

## Assessment of Urbanization As It Affects Biodiversity in Enugu, Nigeria

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#### ABSTRACT

The study assessed how urbanization in Enugu metropolis has affected biodiversity within the environment. The metropolis was classified into neighbourhoods, and stratified into high medium and low density areas. Samples were collected from these through a cross section of the study area. Structured questionnaires were mainly used for collection of data. A total of one thousand four hundred and twenty respondent was determined as the sample size for the assessment. Descriptive statistics involving frequency distribution and percentage were used in assessing the respondents perception of how urbanization has affected biodiversity in the area. Respondents in general agreed that population pressure, deforestation, pollution, soil erosion constituted some of the problems of urbanization. Furthermore, they also affirmed that the biodiversity of the area has been affected by urbanization through introduction of invasive species, over-exploitation of resources, degradation of habitat, disease outbreak, as well as extinction of species. Consequently, the study found that as a result of urbanization, some fauna and flora have been adversely affected. Certain species have been endangered, threatened and some have even gone into extinction as a result of loss of habitat. The study therefore proposed, among others the adoption of the World Bank urban strategy that emphasizes strong systems and urban governance to enable sustainable urban growth with opportunities for all.

### INTRODUCTION

In recent times poor urban growth management has continued to attract the attention of many scholars and stakeholders who attempt, proffering solution to the issue of urbanization. Sadik et al. linked it to the inevitability of urban growth in most urban areas in the upcoming decades<sup>[1]</sup>. In a projected growth pattern, over five billion people are likely to be residing in urban areas by 2025 with about 80% of this coming from developing countries. This trend tend to pose difficult task for urban planners as well as natural resources managers<sup>[2]</sup>. Natural increase and rural-urban drift have been regarded as the catalysts of rapid expansion of Nigerian urban areas. The course of becoming a developed country has posed a lot of difficulties and challenges to Nigeria. This situation has created numerous problems of urban growth management such as loss of natural resources<sup>[3-5]</sup>. However, successive governments in Nigeria have taken some steps to redress these challenges posed by uncontrolled urban growth. Some of the measures include the formulation of the National Urban Development Policy of 1992 and the establishment of federal ministry of Environment in 2004. In spite of these efforts, Okosun et al. observed that Nigerian urban areas are still undergoing unprecedented changes in population and spatial extent<sup>[6]</sup>. The explosive growth of Nigerian urban centres has exacerbated interrelated problems of human settlement and the environment. In Enugu metropolis, the situation is not different. This study therefore assesses how urbanization of the area has affected biodiversity within the metropolis.

#### Literature Review

In the theory of endogenous Urbanization, Harvey, suggested that urbanization requires two separate pre-requisites the re-generation of surplus products that sustain people in non-agricultural activities, and the achievement of a level of social development that allows large communities to be socially viable and stable. Lampard, observed that in a demographic sense, the theory focuses on the rural-urban population shift as the foundation of urbanization, but identifying industrialization as the basic driver

behind the movement of rural population to urban areas for factory job. Looking at urbanization through the lens of modernization, Kasarda and Crenshaw et al. asserted that the present state of urbanization in any giving society is set by its initial state at the onset of modernization. Again, technology is of paramount importance, and the path and pattern of urbanization within and between developed and developing countries are most likely to converge through cultural diffusion, despite breeding inevitable social disequilibrium. According to Given, biodiversity entails the variety of plant and animal life in the broadest sense, and essential to the functioning and survival of life. Myers et al. developed the "hotspot" concept, in which he enumerated eighteen regions that collectively encompass a highly significant proportion of the world's plant diversity<sup>[7]</sup>. Biodiversity can then be seen as the number, abundance, composition, spatial distribution and interactions of genotypes, populations, species functional types and traits as well as landscape units in a given system<sup>[8]</sup>. Among the many human activities that cause biodiversity loss, urbanization produces some of the greatest local extinction rates and frequently eliminates the large majority of native species<sup>[9-11]</sup>. Urbanization and biodiversity interact in multifaceted and complex ways. Both the size and spatial configuration of urban areas matter for biodiversity<sup>[12]</sup>. McKinney et al. observed that some urban areas have high local species richness, which is typically at the cost of native species<sup>[13]</sup>. Urbanization affects biodiversity and ecosystem services both directly and indirectly. Direct impacts primarily consist of habitat loss and degradation, altered disturbance regimes, modified soils and other physical transformation caused by the expansion of areas indirect impacts include changes in water and nutrient availability, increases in abiotic stressors such as air pollution, increases in competition from non-native species and changes in herbivory and predation rates<sup>[14]</sup>. Identifying rural-urban migration as one of the causes of rapid urbanization which can have effects on biodiversity, Cohen et al. asserted that it is often caused by a mixture of pull and push factors<sup>[15]</sup>. Pull factors make urban areas attractive to rural migrants, they often offer higher wages and better employment options, they also tend to have a better and greater availability of services like health-care etc. than rural areas, they as well are centres of modern living which offer large varieties of cultural and social opportunities. Food and Agricultural Organization stated that push factors force migrants to leave rural areas and such factors include; displacement by conflicts, disasters or droughts, land degradation and desertification, population pressure in rural areas and flight from discrimination and social stigma in rural areas<sup>[16]</sup>. Examining the urban problems that often lead to biodiversity loss, Swingland (2003) noted that though biodiversity yields many sustainable development benefits, yet paradoxically human society continues to undermine this valuable resource base, instigating large scale biodiversity losses. According to him, with increase in population and consequent increase in demand for biological resources, natural habitats are being destroyed for plantation establishment, irrigation, food and livestock production, as well as non-timber forest resources utilization. Also population increase results in the increase of human habitats and indeed rapid development of habitats, rapid development industries, filling up of water bodies for construction of dwelling places to meet the needs of the ever rising population thereby leading to loss of various species of crops and animals. Besides, it is now widely recognized that global warming over the recent past is largely due to human activities that have released greenhouse gases into the atmosphere. UNEP (1999) predicted that high temperature, drought and evaporation could have severe implications on water availability, food security and loss of biodiversity Emodi et al. pointed out that the production and use of toxic chemicals pose a major and relatively new threat to mankind and the environment. It has been observed that the activities of oil corporations in the Niger Delta areas of the country seriously threaten the livelihood of neighbouring local communities as a result of different forms of oil generated environmental pollution evident throughout the region. Farming and fishing activities have become extremely difficult in oil spilled affected areas and even drinking water is difficult to come by. Indeed, the primary cause of loss of aquatic genetic diversity is water pollution, Emodi also observed that deforestation is a prominent problem that leads to biodiversity loss. The primary causes of deforestation in the tropics are logging and conversion to agriculture or grazing. Behind these causes are the driving forces such as policies, attitudes and institutions that influence production and consumption. Deforestation is intrinsically linked to the loss of biodiversity as original rainforests host numerous species of precious fauna and flora outlining soil erosion as one of the problems of urbanization that impact on biodiversity, Lekwa and White-side et al. asserted that about 63% of agricultural soils in Nigeria are low in organic matter with low activity clays and about 35% of soils in eastern Nigeria are made up of acid soils with 63 to 93% sand in surface horizon<sup>[17]</sup>. Cations, such as calcium, magnesium and potassium are easily leached, bringing about the toxicity of Al and Mn. This is indeed, prone to high infiltration and eventually erosion, hence, loss of useful soil micro flora and fauna. Consequently, with the economic and social harm caused by erosion sites, a great loss of biodiversity and malfunctioning of the ecosystem. According to Groombridge et al. any form of sustained human activity resulting in some modifications will affect the relative abundance of species and in extreme cases lead to extinction of certain plants and animals<sup>[18]</sup>. Raised rates of extinction are being driven by human consumption of organic resources especially related to tropical forest destruction. This leads to increased pressure on biodiversity and possible extinction of some species. The indirect causes of biodiversity losses in Nigeria include economic policies rising demand for forest products, cultural practices, poor law enforcement and weak laws. Cultural practices that encourage the use of specific species for festivals often limit the population of the species, particularly as it occurs under narrow ecological range. Most of the laws that control the management of several species are out dated and their enforcement is often inadequate. Furthermore, low budgetary allocation for forestry sub sector has curtailed national efforts to reforest large areas that have been deforested. The consequences are over exploitation of resources and subsequent loss of biodiversity. Emphasizing the values of biodiversity, Gaston and Spicer et al. were of the view that humans cannot exist without biodiversity as we use it directly or indirectly in a number of ways; food, fibres, medicines and biological control constitute the direct usages while indirect uses include ecosystem services such as atmospheric regulation, nutrient recycling and pollination. Of other values include, non-use value of biodiversity like the option value -for

future use or nonuse request value – in passing in a resource to future generation existence value – value to people irrespective of use on nonuse intrinsic value – inherent worth, independent of that place upon it by humans. Wilson et al. affirmed that humans are attracted to nature and its living creatures which he described as “biophilia” – man’s innate tendency to affiliate with life and life-like processes <sup>[19]</sup>. According to Melyntyre et al. biodiversity adds to the city’s green space, and Oberndorfer et al. advanced green roofs reduce run off, regulate building temperatures, thus conserving emerging and increasing wildlife habitat area <sup>[20,21]</sup>. However, many of these uses of biodiversity are not incorporated in economic accounts and this leads to under-value biodiversity. According to Millenium Economic Assessment (2005) ecosystem services and resources such as mineral deposits, soil nutrients and fossil fuels are capital assets but traditional national accounts do not include measures of the depletion of these resources. This, however, means a country could cut its forests and deplete its fisheries, and this will show only as a positive gain in Gross National Product without registering the corresponding decline in assets. Nielson et al. in their analysis of effects of urbanization on biodiversity, posited that urbanization or built environment with its highly altered landscapes and rapid human-caused changes to local ecosystem is accepted as a major driver of biodiversity changes <sup>[22]</sup>. The largest driver of biodiversity change due to loss of available habitat and resulting extinctions could be seen as land use and land cover change <sup>[23,24]</sup>. The conversion of wild or agricultural land to urban or-sub-urban use is expanding at a rate approximately twice as fast as urban population increase. Barnosky et al. found out that 40% of earths land has been converted for agricultural use expansion of urban areas and their satellite settlements, along with the construction of supporting infrastructure can result in fragmentation and hence degradation of ecosystem <sup>[25-28]</sup>. Upholding climate change as one of the effects of urbanization on biodiversity, the emission of grievous gases including carbon dioxide, methane,, nitrous oxide, tropospheric ozone and chlorofluorocarbons and their effects on the atmosphere have been seen as the leading cause of climate change <sup>[29]</sup>. The United Nations Environmental Programme (2011) states that the global use of natural resource materials increased by over 40% between 1992 and 2005 from about 42 to nearly 60,000 tones on a per capita basis, and there has been a major increase in extraction of construction materials of almost 80%. The design of urban environment also contributes to how private vehicles, most of which are powered by burning fossil fuels leading to further built environment related Green House gas emissions <sup>[30,31]</sup>. Rocksform et al. asserted that nitrogen deposition is mostly related to industrial fixation of nitrogen for fertilizer. This has resulted in a doubling of the processes that make nitrogen biologically available. Chapin et al. were of the opinion that acid rain caused by certain gases dissolved in atmospheric water to form severe negative changes in aquatic systems <sup>[24]</sup>. Again, major ecological changes in river basin, estuaries and coastal bones have occurred as a consequence of runoff of the nutrients from agricultural and urban areas, partly due to urban environments being made up of mostly impervious surfaces, such as roads, foot path and buildings. Niemela et al. opined that the nature of urban environments and the movement of humans between them tend to increase the prevalence of species exotic to a particular place and hence the existence of invasive species in native ecosystems <sup>[32]</sup>. Also Nielon et al. discovered that in many parts of the world, urban parks are made up of approximately half exotic species <sup>[22]</sup>. The amount of energy and matter available for species also increases towards a city core due to rubbish and the heating of building and some “urban exploiter” species such as pigeons, mice, rats, sparrows. They thrive in these conditions and compete with native species <sup>[14]</sup>. However, the largest assessment of the effects of humans on the earth’s ecosystem came from millennium ecosystem assessment, identifying habitat change, climate change, invasive species, over exploitation and pollution as the primary drivers leading to loss of biodiversity (MEA, 2005). Accordingly Humans have had an effect on every habitat on earth particularly due to the conversion of land for agriculture. Cultivated system (areas where at least 30% of the landscape is in croplands, shifting cultivation, confine livestock production or fresh water aquaculture) now cover one quarter of earth’s territorial surface. Habitat loss also occurs in coastal and marine systems, though these changes are less well documented. Trawling of the seabed for instance can significantly reduce the diversity of benthic habitats. Observed recent changes in climate especially warmer regional temperatures have already had significant impacts on biodiversity and ecosystems. They include changes in species distributions, population sizes, the timing of production or mitigation events and an increase in the frequency of pests and disease outbreaks. The spread of invasive alien species has increased because of increased trade and travel. While increasingly there are measures to control some of the pathways of invasive species, for example, through quarantine measures and new rules on the disposal of ballast water in shipping several pathways are not adequately regulated, particularly with regard to introduction into freshwater systems. For marine systems, the dominant direct driver of change globally has been overfishing. Demand for fish as food for people and as feed for aquaculture production is increasing, resulting in increased risk of major long-lasting collapses of regional marine fisheries. MEA (2005) observed that 50% of the world’s commercial marine fisheries are fully exploited and 25% are being over exploited. For example, the Atlantic cod stocks, off the east coast of New found land collapsed in 1992, forcing the closure of the fishery. The depleted stock may not recover, even if harvesting is significantly reduced or eliminated. For more than five decades now, human mediated increases in nitrogen, phosphorous, sulphur and other nutrients has emerged as one of the most important drivers of ecosystem change in terrestrial, freshwater and coastal ecosystems, and this driver is projected to increase substantially in the future. For example, humans now produce more biologically available nitrogen than is produced by all the natural pathways combined. Aerial deposition of reactive nitrogen into natural terrestrial ecosystems especially temperate grasslands, shrub lands and forests leads directly to lower plant diversity, excessive levels of reactive nitrogen in water bodies including rivers and other wetlands, frequently leading to algal blooms and eutrophication in inland waters and coastal areas. Similar problem has resulted from phosphorus, the use of which has trippled between 1960 and 1990. Proffering measures to ameliorate the urbanization pressures on the environment, Okosun et al. advanced the adoption of Geographic information system as a technique towards bring-

ing about proper and orderly planning and development <sup>[6]</sup>. This could be actualized through master plan for the area, building control, traffic and transport planning, as well as infrastructural development and management. Master plan entails the land use zoning plan that determines the use of each land parcel in the development area, structural road network plan that guides laying of the trunk infrastructure in the development area, and development control regulations that determine the built form in the development area. Growth management has been advanced as a way of balancing the benefits of urban growth with the costs imposed on the environment and the quality of life. Approaches to growth management entails the use of development to turn a fringe community into a suburb, targeting some areas for and environmental protection and making development difficult and keeping change to a minimum <sup>[33,34]</sup>. Growth management legislations require various levels of governments to identify lands with high natural resource, economic and environmental value and protect them, from development. Centre intelligent agency (2013) observed that the world Banks urban strategy for the mitigation of the effects of urbanization on biodiversity emphasizes strong system and urban governance to enable sustainable urban growth with opportunities for all. Hence, there is plan for green cities which involve low carbon, climate resilient growth, accessing necessary financing, improving solid waste management systems and addressing pollution and livability challenges. There is also inclusive city which comprises improving access to land, affordable housing, jobs and basic services, economic opportunities, scale up efforts to upgrade slums, enhancing community participation and tackling urban poverty as well as social inclusion. Also included in the plan is resilient cities which comprises strengthening cities residence, their ability to cope and better management of climate and disaster risk, economic shocks and social conflict. The competitive cities comprises attracting investment and jobs by improving land markets, connectivity and regulation at the sub-national level create an enabling environment for business and better leverage land and real estate assets. Besides, strong city systems and governance is also involved, and this entails strengthening land and housing markets, enhancing municipal finances and services delivery and increasing the capacity to carry out integrated territorial development policies and land use planning. However, Millennium Ecosystem Assessment (2005), outline certain measures that could be adopted in reducing biodiversity loss. They include; species protection and recovery measures for threatened species, public awareness, communication and education, Ex-situ and in-situ conservation of genetic diversity, elimination of subsidies that promote excessive use of ecosystem services, addressing unsustainable consumption patterns, integration of biodiversity conservation and development planning, increased transparency and accountability of government and private sector performance in decisions that affect ecosystems including through greater involvement of concerned stakeholders in decision making, as well as making available scientific findings and data need to all of the society. Furthermore, Iyi et al. added inter-governmental approach where there is a patterned, interdependent and bargained behavior among concerned federal, state and local officials <sup>[35]</sup>.

## MATERIALS AND METHODS

### The Study Area

Enugu metropolis, the study area is located between latitudes 6°27N and 7°28N and longitudes 7°30E and 8019E. The urban land area is roughly 72.8 square kilometers with the rural environs covering an additional area of about 200 square metres. The study area comprises three Local Government Areas namely, Enugu North, Enugu East and Enugu South. It is bounded on the north by Isi-Uzo local Government Area on the South by Nkanu West Local Government Area, on the east by Nkanu east local Government Area and on the West by Udi Local Government Area. The metropolis which lies on an altitude of 232.6 metres above sea level exists with natural dunes in the South and undulating plains forming the foothills of Udi Escarpment in the north. It widens out into the upper Ebonyi River plains. The metropolis has virtually an undulating terrain and this accounts for its good natural drainage. It has an annual rainfall of 1247.8 mm and the rainfall is mostly during the months of April through October, having July as the peak, period. The annual temperature is about 30.80°C and the variation within the season is normally less than 10°C. The relative humidity fluctuates between 40 and 80 percent. The prevailing winds are the local monsoons; the North East trade wind and the south West Trade Wind. The North East Trade Wind blows from across Sahara desert, with dry and dusty air over the area, hence, resulting in dry season characterized by dusty harmattan weather, this season usually lasts from November to March. The South West Trade Wind blows from across the Atlantic ocean, bringing about the raining season. The metropolis has a type of soil that is predominantly reddish brown in colour, with the underlying rock having a high load bearing capacity. This makes the soil suitable for intense building construction. The soil also supports moderate agricultural activities. Enugu is embedded in the Guinea savannah belt, which is the broadest vegetation belt in Nigeria. It spans between Zaria and Enugu State, encompassing the entire middle belt. Here the natural vegetation is primarily of tall, medium and short grasses. Most of the trees found here are deciduous, and this minimizes the loss of moisture through transpiration. Among the common tree-species found here are in most cases less than six metres high and they include isoberlina, sheer butter, locust beans, oil been etc. Enugu started as a photo-urban settlement near the mines, following the discovery of coal in the Udi hill around 1909. Iva Valley and Ogbete areas which were the first areas to develop functioned primarily as coal miners residences. These areas became the oldest parts of the metropolis; including the European reservation Area known as the Government Reserved Area (GRA) and the African settlement located South of the escarpment. The GRA and African settlement were separated by a neutral zone of about 6.1 kilometres wide. With the discovery of deep sea harbor in Port-Harcourt, construction of Enugu-Port-Harcourt rail line commenced in Enugu in 1914. The first freight of coal was transporter from Enugu to Port-Harcourt in 1916. In 1917, Enugu attained township status and was then referred to as Enugu Ngwo. As a result of rapid expansion towards areas owned by mixed indigenous communities rather than towards Ngwo highlands, it was renamed Enugu in 1928. By 1939 Enugu has become the headquarters of the then southern

province. It became a regional capital and the important administrative centre in the then Eastern Region with the creation of the three regions in Nigeria in 1961. Presently, it is the capital of Enugu state of Nigeria. The neutral zone in the metropolis now tend to be the central business district (CBD) as well as harbor government offices and establishments as the area develop. The Southern portion of the GRA was invaded by establishments of foreign commercial firms. A daily market (Ogbete) was founded in the Northern portion of the African location and has become a force of African retail and other commercial activities. The population of Enugu metropolis has been on the increase in the last few decades, as a result of rapid urbanization and subsequent influx of people. In 1953 the population was 63000. This rose to 482,977 in 1991 and by 2006, the population was put at 722, 664 (NPC, 2006).

**Methodology**

The study was carried out based on survey research method. The metropolis was classified into neighbourhoods, and stratified into high, medium, and low density areas. From these areas samples were collected randomly through a cross section of the metropolis. Questionnaires were mainly used for the collection of data. Direct contact method of reaching the respondents was used. Closed form questionnaires were mainly used in which choices of possible answers to open questions were provided. Open-ended questions, however, were equally used, which afforded the participants the opportunity to reveal their background or provisional conditions upon which their answers were based. One thousand five hundred copies of questionnaire were distributed to the respondents. One thousand four hundred and twenty six of the number distributed were returned. Six questionnaires were not properly filled as to elicit information to be used in the analysis. Hence, information from one thousand four hundred and twenty copies of the questionnaire were used in the analysis. Descriptive statistics involving frequency distribution and percentage were used to analyze the data collected through the questionnaires. The data were first shown in tables and followed with interpretations (Comments) in relation to the aim and objectives of the study.

**Data Presentation and Analysis**

The various options of causes of rapid urbanization in Enugu metropolis and the response from the respondents are presented in **Table 1**.

**Table 1.** Causes of rapid urbanization in Enugu metropolis.

S/No	Option	Strongly Agreed	Agreed	Disagreed	Strongly Disagreed
1	Natural growth	720 (50.7%)	672 (47.3%)	22 (1.5%)	6 (.4%)
2	Rural-urban migration	948 (66.8%)	468 (33%)	4 (.2%)	0 (0%)
3	Better and greater availability of services	684 (48.2%)	633 (44.9%)	64 (4.5%)	34 (2.4%)
4	Higher wage and better employment opportunities	716 (50.7%)	608 (42.8%)	76 (5.4%)	20 (1.4%)
5	Varieties of cultural and social opportunities	202 (14.2%)	201 (14.8%)	406 (28.6%)	602 (42.4%)
6	Flight from discrimination and social stigma	211 (14.9%)	304 (21.4%)	604 (42.5%)	301 (21.2%)
7	Displacement by conflicts, Environmental Disaster etc.	702 (49.7%)	609(42.9%)	102 (7.2%)	7 (.5%)
8	Reclassification of rural villages into small urban settlements	502 (35.4%)	416 (29.3%)	301 (21.2%)	201 (14.2%)

**Table 1** above shows the responses from respondents on the causes of rapid urbanization in the study area. Out of the 1420 respondents who responded, 720, representing 50.7% of the entire respondents strongly agreed that natural growth is none of the causes of rapid urbanization in the study area; 672 (47.3%) agreed to this. 22 (1.5%) disagreed while 6 (.4%) strongly disagreed. 948 respondents (66.8%) strongly agreed that rural-urban migration is a major factor in rapid urbanization in the area. 468 respondents (33%) agreed. While 4 respondents (.2%) disagreed. Non (0%) strongly disagreed. 716 respondents (50.4%) were strongly of the opinion that high wages and better employment opportunities constitute major causes of rapid urbanization. 608 respondents (42.8%) agreed to this but as 76 respondents (5.4%) disagreed, 20 respondents (1.7%) strongly disagreed. 684 respondents (48.2%) were strongly of the view that better and greater availability of services tend to bring about rapid urbanization in the area.. 638 respondents (44.9%) agreed with them. 64 respondents (4.5%) disagreed to this view and 34 respondents (2.4%) strongly disagreed. 202 respondents (14.2%) strongly agreed that varieties of cultural and social opportunities may offer reasons for rapid urbanization here, 2010 respondents (4.8%) agreed with them. While 406 respondents (28.6%) disagreed

with this view, 602 respondents (42.4%) strongly disagreed. As it concerns flight from discrimination and social stigma, 211 respondents (14.9%) strongly agreed, 304 respondents (21.4%) agreed, 604 respondents (42.5%) disagreed and 301 respondents (21.2%) strongly disagreed. 702 respondents (49.4%) strongly agreed that displacement by conflict, environmental disasters and the likes are capable of causing rapid urbanization in the area. 609 respondents (42.9%) agreed with them. 102 respondents (7.2%) disagreed and 7 respondents (.5%) strongly disagreed. 502 respondents (35.4%) were strongly of the opinion that reclassification of rural villages into small urban settlements causes rapid urbanization 416 respondents (29.3%) agreed to this opinion 301 respondents (21.4%) disagreed and 201 respondents (14.2%) strongly disagreed. In **Table 2** the problems associated with urbanization in the area as responded to by the respondents are presented.

**Table 2.** Problems of urbanization in Enugu metropolis.

S/No	Option	Strongly Agreed	Agreed	Disagreed	Strongly Disagreed
1	Population pressure	682 (48%)	528 (37.2%)	109 (7.1%)	101 (7.1%)
2	Pollution	661 (46.5%)	503 (35.4%)	204 (14.4%)	52 (3.7%)
3	Deforestation	744 (52.4%)	662 (46.6%)	14 (1%)	0 (0%)
4	Climate change	626 (44.1%)	542 (38.2%)	241 (17%)	11 (.8%)
5	Soil Erosion	608 (42.1%)	542 (38.2%)	241 (17%)	11 (8%)
6	Poor law enforcement/ economic policies	28 (2%)	102 (7.2%)	587 (41.3%)	703 (49.5%)
7	Habitat loss	786 (55.4%)	624 (43.9%)	10 (.7%)	0 (0%)

**Table 2** indicates the responses of the respondents in the study area as to what constitute problems of urbanization in the area. 692 respondents (48%) out of the entire 1420 respondents strongly affirmed that population pressure is a problem in urbanization 528 respondents (37.2%) agreed to that and 109 respondents (7.7%) disagreed, while 101 respondents (7.1%) strongly disagreed. 661 respondents (46.5%) strongly agreed that pollution constitutes problem of urbanization. 503 respondents (53.4%) agreed. 204 respondents (14.4%) disagreed and 101 respondents (7.1%) strongly disagreed. 744 respondents strongly. Included to the view that deforestation is a problem in urbanization. 662 respondents (46.6%) agreed. 14 respondents (1%) disagreed and none strongly disagreed. 626 respondents (44.1%) were of the opinion that climate change is a problem of urbanization. 542 respondents (38.2%) agreed. 241 respondents (17%) disagreed, and 11 respondents (.8%) strongly disagreed. 608 respondents (42.8%) strongly agreed that soil erosion emanates as a problem of urbanization. 542 respondents (38.2%) agreed. 241 respondents (17%) disagreed and 11 respondents (8%) strongly disagreed. Considering poor law enforcement and economic policies as problems of urbanization, 28 respondents (2%) strongly agreed. 102 respondents (7.2%) agreed. 587 respondents (41.3%) disagreed and 703 respondents (49.5%) strongly disagreed. 786 respondents (55.4%) strongly agreed that loss of habitat is a problem in urbanization. 624 respondents (43.9%) agreed. While 10 respondents (.7%) disagreed and none of the respondents strongly disagreed.

**Table 3.** Effects of urbanization on biodiversity in the area.

S/No	Option	Strongly Agreed	Agreed	Disagreed	Strongly Disagreed
1	Loss of habitat	741 (52.4%)	572 (40.3%)	104 (7.3%)	0 (0%)
2	Introduction of invasive species	622 (43.8%)	638 (44.9%)	86 (6.1%)	74 (95.2%)
3	Over-exploitation of resources	604 (42.5%)	686 (48.3%)	108 (7.6%)	22 (1.6%)
4	Changes in species distribution	521 (36.7%)	484 (34.1%)	306 (21.5%)	109 (7.7%)
5	Population changes of species	566 (39.9%)	482 (33.9%)	308 (32.7%)	64 (4.5%)
6	Disease outbreak	408 (28.7%)	421 (29.6%)	329 (23.2%)	262 (18.5%)
7	Alternation in reproduction cycle of species	498 (35.1%)	472 (33.2%)	321 (22.6%)	129 (9.1%)
8	Degradation of habitat	682 (48%)	611 (43%)	116 (7.3%)	11 (.7%)
9	Extinction of species	766 (53.9%)	622 (43.8%)	21 (1.6%)	11 (.7%)

**Table 3** shows how the respondents responded to the effects of urbanization on biodiversity in the study area. **Table 3** shows the responses of the respondents as they concern the effects or urbanization on biodiversity in the study area. Out of the 1420 entire respondents, 741 (52.4%) strongly agreed that loss of habitat is an urbanization effect on biodiversity, 572 (40.3%) agreed to that while 104 respondents (7.3%) disagreed and none strongly disagreed. 422 respondents (43.8%) were strongly of the opinion that introduction of invasive species constitutes an effect of urbanization on biodiversity, 638 respondents (44.9%) agreed to that, 86 respondents (96.1%) disagreed and 74 (5.2%) strongly disagreed. 604 (42.5) respondents were strongly of the opinion that over exploitation of resource is one of the effects of urbanization on biodiversity in the study area. 638 (44.9%) respondents agreed to that, 108 (7.6%) strongly disagreed and 22 (1.6%) respondents strongly disagreed. On the issue of changes in specie distribution as it is affected by urbanization, 521 (36.7%) respondents strongly agreed to that, 484 (34.1%) agreed, 306 (21.5%) disagreed, while 109 (7.7%) respondents strongly disagreed. 566 (39.9%) of the respondents strongly agreed that urbanization affects the population changes of species in the area, 482 (93.9%) agreed to that, 306 (21.5%) disagreed and 109 (7.7%) strongly disagreed. 408 (28.75) respondents strongly agreed that disease outbreak is an urbanization effect on biodiversity, 421 (29.6%) respondents agreed to this, 329 (23.2%) of the respondents disagreed and 262 (18.5%) of the respondents strongly disagreed. Considering alteration in reproduction cycle as an effect of urbanization on biodiversity, 493 (35.1%) respondents strongly agreed, 472 (33.2%) agreed, 321 (22.6%) disagreed and 129 (9.1%) respondents strongly disagreed. 682 (48%) of the respondents agreed that degradation of habitat is one of the urbanization effects on biodiversity, 611 (43%) agreed to that, 116 (7.3%) disagreed and 11 (0.7%) of the respondents strongly disagreed. On the issue of extinction of species as one of the effects of urbanization on biodiversity, 764 (53.9%) respondents strongly agreed that it is one of the effects, 622 (43.8%) agreed equally to that, 21 (1.6%) disagreed and 11(0.7%) strongly disagreed. Identifying the causes of urbanization, majority of the respondents in **Table 1** either strongly agreed or agreed that natural growth is a cause to urbanization in the area. 720 respondents out of 1420 total respondents strongly agreed while 672 representing 47.3% of the total respondents agreed to it. Hence, 1392 respondents representing 98% of the total respondents were in agreement. 99.8% of the entire respondents either strongly agreed or agreed that rural-urban migration is a cause of urbanization. 93.1% of the respondents either strongly agreed or agreed that better and greater availability of services constitute a cause of rapid urbanization. 93.2% of the respondents were in affirmative as to higher wages and better employment opportunities causing rapid urbanization. 92% of the respondents stood for displacement by conflict and environmental disaster causing rapid urbanization in the area. Also majority of 64.7% were of the opinion that reclassification of rural villages into smaller urban settlements constitute a cause of rapid urbanization in the area. However, most respondents (64.7%) rejected flight from discrimination and social stigma as a cause of rapid urbanization in the area. In **Table 2** most of the respondents affirm that population pressure (85.2%), pollution (81.9%), deforestation (99%) climate change (82.3%), soil erosion (81%) and habitat loss (99.3%) are problems of urbanization in the area. On the other hand, majority of the respondents agreed that poor law enforcement is not a problem of urbanization here. Most of the respondents in **Table 3** agreed that all the options here constitute effects of urbanization on biodiversity in the area. Loss of habitat (2.7%), introduction of evasive species (88.7%), over exploitation of resources (90.8%) changes in species distribution (70.1%), population changes of species (73.8%), disease outbreak (95.2%), alteration in reproduction cycle (68.3%), degradation of habitat (91%) extinction of species (97.7%).

## RESULTS AND DISCUSSION

Enugu metropolis, being highly populated is experiencing urbanization processes, which are being brought about by factors such as natural growth, rural-urban migration, higher wages, better employment opportunities, greater availability of social services and the likes. As the country Nigeria entered the oil boom era from early 1970s and the economy developed then, a lot of income started accruing from the oil sector. These incomes were used mainly in urban areas of the country. As many Nigerians could have more access to money unlike before, people started living frivolously. Consequently, couple with improved life and health facilities, there was a rapid increase in the population of Nigerians. The country with less than 56 million people in 1963 was having a population of more than 100 million in 1990s (NPC, 1963, 1991). Meanwhile because of the huge revenue accruing from oil and opportunities created in urban areas, many people particularly the youths who were formerly engaged in agricultural activities in rural areas drifted to urban areas in search of white collar jobs. This trend increased drastically the population growth in urban areas in Nigeria. According to the 1991 census, 42% of the country's population was living in urban areas as against 7% in 1931, 10% in 1952, 19% in 1963 and 33% in 1984 Enugu metropolis has not been an exception. The population has been on the increase within the metropolis in the last few decades as a result of rapid urbanization and subsequent influx of people. In 1953 the population was 63,000. This rose to 482,977 in 1991 and by 2006, the population was put at 722,664 (NPC, 2006). As a result of the increase in population various environmental problems started to emanate. These problems include deforestation, climate change, pollution, erosion as well as habitat loss among others. As a result of population pressure within the metropolis, there is equally unprecedented pressure on the available housing units in the area. Hence, rental values of residential housing units are increasing and many low classed residents are moving out of the core city to the suburbs like Ugbo Odogwu, Ugbo Alfred etc. they resort to erecting shanties here and in most cases at the peripheries of the city where they virtually pay little to nothing for land acquisition, as most of these shanties are erected along undulating hilly areas. The consequences of this development are that top cover of the soil is being removed while erecting these shanties, and natural habitat destroyed. Hence there is easy, run-off from these hilly developed areas down to the city bringing about flooding and erosion. Furthermore, under undisturbed vegetation, plants around the metropolis generate a lot of oxygen needed by residents of the metropolis, and absorb excess carbon

dioxide given out in the area. This brings a balance in temperature in the metropolis. But as the vegetative parts of these hilly areas are cleared, the excess carbon dioxide generated in the core city finds it difficult to be reabsorbed and no additional source of oxygen comes into the area. Hence, there is imbalance in temperature which tends to contribute a great deal to the warming of the environment within the metropolis. Emodi re-affirmed that plants are the lungs of the metropolis” the idea being that excess carbon dioxide produced in urban areas would be absorbed by the photosynthetic process of plants and oxygen given off. This is a contribution to purification of the air. According to him, the green surfaces mitigate the loss desirable aspects of the urban areas. Within their confines and beyond, they reduce the stress produced by heart; decrease the noise levels and filter out certain pollutants. Gaston and Spicer et al. asserted that the reasons of studying biodiversity in urban areas are many, that humans cannot exist without biodiversity as we use it directly or indirectly in a number of ways <sup>[19]</sup>. These include for food, medicinal purpose, fibres biological control, ecosystem services, nutrient cycling and the likes consequently as urbanization encroaches, these roles of biodiversity in the environment are disturbed and destroyed. This has resulted in habitat loss in the area, environmental degradation, introduction of invasive species to the study area. Niemela et al. observed that the nature of urban environments and the movement of humans between them tends to increase the prevalence of species exotic to a particular place and hence the existence of invasive in native ecosystem <sup>[32]</sup>. Nielsen et al. noted that in many parts of the world urban parks are made up of approximately half exotic species <sup>[22]</sup>. A lot of natural environments have been encroached upon as a result of urban development in the metropolis. A number of them like the Enugu international Airport and various industrial projects in the metropolis have brought about the extinction of carious plants and animals in the area. Deforestation is intrinsically linked to the loss of biodiversity as original rainforests host numerous species of precious fauna and flora. Some of the animals that are either in extinction, endangered or threatened in the area include, lion, tiger, elephant, gorilla and chimpanzee. The plants among others include; kaki leave, African walnut, Obeche, Iroke, African nutmeg etc. Among the many human activities that bring about biodiversity loss, urbanization produced some of the greatest local extinction rates and frequently eliminates the large majority of native species <sup>[36]</sup>.

## CONCLUSION

Urbanization interacts with biodiversity in multi-faceted and complex ways in Enugu metropolis. Urbanization processes in the areas came about as a result of factors such as natural growth, rural-urban migration, better employment opportunities, greater availability of services among others. The population pressure exerted by mainly the migration of mainly youth from rural areas created different problems, among which are the effects of climate change in the area, pollution of all kinds, deforestation in an unprecedented manner, flooding as well as soil erosion. Hence, the roles of biodiversity such as provision of food, fibres, medicine, provision of various ecosystem services and other roles are disturbed and destroyed. This has resulted to loss of habitat in the area, environmental degradation, introduction of invasive species to the ecosystem, extinction of native species, endangering and threatening of the available local species. It is therefore not an irony of circumstance to assert that the recommendations therein will go a long way towards proffering solutions to these problems in the study area.

## RECOMMENDATIONS

It is hoped that the following recommendations will go a long way towards curbing the various problems associated with urbanization as it affects biodiversity in the study areas;

- The adoption of the World Banks urban strategy which emphasizes strong systems and urban governance to enable sustainable urban growth with opportunities for all. This will include, Green Cities, which comprises low carbon, climate resilient growth, accessing necessary financing, improving solid wastes management systems and addressing pollution and livability challenges.
- Special protection and recovery measures for threatened species should be encouraged. Endangered and threatened species should deliberately protected and preserved. Conscious efforts should be made to create natural environment for such, like in Yankari, Bauchi State of Nigeria.
- Ex-situ and in-situ conservation of genetic diversity. Both the flora and fauna should be provided with conducive environment to survive their natural environment. Where necessary, artificial environment could augment.
- Public awareness, communication and education. Enlightenment programs should be made available to the public on the implications of urbanization processes on biodiversity and the environment at large, as well as the need for efforts mitigation.
- Elimination of subsidies that promote excessive use of ecosystem services.
- Both Federal, State and Local Government should make vigorous efforts at providing adequate physical, economic and social infrastructures to match the teeming population in the area. This will reduce the pressures on the natural environments at the suburbs.
- Addressing unsustainable consumption patterns. Conscious effort should be encouraged towards replacing certain species, particularly of the flora. Planting of trees should be encouraged.



- Biodiversity conservation should be integrated in the development plan of the area.
- Increased transparency and accountability of government and private sector performance in decisions that affect ecosystems in the area. Ideal governance should be embraced, which will entail ensuring that the right people with reputations and professional expertise and expectancies be appointed to positions that have to do with environment, physical planning and urban development. This will ensure increased productivity.
- Enabling environment should be created by the government concerned for the populace both at the rural and urban centres, to help reduce the problems of poverty and unemployment. When this is done, slums in urban centres could be demolished and the areas returned to green areas.
- The adoption of Geographic information system could be incorporated in urban management of the area to ensure an orderly urban development that will not so much encroach on the fauna and flora in the area.
- Intergovernmental approach where there is a patterned interdependent and bargained behavior among concerned federal state and local governments officials will add value towards the up keep of biodiversity in the area.

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