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Landscaping as a strategy for curbing Air Pollution and Environmental degradation in Enugu Metropolis

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Abstract

Air pollution, will remain a menace to the livelihood on this planet. What's important is how it is addressed. The study examined landscaping as a strategy for combating air pollution and environmental degradation in Enugu metropolis. The methodology adopted by this study comprised field survey and review of relation literature for purpose of collecting primary and secondary data respectively. Structured questionnaire was used to collect primary data from 400 city residents of Enugu which was sampled from 775,374 estimated population of Enugu urban using the Yaro Yamanne sampling model. The two hypotheses put forward in the study were tested using two inferential statistics known as Spearman Rank Order Correlation Analysis and One-way Analysis of Variance (ANOVA) using SPSS Version 16. Both result showed that the hypotheses were disqualified, hence with alternative hypotheses proffered. Hence, recommendations were not far from admitting the need for higher air pollution measures, from government intervention, public enlightenment, and regulation of emissions from traffic, factories, and domestic activities among others.

Keywords: *Air pollution, degradation, landscaping, pollutants, environment*

1. Introduction

"Man has been endowed with reason, with the power to create, so that he can add to what he's been given. But up to now, he hasn't been a creator, only a destroyer. Forests keep disappearing, rivers dry up, wildlife's become extinct, the climate's ruined and the land grows poorer and uglier every day."- Anton Chekhov (1860 - 1904) (Uncle Vanya, 1897)

"As crude a weapon as the cave man's club, the chemical barrage has been hurled against the fabric of life."- Rachel Carson (1907 - 1964) U.S. ecologist.

"We live in a land of vanishing beauty, of increasing ugliness, of shrinking open space, and of an overall environment that is diminished daily by pollution and noise and blight." - Stewart L. Udall (1920 -) U.S. politician and conservationist. Referring to the United States. (*The Quiet Crisis*)

"The emergence of intelligence, I am convinced, tends to unbalance the ecology. In other words, intelligence is the great polluter. It is not until a creature begins to manage its environment that nature is thrown into disorder."- Clifford D. Simak (1904 - 1988) U.S. writer. (*Shakespeare's Planet*)

These are some but few of opinions carried in the hearts of men concerning the deteriorating effects of man's activity which commonly leads to pollution. Pollution is not new to any individual on the planet, it is observed everywhere, whether consciously or unconsciously by the individual(s) or on a micro or macro scale based on the surrounding environment.

"Pollution, can be viewed as the contamination of Earth's environment with materials that interfere with human health, the quality of life,

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or the natural functioning of *ecosystems* (living organisms and their physical surroundings). Although some environmental pollution is a result of natural causes such as volcanic eruptions, most is caused by human activities" (Microsoft Encarta Premium, 2009).

As viewed from the above definition, pollution is emphasized as the result of materials, which interfere, with the health of both humans and other living organisms, the quality of life (living conditions) and altering the existing state and functionality of the various ecosystems. Hence, pollution, further stated, is the relocation of harmful materials to places of incompatibility i.e. based on the different strata of the earth (atmosphere, lithosphere, hydrosphere, lithosphere), giving a negative effect on all constituents of the environment.

Landscaping, on the other hand, is the art of enhancing the appearance of land, especially around buildings, by altering its contours and planting trees, shrubs, and flowers (Redmond, 2008). In Nigeria, for example, it is considered a thing of luxury having a consciously landscaped property. It is not seen as an important addition to the environment. In approval of building plans, major attention is paid to the structural attributes, but not the environmental benefits. The purpose was to drive the forgotten importance of greenery in our society, as it would pose an additional advantage at curbing air pollution. This paper examined the major effects air pollution and environmental degradation, and conscious application of landscaping activities, as a strategy for combating the former in Enugu metropolis of Nigeria.

Objectives of the Study

i. To identify the factors that determines air pollution in Enugu

ii. To examine the effects of air pollution on the surrounding environment

iii. To identify the problems associated with already existing air pollution control measures

vi. To examine if there is significant relationship that exists between Enugu Metropolis neighborhood's grade of landscaped architecture and the prevalent of air pollution related ailments.

v. To examine if there are significant differences in the occurrence of air pollution-related ailments around the neighborhoods of Enugu metropolis.

Research Hypotheses

H_1 - There is no significant relationship between the areas in Enugu Metropolis that are lowly landscaped and the prevalence of air pollution-related ailments.

H_2- There is no significant difference in the occurrence of air-pollution-related ailments around the grades of vegetative belt in Enugu metropolis.

Conceptual Framework

- **Air Pollution**

According to Woodford (2010), air let's our living planet breathe—it is the mixture of gases that fills the atmosphere, giving life to the plants and animals that make the Earth such a vibrant place. Broadly speaking, air is almost entirely made up of two gases (78 percent nitrogen and 21 percent oxygen), with a few other gases (such as carbon dioxide and argon) present in absolutely minute quantities. We can breathe ordinary air all day long with no ill effects. Other planets have sunlight, but the Earth is the only planet we know that has air and water. Without air and water, the Earth would be unable to sustain life. A diverse community of plants and animals has thrived on this planet for millions of years, sustained by the sun and supported by the soil, water and air. Air pollution has varied definitions from all walks of life. Generally, air pollution is perceived as a gas, liquid or solid dispersed through ordinary air in a big enough quantity to harm the health of people or other animals, kill plants or stop them from growing properly, damage or disrupt some other aspect of the environment (such as making buildings crumble), or cause some other kinds of nuisance (reduced visibility, perhaps, or an unpleasant odor). The views vary, when it comes to describing the major cause of air pollution, which depends on the context used (Woodford, 2010).

- Air Pollution is the introduction of particulates, biological molecules, or other harmful gases into the Earth's atmosphere thereby causing diseases, death to humans or damage to other living organisms such as food crops, the natural or built environment (Wikipedia, 2015).
- Air pollution means contamination of air by smoke and harmful gases, mainly oxides of carbon, Sulphur, and nitrogen. (The American Stedman's Medical Dictionary, 2015)
- Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution. (W.H.O. – World Health Organization, 2015)

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- Air pollution may be described as contamination of the atmosphere by gaseous, liquid, or solid wastes or by-products that can endanger human health and welfare of plants and animals, attack materials, reduce visibility or produce undesirable odors.

- **Pollutants**

It is important to note that pollution, especially air pollution, cannot be actualized without the presence and influence of agents of pollution, otherwise known as *pollutants*. Pollutants can simply be described as something causing pollution; a substance that pollutes something, e.g. a chemical or waste product contaminating the air, soil, or water. Air pollutants mainly occur as a result of gaseous discharges from industry and motor vehicles. These problems are very complex, and require international cooperative efforts to find solutions.

Pollutants can be classified into two:

a. Primary pollutants: are substances that are directly emitted into the atmosphere from sources. The main primary pollutants known to cause harm in high enough concentrations are the following:

i. Carbon compounds, such as CO, CO_2, CH_4, and VOCs

ii. Nitrogen compounds, such as NO, N_2O, and NH_3

iii. Sulfur compounds, such as H_2S and SO_2

iv. Halogen compounds, such as chlorides, fluorides, and bromides

v. Particulate Matter (PM or "aerosols"), either in solid or liquid form.

b. Secondary pollutants: Secondary pollutants are not directly emitted from sources, but instead form in the atmosphere from primary pollutants (also called "precursors"). The main secondary pollutants known to cause harm in high enough concentrations are the following:

i. NO_2 and HNO_3 formed from NO

ii. Ozone (O_3) formed from photochemical reactions of nitrogen oxides and VOCs

iii. Sulfuric acid droplets formed from SO_2, and nitric acid droplets formed from NO2

iv. Sulfates and nitrates aerosols (e.g., ammonium (bi)sulfate and ammonium nitrate) formed from reactions of sulfuric acid droplets and nitric acid droplets with NH_3, respectively

v. Organic aerosols formed from VOCs(Volatile Organic Compounds)in gas-to-particle reactions

Also, air pollutants are of two types/ forms: -

a. Suspended particulate matter, and

b. Gaseous pollutants like carbon dioxide (CO_2), etc.

(WHO, 2014)

A. Suspended Particulate Matter

These are dust and soot released from the industrial chimneys. Major source of SPM (suspended particulate matter) are vehicles, power plants, construction activities, oil refinery, railway yard, market place, industries, etc.

i. Fly ash

Fly ash is ejected mostly by thermal power plants as byproducts of coal burning operations. Fly ash pollutes air and water and may cause heavy metal pollution in water bodies. Fly ash affects vegetation as a result of its direct deposition on leaf surfaces or indirectly through its deposition on soil. Fly ash is now being used for making bricks and as a land fill material.

ii. Lead and other metals particles

Tetraethyl lead (TEL) is used as an anti-knock agent in petrol for smooth and easy running of vehicles. The lead particles coming out from the exhaust pipes of vehicles are mixed with air. If inhaled it produces injurious effects on kidney and liver and interferes with development of red blood cells. Lead mixed with water and food can create cumulative poisoning. It has long term effects on children as it lowers intelligence. They create physiological, biochemical and developmental disorders in plants and also contribute towards reproductive failure in plants. (Hart 2008)

B. Gaseous Pollutants

Power plants, industries, different types of vehicles – both private and commercial use petrol, diesel as fuel and release gaseous pollutants such as carbon dioxide, oxides of nitrogen and Sulphur dioxide along with particulate matter in the form of smoke. All of these have harmful effects on plants and humans (C.E.I., 2002).

i. Carbon compound (CO and CO_2) - this is commonly gotten from automobile exhaust, burning of wood and coal. The effect of this contaminant is Greenhouse effect and also, respiratory problems among organisms and human beings also (Hart, 2008).

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ii. Sulphur compounds (SO_2 and H_20) - gotten mostly from the waste of power plants and refineries, and volcanic eruptions. The impacts of this compounds results in loss of chlorophyll in plants (chlorosis), Respiratory problems in humans and acid rain (Hart, 2008).

iii. Nitrogen Compound (NO and N_2O) – produced from motor vehicle's exhaust atmospheric reaction. This is common in areas with high transportation activity. The resultant effect is Irritation in eyes and lungs, low productivity in plants & acid rain damages material (metals and stone). (Hart, 2008)

iv. Hydrocarbons (benzene, ethylene) – these are wastes, which are gotten from automobiles and petroleum industries. Common problems caused by this pollutant are respiratory problems and cancer causing properties.(Hart, 2008)

v. SPM (Suspended Thermal power plants, Particulate Matter) (Any solid and liquid) particles suspended in the air, (flush, dust, lead), which originates mostly from construction activities, metallurgical processes and automobiles. Hence, consequences of this pollutant can be: - Lead interferes with the development of red blood diseases and cancer, Smog (smoke & fog) formation leads to poor visibility and aggravates asthma in patients, Poor visibility & breathing problems.(Hart, 2008)

vi. Fibers (Cotton, wool). Commonly gotten from textiles and carpet weaving industries. Mostly Lung disorders occur as an effect of this pollutant (Hart, 2008).

Causes of Air Pollution

Air pollution can result from both human and natural actions. Natural events that pollute the air include forest fires, volcanic eruptions, wind erosion, pollen dispersal, evaporation of organic compounds and natural radioactivity. Pollution from natural occurrences are not very often. Human activities that result in air pollution include:

i. *Burning of Fossil Fuels:* Sulfur dioxide emitted from the combustion of fossil fuels like coal, petroleum and other factory combustibles is one the major cause of air pollution. Pollution emitting from vehicles including trucks, jeeps, cars, trains, airplanes cause immense amount of pollution. Fumes from car exhaust contain dangerous gases such as carbon monoxide, oxides of nitrogen, hydrocarbons and particulates. On their own, they cause great harm to people who breathe them.

ii. *Agricultural Activities:* Ammonia is a very common by product from agriculture related activities and is one of the most hazardous gases in the atmosphere. Use of insecticides, pesticides and fertilizers in agricultural activities has grown quite a lot. They emit harmful chemicals into the air and can also cause water pollution (C.E.F., 2015).

iii. *Exhaust from factories and industries:* Manufacturing industries release large amount of carbon monoxide, hydrocarbons, organic compounds, and chemicals into the air thereby depleting the quality of air. Manufacturing industries can be found at every corner of the earth and there is no area that has not been affected by it. Petroleum refineries also release hydrocarbons and various other chemicals that pollute the air and also cause land pollution.

iv. *Mining operations:* Mining is a process wherein minerals below the earth are extracted using large equipment. During the process dust and chemicals are released in the air causing massive air pollution. This is one of the reason which is responsible for the deteriorating health conditions of workers and nearby residents (C.E.F, 2015).

v. *Indoor air pollution:* Household cleaning products, painting supplies emit toxic chemicals in the air and cause air pollution, farming chemicals crop dusting, fumigating homes, over the counter insect/pest killers, fertilizer dust emit harmful chemicals into the air and cause pollution. In many case, when we use these chemicals at home or offices with no or little ventilation, we may fall ill if we breathe them (C.E.F., 2015).

Effects of Air Pollution

Below are a few key effects of air pollution.

i. **Acidification**: Chemical reactions involving air pollutants can create acidic compounds which can cause harm to vegetation and buildings. Sometimes, when an air pollutant, such as sulfuric acid combines with the water droplets that make up clouds, the water droplets become acidic, forming acid rain. When acid rain falls over an area, it can kill trees and harm animals, fish, and other wildlife. Acid rain acidification for children Acid rain destroys the leaves of plants. When acid rain infiltrates into soils, it changes the chemistry of the soil making it unfit for many living things that rely on soil as a habitat or for nutrition. Acid rain also changes the chemistry of the lakes and streams that the rainwater flows into, harming fish and other aquatic life (WHO, 2010).

ii. **Eutrophication:** Rain can carry and deposit the Nitrogen in some pollutants on rivers and soils. This will adversely affect the nutrients in the soil and water bodies. This can result in algae growth in lakes and water bodies, and make conditions for other living organism harmful (WHO, 2010).

iii. **Ground-level ozone:** Chemical reactions involving air pollutants create a poisonous gas ozone (O3). Gas Ozone can affect

people's health and can damage vegetation types and some animal life too (WHO, 2010).

iv. **Particulate matter**: Air pollutants can be in the form of particulate matter which can be very harmful to our health. The level of effect usually depends on the length of time of exposure, as well the kind and concentration of chemicals and particles exposed to. Short-term effects include irritation to the eyes, nose and throat, and upper respiratory infections such as bronchitis and pneumonia. Others include headaches, nausea, and allergic reactions. Long-term health effects can include chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys. Continual exposure to air pollution affects the lungs of growing children and may aggravate or complicate medical conditions in the elderly (WHO, 2010).

Environmental Degradation

Bury (1999) posits that environmental degradation is the deterioration of the environment through depletion of resources such as air, water, and soil, the destruction of ecosystems and the extinction of wildlife. Environmental degradation can occur naturally, or through human processes. The largest areas of concern at present are the loss of rain forest, air pollution and smog, ozone depletion, and the destruction of the marine environment (Etuonovbe, 2009). Environmental degradation is the disintegration of the earth or deterioration of the environment through consumption of assets, for example, air, water and soil; the destruction of environments and the eradication of wildlife (Kannuri, 2015).

Causes of Environmental Degradation

i. **Land Disturbance:** A more basic cause of environmental degradation is land damage. Numerous weedy plant species, for example, garlic mustard, are both foreign and obtrusive. A rupture in the environmental surroundings provides for them a chance to start growing and spreading. These plants can assume control over nature, eliminating the local greenery. The result is territory with a solitary predominant plant which doesn't give satisfactory food assets to all the environmental life. Whole environments can be destroyed because of these invasive species.

ii. **Pollution:** Pollution, in whatever form, whether it is air, water, land or noise is harmful for the environment. Air pollution pollutes the air that we breathe which causes health issues. Water pollution degrades the quality of water that we use for drinking purposes. Land pollution results in degradation of earth's surface as a result of human activities. Noise pollution can cause irreparable damage to our ears when exposed to continuous large sounds like honking of vehicles on a busy road or machines producing large noise in a factory or a mill.

iii. **Overpopulation:** Rapid population growth puts strain on natural resources which results in degradation of our environment. Mortality rate has gone down due to better medical facilities which have resulted in increased lifespan. More population simple means more demand for food, clothes and shelter. You need more space to grow food and provide homes to millions of people. This results in deforestation which is another factor of environmental degradation.

iv. **Landfills:** Landfills pollute the environment and destroy the beauty of the city. Landfills come within the city due the large amount of waste that gets generated by households, industries, factories and hospitals. Landfills pose a great risk to the health of the environment and the people who live there. Landfills produce foul smell when burned and cause huge environmental degradation.

v. **Deforestation:** Deforestation is the cutting down of trees to make way for more homes and industries. Rapid growth in population and urban sprawl are two of the major causes of deforestation. Apart from that, use of forest land for agriculture, animal grazing, gathering of fuel wood and logging are some of the other causes of deforestation. Deforestation contributes to global warming as decreased forest size puts carbon back into the environment.

vi. **Natural Causes:** Things like avalanches, quakes, tidal waves, storms, and wildfires can totally crush nearby animal and plant groups to the point where they can no longer survive in those areas.While environmental degradation is most normally connected with the things that people do, the truth of the matter is that the environment is always changing. With or without the effect of human exercises, a few biological systems degrade to the point where they can't help the life that is supposed to live there (Kannuri, 2015).

Effects of Environmental Degradation

i. **Impact on Human Health:** Human health might be at the receiving end as a result of the environmental degradation. Areas exposed to toxic air pollutants can cause respiratory problems like pneumonia and asthma. Millions of people are known to have died of due to indirect effects of air pollution (C.E.F., 2015).

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ii. **Loss of Biodiversity:** Biodiversity is important for maintaining balance of the ecosystem in the form of combating pollution, restoring nutrients, protecting water sources and stabilizing climate. Deforestation, global warming, overpopulation and pollution are few of the major causes for loss of biodiversity (C.E.F, 2015).

iii. **Ozone Layer Depletion:** Ozone layer is responsible for protecting earth from harmful ultraviolet rays. The presence of chlorofluorocarbons, hydro chlorofluorocarbons in the atmosphere is causing the ozone layer to deplete. As it will deplete, it will emit harmful radiations back to the earth (C.E.F, 2015).

iv. **Loss for Tourism Industry:** The deterioration of environment can be a huge setback for tourism industry that rely on tourists for their daily livelihood. Environmental damage in the form of loss of green cover, loss of biodiversity, huge landfills, increased air and water pollution can be a big turn off for most of the tourists (C.E.F., 2015).

v. Economic Impact: The huge cost that a country may have to borne due to environmental degradation can have big economic impact in terms of restoration of green cover, cleaning up of landfills and protection of endangered species. The economic impact can also be in terms of loss of tourism industry. A lot of things can have an effect on the environment. If we are not careful, we can contribute to the environmental degradation that is occurring all around the world (C.E.F., 2015).

Landscaping

Otherwise known as landscape architecture, landscaping is the science and art of modifying land areas by organizing natural, cultivated, or constructed elements according to a comprehensive, aesthetic plan (Microsoft Encarta, 2000). No unalterable rules exist in landscape architecture because each plot of ground offers unique problems caused by variation in contour, climate, and surrounding areas. According to Microsoft Encarta (2009), landscape architecture was formerly called Landscape gardening and was limited to the creation of gardens around private dwellings. Today landscape architecture covers a much wider area of concerns, ranging from the setting out of small gardens to the ordering of parks, malls, and highways. It includes landscape gardening, which is now understood as the work done by commercial gardeners, who install and care for flowers and greenery according to the design of landscape architects.

Benefits of Landscaping

a. Environmental benefits: - Trees, shrubs, hedges and flowers offer substantial environmental benefits, because vegetation like this protects water supplies, provides food (in the form of vegetable gardens), and reduces air pollution by absorbing carbon dioxide and releasing oxygen. Having your garden landscaped can also reduce noise pollution in your home by blocking out surrounding noises. Other reasons for landscaping are reduction of storm water runoff thereby reducing flooding. Also, in controlling extreme temperature, so as to stay cooler in summer and warmer in winter. Landscaping is also beneficial in the act of Erosion control, reducing loss of soils in waterways. Important also is the use of landscaping in to gain reduction in evaporation and also, soil degradation (Marc-Frank, 2003).

b. Improving Biodiversity: - Landscaping provides food and shelter for the insects, birds and animals that evolved along with them. Development has resulted in significant clearing of natural areas and fragmentation of wildlife habitat. In managing our private and public lands, we can provide food, shelter, water and connectivity to mitigate loss, stemming from activities like deforestation (Novak, 2003).

c. Health reasons: - Creates a healthier environment, by filtering pollutants and providing cleaner air. It helps to keep the inhabitants of the environment fit by fostering an active lifestyle. It also creates a beautiful environment harmful to those factors that promote stress and all other health challenges and also provides privacy for individuals (Novak, 2003).

d. Economic reasons: - Landscaping Increases the economic value of properties. It also increases investment in the environment it is concerned with, because of certain attributes that landscaping adds to physical development (Novak, 2003).

e. Social reasons: By creating green buffer zones, it increases the livability of our communities. Noticeable also is convinced reduction in local noise and heat reduction too. Attractive environment serves also as an agent of entertainment and relaxation. It also enhances livability of high density developments (Novak, 2003).

Brief Description of Enugu Metropolis

According to Wikipedia 2015, Enugu is the capital of Enugu State in Nigeria. It is located in southeastern Nigeria. The city has a population of 722,664 according to the 2006 Nigerian census.The name *Enugu* is derived from the two Igbo words *Énú Ụgwụ́* meaning "hill top" denoting the city's hilly geography. The city was named after Enugwu Ngwo, under which coal was found.

Despite its name meaning *hill top* in the Igbo language, Enugu lies at the foot of an escarpment and not a hill. Enugu is located in the

Cross River basin and the Benue trough and has the best developed coal in this area. Coal seams in the Enugu coal district measure between 1 and 2 meters (3.3 and 6.6 ft.) in thickness and the reserves have been estimated to be more than 300 million tonnes. Enugu's hills at the extreme may reach an elevation of 1,000 meters (3,300 ft.). Highlands surrounding Enugu for the most part are underlain by sandstone, while lowlands are underlain by shale. Much of the escarpment stretching from Enugu to Orlu has been ravaged by soil and gully erosion. Other geological features in Enugu include the Nike Lake near which the Nike Lake Hotel has been built. The Ekulu, Asata, Ogbete, Aria, Idaw and Nyaba rivers are the six largest rivers located in the city. The Ekulu River is the largest body of water in Enugu urban and its reservoir contributes to part of the city's domestic water supply (Wikipedia, 2015).

Enugu is located in a tropical rain forest zone with a derived savannah.The city has a tropical savanna climate. Enugu's climate is humid and this humidity is at its highest between March and November.For the whole of Enugu State the mean daily temperature is 26.7 °C (80.1 °F).As in the rest of West Africa, the rainy season and dry season are the only weather periods that recur in Enugu. The average annual rainfall in Enugu is around 2,000 millimeters (79 in), which arrives intermittently and becomes very heavy during the rainy season. Other weather conditions affecting the city include Harmattan, a dusty trade wind lasting a few weeks of December and January. Like the rest of Nigeria, Enugu is hot all year round (Wikipedia, 2015).

The indigenous people of Enugu include the Ogui Nike who live in the areas surrounding Hotel Presidential, Obiagu, Ama-Igbo, Ihewuzi and Onu-Asata. Other groups include the Awkunanaw people, who live mainly in the Achara Layout and Uwani areas. (Wikipedia, 2015)

According to the 2006 Nigerian census, the Enugu metropolitan area has an estimated population of 775,374.The growth of the City is evident from the various population census figures from 1952 to 2006. It recorded a population of 62,764 in 1952; the 1991 Census puts the population figure of Enugu to be 462,514, accommodated in 28 residential layouts. The 2006 Census records the population of Enugu to be 722,664. The neighborhood distribution of 1991 Population Census was projected using the Thomas Malthus Exponential Model,

$Pt + n = Pt (1+r)^n$.

The Urban Residential Space in Enugu

The urban residential space in Enugu is classified into low, medium and high density areas. The residential space (layouts) in Enugu is classified into high, medium and low density respectively. Due to the influence of spread effects, mixed densities exist. Planned and unplanned areas spring alongside Enugu metropolis which is as a result of high demand in residential accommodation.

Urban residential space in Enugu metropolis is not necessarily as a continuous zone but arbitrarily defined circumscribing about twenty neighborhoods and some inner open space. Many informal businesses sectors grow along with the residences. For instance, Kenyatta, Edozie street areas, Agbani, Ziks Avenue, Ogui Road, Obiagu road, Abakpa Road, Emene Road, Chime Avenue etc. (Wikipedia, 2015). The low density account for 2% of the residential areas in Enugu, the medium density neighbourhood accounts for about 28% of the residential areas of Enugu whereas the high density residential areas in Enugu account for about 70% of the entire residential neighborhood in Enugu (Enugu master plan, 1978).

Legal Framework for Environmental Management in Enugu

Enugu state Government In an attempt to effectively manage the environment of the state, has set up a legislative framework to help address the problem of indiscriminate waste disposal in Enugu urban.

The Federal Environmental Protection Agency (FEPA) law of 1992 is the main guide from which state legislation derives. There is a development control guide on Environmental Impact Assessment of some development projects, in the state; this is provided by the Enugu state Waste Management Authority edict of 2004 as the legislative guide for the management of the environment of the State (DFID report, 2008).

Enugu Metropolis, Air Pollution and Landscape Architecture

Like some cities in Nigeria, pollution is seldom a conscious activity in the course of development. In the course of what we term physical development, the air is contaminated, trees are cut down, hills are bulldozed etc. Enugu falls within such group of cities currently on the drive for development, causing rapid urbanization, but also failing in assessing the effect on the environment. Cases arising from industrial activities to transportation activities can clearly observe the effect being left on the atmosphere (which is the focus of this study). Human activities and the environment go hand in hand. This is because any activity of man is done in the environment and the resultant effect is either positive or negative to man. Human activities

are diverse. According to Uchegbu (1998), negative effects of man arise from these economic and domestic activities. Sectors where air pollution occurs most often are transportation, commercial and industrial activities, domestic activities, burning of fossil fuels, and waste disposal (Uchegbu, 1998).

On the issue of transportation, Enugu is similar to most developing cities in the world and develops in like fashion. The economic status of the inhabitants of this area is popularly middle income class. Urban transport in Enugu is very crucial in the transfer of goods and people, hence standing as the backbone of the economy. It is expected, therefore, that provided the majority of travels are done on the roads, the metropolis will is customarily plagued with traffic problems like high cost of travels, traffic congestion and ultimately, pollution of the environment. The urban traffic faces many challenges which are mainly caused by rapid urbanization and an increase in car ownership which influences the rate of traffic use and its effect on the environment. With the fluctuations in economy, transport charges have increased, thereby increasing the traffic use in Enugu metropolis. Hence, Newman and Jeffrey (1997) highlighted the negative impacts of urban traffic, as it contributes to accidents, water and air pollution as well as traffic congestion on the roads.

With high traffic areas like Ogbete, Coal Camp, Agbani Road etc, it is expected that the pollution generated will be evident. In situation similar to this, carbon monoxide (CO) is emitted unconsciously from vehicles (e.g. cars, buses, trailers etc.). The issue being that most transport vehicles in Enugu are mostly out of maintenance and hence the faulty engines produce a lot of toxic fumes, of which CO is commonly found in CO not being easily detectable upon emission, can result in degenerating climatic conditions, for example, Ozone layer depletion and Global Warming. Therefore, whether it is a deliberate attempt of the urban traffic constituents to emit the harmful atmospheric pollutants, it is still a means of development. Most vehicles should be fitted with exhaust filters that separate the harmful chemicals before their emission into the atmosphere. This is an alternative towards the reduction of air pollution.

Enugu is clearly notable for its industrial activities. In the 20th century, Enugu was at the forefront of mining activities, of which coal was paramount. Currently, production in Enugu spans the spheres of steel production, tiles and pottery, asbestos, cement, petroleum products, pharmaceuticals and machinery. Notable industries in Enugu state include Nigerian Breweries located at 9th Mile Corner Ngwo, Enugu, Innoson Ind. & Tech. Company Ltd, Emenite Ltd located in Emene, ANAMMCO (Anambra Motor Manufacturing Company) etc. These industries are known for their heavy production activities resulting in significant emission air pollutants. Thus, an increase in smoke generation goes unnoticeable- unleashing unwanted toxins into the air.

The causes of industrial pollution range from lack of policies to control pollution. Lack of effective policies and poor enforcement drive allowed many industries to bypass laws made by environmental control board which resulted in large-scale pollution that affects lives of many people. Another factor is unplanned industrial growth. It is observed in most industrial townships where unplanned growth takes place wherein those companies disobey rules and regulations and polluted the environment with both air and water pollution. For example, many small scale industries are springing up in areas like Ogbete, of which palm kernel processing is common. The area is commonly prone to smoke from the processing of raw materials like palm kernels, rubber etc. The use of outdated technologies is also a strong factor. Most industries still rely on old technologies to produce products that generate large amount of waste. To avoid high expenditure, many companies still make use of obsolete traditional technologies to produce high end-products. These large amount of waste are then disposed off carelessly, thus releasing into the air and water. Presence of large number of small scale industries is also a determinant. This is where many small scale industries and factories that don't have enough capital base rely on government grants to run their day-to-day businesses often evading environmental regulations as they release large amount of toxic gases in the atmosphere. Illiteracy is a factor also, in this case about pollution. People are unsure about the harm they inflict while polluting the air.

In domestic activities and burning of fossil fuels, studies have shown that the unregulated burning around the globe is pumping more pollution into the atmosphere. Domestic activities are also one of the most paramount source of air pollution. Households in Enugu are known for use of energy for numerous activities, mostly cooking. The economic structure of Enugu, as earlier stated is high on the side of the low income class which commonly makes use of traditional methods of cooking and performing other activities e.g. people use wood to cook, and hence releasing large amount of CO into the atmosphere. This is compared with the high income earners that use electricity or gas to cook. Air pollution is being caused by this factor is being

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underestimated because no person/ organization really tracks the rate of increase in the burning of fossil fuels and through domestic activities. Waste disposal in Enugu is also a cause of air pollution. The more the waste generated, the more we have to dispose of it. Some methods of waste disposal release air pollutants and greenhouse gases into the atmosphere. **Waste disposal** in Enugu (through the activities of ESWAMA and other local parties) is mostly characterized by traditional methods of disposal i.e. burning of waste/refuse. This happens either at the collection centers or even at the households. The best case of recycling of waste is to pursue other methods of disposal that don't emit pollution at a high scale, but are environmentally friendly, including burning of fossil fuels – petroleum, coal, natural gases, and others - when refining in refineries and the burning (use) of these fossil fuels. These activities are dangerous to the environment, because they release more pollutants into the atmospheric because they facilitate the increase of two main environmental deteriorating agents- acid rain and global warming.

In the case of **landscaping architecture**, landscaping in Enugu isn't different from other cities. There is hardly a case of deliberate landscaping, either macro or micro. People view landscaping as an unnecessary component when carrying out development. Individuals are seldom aware of the extent of the functionality of landscaping in the environment. So definitely, Enugu cannot be different. Roads are constructed, buildings are erected and infrastructural facilities developed, but little emphasis is placed on the need for landscaping. In excellent cases, landscaping is only carried out in excess of funds.

Development in Enugu has shown the negative impacts on the environment. Obiagu and Asata are key areas that development and rapid urbanization have taken place. Note that the focus on landscaping as a cure for the rising effect of pollution borders mainly on the application of vegetation (afforestation). The benefits of vegetation as a remedy towards pollution are numerous. For example, vegetation reduces excess carbon dioxide (CO_2) that is caused by many factors and which contributes to climate change. Trees absorb CO_2, removing and storing it while releasing the oxygen back into the air. Trees and plants release more than just oxygen into the atmosphere as a result of photosynthesis. They also release a variety of gases that contribute to air pollution. In fact, the planet's vegetation accounts for about two-thirds of the pollutants known as volatile organic compounds (VOCs) emitted globally. Research has shown that, in one year, an acre of mature trees absorbs the amount of CO_2 produced when a car is driven 26,000 miles. Trees absorb odors and pollutant gases (nitrogen oxides, ammonia, sulfur dioxide and ozone) and filter particulates out of the air by trapping them on their leaves and bark. Trees, shrubs and turf remove smoke, dust and other pollutants from the air. One tree can remove 26 pounds of carbon dioxide from the atmosphere annually, equaling 11,000 miles of car emissions. One study showed that one acre of trees has the ability to remove 13 tons of particles and gases annually, while about 2,500 square feet of turf absorbs carbon dioxide from the atmosphere and releases enough oxygen for a family of four to breathe. Trees also conserve energy, it has been discovered that not less than three trees placed strategically around a single-family home can cut summer air conditioning needs by up to 50 percent. By reducing the energy demand for cooling our houses, there can be reduction in carbon dioxide and other pollution emissions from power plants. Additionally, trees can also shield people from ultra-violet rays. Skin cancer is the most common form of cancer. Trees reduce ultraviolet exposure by about 50 percent, thus providing protection to people, during their outdoor activities.

Methodology

Data used for this study were gotten from both primary and secondary sources by use of research questionnaire and review of related literature respectively.

The Yaro Yamanne formula was applied to the population of the city (775, 374) to determine the sample size for the study. The formula is given by:

$$n = \frac{N}{1+N(e)^2}$$

Where, n = sample size desired

N = population for the study

e = level of significance (5% or 0.05).

At the end, a sample size of 400 was arrived at and used for the study.

The two hypotheses put forward in this study were two inferential statistics known as Spearman's Rank Correlation Analysis employed to examine the significant relationship between Enugu Metropolis neighborhoods' grade of landscaped architecture and the prevalent of air pollution related ailments and Analysis of Variance (ANOVA) used to examine the significant differences in the occurrence of air pollution related ailments around the neighborhoods of Enugu metropolis.

i. Spearman's Rank Correlation Analysis is given by:

$$Rs = 1 - \frac{6\sum d^2}{N(n^2-1)}$$

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ii. Analysis of Variance (ANOVA) model is given by:

$SST = \Sigma x^2 - (\Sigma x)^2$ ……. (1)

$SSB = (\Sigma x_1)^2 \times (\Sigma x_2)^2 \times (\Sigma x_3)^2 \times (\Sigma xn)^2$……. (2)

$SSW = SST - SSB$ ……. (3)

Where, SST = Total variation (Total sum of squares)

SSB = Variation between groups (sum of squares between)

SSW = Variation within groups (sum of within)

Test of Hypotheses

Hypothesis No. I

H_1: There is no significant relationship that exists between Enugu Metropolis neighborhood's grade of landscaped architecture and the prevalent of air pollution related ailments.

As shown in table 1 in appendix 1, Spearman's Rank Correlation Analysis was used to rank the data collected from the numbers of trees/ sq.km to represent the landscape architectural grade of each neighborhood and the occurrence of air pollution related ailments. Using 0.05 as the confident interval the result reflects that;

$$P = \frac{1 - 6(1540.25)}{18(182 - 1)} = \frac{1 - 9241.5}{5832} = P = -0.5846$$

At the end, P = 0.6. Based on the above facts, we can conveniently reject the null hypothesis which states that there is no significant relationship that exists between Enugu Metropolis neighborhood's grade of landscaped architecture and the prevalent of air pollution related ailments. The study, therefore, accepts the alternative hypothesis which states that there is a significant relationship between Enugu Metropolis neighborhoods' grade of landscaped architecture and the prevalent of air pollution related ailments.

Hypothesis No. II

H_2: There is no significant difference in the occurrence of air pollution related ailments around the neighborhoods of Enugu metropolis.

The process of One Way ANOVA utilizes headache, asthma and bronchitis in this analysis as dependent list on factor of other related diseases, SPSS E-views 7.0 was used in the cause of this study. One Way ANOVA was conducted and the result include descriptive statistics, which showed means, standard deviation, standard error, 95% confidence interval for means. It also includes test of homogeneity on variance to encompass sum of squares, degree of freedom, means square, F value, and significant. Finally, the result of One Way ANOVA further displayed robust test of equality in means and means plot for all the air pollution related ailments used in the analysis. The result of description for each of three diseases, namely, headache, asthma, and bronchitis is disclosed segment by segment.

The results of one way ANOVA conducted and analyzed show that the calculated F Values for all the air pollution related ailments are less than the Critical F Value of 3.20 at 3and 17 degree of freedom with confident level of 0.05. The analysis also shows that the calculated significant level is above 99% in all the variables. This means that, there is a significant differences in the occurrence of air pollution related ailments around the neighborhoods of Enugu metropolis. Based on the above facts, we can conveniently reject the null hypothesis which states that there is no significant differences in the occurrence of air pollution related ailment around the neighborhoods of Enugu metropolis. The study, therefore, accepts the alternative which states that there is a significant difference in the occurrence of air pollution related ailment around the neighborhoods of Enugu metropolis.

Summary and Findings

This paper made a number of findings. Prominent among such are:

1. Burning of fossil fuels, improper agricultural practices, exhaust fumes of automobiles, vehicular traffic, factories and industries, mining operations, and indoor activities are the major factors that cause air pollution and environmental degradation in cities and elsewhere.
2. The major adverse consequences of air pollution include acidification, eutrophication, ozone layer depletion, skin cancer, release of particulate matter into the ambient surroundings, diseases etc.
3. The major causes of environmental degradation include land disturbance, pollution (air, water, soil), overpopulation, landfills, deforestation, and natural disasters.
4. The prominent consequences of environmental degradation are ill-health to man, loss of biodiversity, ozone layer depletion, depletion of national income, and loss of tourist sites.

5. Landscaping comes with a number of environmental, biodiversity, health, economic, and social benefits, which highly recommends it as a potent strategy for curbing the adverse effects from air pollution and environmental degradation in Enugu metropolis.

Recommendations

Air pollution, is a product of man's yearning need for a better livelihood, ignorant of the after-effects, hence sustained development at all sectors of the society with its devastating effect on the inhabitants and the natural environment.

To squarely address the consequences associated with air pollution and environmental degradation in cities in Nigeria, efforts should, first and foremost, be made to strengthen the official mechanisms for control of pollution such as emission from traffic, industries, and automobiles by the relevant authorities of government.

Secondly and most crucially, there should be increased use of landscaping as a tool for curbing air pollution. Landscaping has a role to play in our urban environment, Enugu, in this period of rapid urbanization. It is not only of lesser cost, because it deals with the natural environment which is almost complete and free, but without the conscious activity of man, wouldn't materialize. This is why landscaping should be encouraged, since it has been shown that areas with high vegetative belts of high quality experience the least occurrences of diseases, unlike the lowly vegetative areas.

Conclusion

Development is viewed as a very costly enterprise but it after-effects largely go unnoticed. One of them, being air pollution, the introduction of harmful particles into the atmosphere, is the reason for health and environmental mishaps in our society today. Generally, solutions have been forthcoming and one of them is landscaping. Landscaping, which aims at shaping the environment for the comfort of man, with careful application in the urban environment, would go a long way to securing the expected livelihood of the inhabitants of the society, particularly in Enugu urban.

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