that must be avoided and not just minimized. Zero Waste involves moving from the back end of waste disposal to the front end of resource management. If a product cannot be reused, repaired, rebuilt, refurbished, refinished, resold, recycled or composted, then it should be restricted, redesigned, or removed from production line. They stipulate that zero waste involves utilizing the precautionary principle to eliminating potential toxins. They advocate the use of adherence to the principle of highest and best use as optimization principle. They also emphasize the recognizing and addressing of institutional and ideological barriers that lead to waste accumulation. In harnessing the maxim of avoiding waste and not just minimizing or reducing it, they said "Waste that is not generated cannot create any problems making non-generation the cheapest waste handling measure. Recovery is good but avoidance is best. Reduction is potentially more dangerous; Zero is a perpetual goal".

Empirical Analysis

Moha (2017) conducted a secondary research on how sewage disposal system of oh-site has affected health of Ngwa Road Sqalor dwellers in Aba City by using data collected from Abia State Ministry of health between 1995 - 2015. It was discovered that squalor dwellers abuse the on -site sewage disposal system, which prompted the recommendation that lagoons system be adopted. Chimere (2018) conducted a regression research on how sewage system disposal of lagoon deposit has improved sewage disposal system of Trans Ekulu environ of Enugu State between 2000 to 2016 from data collected from Enugu State Ministry of Health. It was discovered that lagoon system of sewage disposal, though very neat and cheaper to operate, is often abused as health workers neglect routine repairs on the laid sewage pipes which obedience must be made to percolate down to the ordinary people. In the empirical analysis, Moha (2017) did not point out the fact that Builders destroy laid sewage disposal pipes and often fail to repair them which leads to pollution and health hazards.

Area of Study

Enugu Metropolis lies within 221m and 317m above sea level. It is located on latitude $70^0 29^1$E and longitude 60^0 25^1N. It is located within the guinea savanna region. Enugu lies on the upper stretches of the Cross River plain. Enugu Metropolis is bounded in the North by Enugu East LGA; South by Nkanu LGA; East by Udi LGA and West by Emene. The Metropolis is generally surrounded by a rolling escarpment in the nature of eastern scarpland. Presently in Enugu Metropolis many land uses exist but largely unplanned. It is even worsened by poor environmental quality caused by industrial establishment, and poor refuse disposal among others (Agu 1999). The temperature and rainfall patterns follow the average pattern: high and equable temperature with corresponding high rainfall (75^0F and > 2000mm) respectively.

Enugu Metropolis has a population of about 722 664 (NPC 2006). It also has a total land area of 556km^2 leaving a population density of about 1,300 persons per km^2.

The gradual growth of industrial processes and production over the last few decades meant that industrial and domestic wastes now contribute to the overall waste regime in the Metropolis contributing to environmental degradation in the area.

Research Methodology

Research Design

The topic of the research is-sewage disposal system and human health in densely populated city squalors. a study of Obiagu and Abakpa in Enugu city. The research adopted survey design which addressed respondents from Enugu State Ministry of Health as well as Enugu State Environmental Waste Management Agency (ESWAMA). The research used interviews and questionnaire to gather relevant pieces of information on sewage disposal systems from the respondents.

The study was carried out in Enugu Metropolis in ESWAMA and Enugu State Ministry of Health.

Population of the Study

The population of the study is five hundred and thirty (5 30) workers of Enugu State Ministry of Health and ESWAMA, distributed as follows:

ESWAMA	310
Enugu State Ministry of Health	220
Total	530

Sample Size Determination and Distribution

The Sample size is two hundred and twenty eight (228). It is determined from Yameni's Statistical Distribution Formula

$N \div 1 + Ne^2$

Where

N= 450, e= sampling error taken at 5% and 1=statistical constant 212 which is distributed to the respondent as:

ESWAMA	310-530x228 =	134
Enugu State Ministry of Health	220-530x228 =	94
Total		228

The research adopted simple random sampling technique which did not discriminate any respondent.

Methods of Data Analysis

Simple content analysis was adopted in analyzing the research questions. After the analysis, simple percentage distribution was used to present the responses and in reporting the responses. Sample size Statistic was used in testing the hypotheses. In all, primary data analysis was adopted by the use of parametric analysis.

Data Presentation and Analysis

The hypotheses were tested using Sample Mean difference statistics of:

$Z = (x - \mu) \div s$

Where Z = Sampling Statistic

x = sampling mean

μ = population mean

s = sample standard deviation

H_1: On-site sewage disposal system negatively affects human health in densely populated city sqalors like Obiagu and Abakpa in Enugu Metropolis.

After variable substitution and calculation, it is computed that calculated value of Z is 1.70 which is greater than the table value of 1.65, which implies that On-site sewage disposal system negatively affect human health in densely populated city squalors like Obiagu and Abakpa in the study area.

$H_{2:}$ Lagoon sewage disposal system positively correlates with human health in densely populated city squalors of Obiagu and Abakpa in the study area.

After variable substitution and calculation, it is computed that calculated value of Z is 1.66 which is greater than the table value of 1.65, which implies that Lagoon sewage disposal system positively correlate with human health in densely populated city squalors like Obiagu and Abakpa in Enugu Metropolis.

Summary of Findings, Discussion of Results Conclusion and Recommendations

Summary of Findings

After the testing of the hypotheses, it was discovered that:

a. On-site sewage disposal system negatively affect human health in densely populated city squalors of Obiagu and Abakpa in the study area.

b. Lagoon sewage disposal system positively correlate with human health in densely populated city squalors of Obiagu and Abakpa in the study area.

Discussion of Results

The study discovered that On-site sewage disposal system negatively affects human health in densely populated city squalors of Obiagu and Abakpa in Enugu Metropolis. This tallies with the observation of Obiekwe (2018) in the literature review that sewage disposal has been most neglected in Nigerian cities to the extent that slush are seen messing up the street from broken sewage pipes. The study found out that Lagoon sewage disposal system positively correlate with human health in densely populated city squalors of Obiagu and Abakpa in Enugu Metropolis. This is in tandem with the view in literature review of Kanu(2018) that sewage disposal system should adopt the lagoon system and neatly follow up to be constantly checking breakage of pipes.

Conclusion

Sewage disposal maybe by on-site or lagoon. Many homes adopt the on -site disposal technique because the relative easiness and less financial encumbrance. But the danger of cutting corners by not doing them well is another thing. Domestic sewage, produced in urban residences, institutions, and businesses, is usually collected by pipes and conduits called sanitary sewers, which lead to a central discharge point. In rural residences domestic sewage is often collected in a septic tank on the property. Industrial wastes, which consist of liquids produced in manufacturing processes, are sometimes collected in sanitary sewers, but the nature of many industrial wastes may make it dangerous or difficult to do so. In the words of *Corcoran, Nellemann, Baker, Bos, Osborn and* Save *(2010),* often industries dispose of their own wastes. Storm sewage, which comes from rain and groundwater, is collected either in a storm sewer or, with domestic sewage and industrial wastes, in what is called a combined sewer.

Recommendations

In view of the finding of the research, is recommended, therefore, that:

a. On-site sewage disposal system should be made compulsory in densely populated city squalors of Obiagu and Abakpa in Enugu Metropolis.

b. Lagoon sewage disposal system should be adopted by to improve human health in densely populated city squalors of Obiagu and Abakpa in the study area.

c. Sewage systems should be inspected every year, and they usually need servicing every 2 to 5 years, depending on the number of people using the system and the volume of daily sewage flow.

d. Homeowners should consult an authorized person or the sewage system maintenance plans for specific monitoring and maintenance requirements.

e. An owner of a sewage system should contact an authorized person to set up an annual service contract.

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