

# Reducing the Threats of Environmental Factors to Buildings: A Case Study of Nsukka Urban in Enugu, Nigeria

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## ABSTRACT

The effects of environmental factors on buildings have become a major issue in recent times as it causes worry and discomfort for building occupants. Some of the threats of environmental factors to buildings include: dust, smoke, acidic rain, flood, loss of life and properties, building failure and collapse. As a result of this, the cost of building construction and maintenance is increasing at an alarming rate and that is why this research aims to identify the ways of reducing the threats of environmental factors to buildings especially in Nsukka Urban area of Enugu State, Nigeria. The research aims at analyzing the threat of environmental factors to buildings, and proffer remedial measures to these effects. The instrument used for the data collection was structured questionnaire and the target population consisted of groups of professionals who were architects, builders, quantity surveyors, engineers and some residents in Nsukka. Analysis of the data was done using the mean item scores. The study revealed that interface with the ecosystem, increase in various types of pollution and deforestation are major environmental threats to buildings. The study identified ways of reducing the threat of environmental factors to buildings some of which includes the use of energy-efficient and eco-friendly equipment for building construction, planting trees and shrubs as wind breakers near the houses and homes to reduce the speed of wind. The study recommends the

need to adopt and implement sustainable construction practices as a way of reducing the environmental threats to buildings. This can be achieved if all the stakeholders are involved, especially the government, which plays a cardinal role in the formulation of regulations and policies that support sustainable construction practices.

**Keywords:** Buildings, Environmental Factors, Threats of Environmental Factors and Nsukka Urban

## INTRODUCTION

The building construction industry plays an important role in the economic and social development of nations around the world. In Nigeria, the building construction industry is made up of a wide range of loosely integrated practitioners that collectively design, construct and maintain a wide range of different buildings and civil engineering projects. The state of affairs of the construction industry in Nsukka which is suburb of Enugu State, Nigeria is not quite different from other developing countries. The focus of the construction industry in Nsukka Urban is largely on economic growth and improving the quality of life of the people whilst the environmental impacts are utterly neglected [1]. The GDP released for the third quarter of 2016 by the Nigerian Institute of Building (NIOB), indicates that

the construction industry contributed 19.2% to the economy [2]. Accordingly, the construction industry is the third largest sector in the Nigerian economy after the oil and agricultural sector illustrating its contribution to the social and economic gains. [3] stated that for the sustenance of livelihood, every growing society is characterized by the erection of either permanent or temporary structures (buildings) for the purpose of shelter which is the second necessity of life.

Building or housing is the most fundamental need for humankind as it provides shelter for man and her properties. [4] defined a building as an edifice or a structure with a roof and walls standing more or less permanently in one place, such as a house or factory. [5] stated that a building represents a physical division of the human habitat (a place of comfort and safety) and the outside (a place that at times may be harsh and harmful). Buildings serve several societal needs, primarily as shelter from weather, security, living space, privacy, to store belongings, and to comfortably live and work. All buildings are built with the same components such as foundations, walls, floors, rooms, and roofs. [6] pointed that all building has three basic requirements and components which are, foundation, plinth and superstructure. The foundation is the part of the building which is deeply rooted to the ground, it carries the strength and distributes the load of the house to the surrounding ground. The plinth is that part between the surrounding ground surface and floor space immediately above the ground of a building. Plinth resists entry of rainwater and insects inside the building. The superstructure is constructed above the underground level and it consists of the floor structures, sunshade, parapet, lintel, doors, windows, walls, columns and roof structures [7]. There are other building services after the construction, which are also counted as components of building construction. They include: water supply, electricity supply, drainage, and sanitation supply, internal closets' and cupboards'

services. [8] stated that the quest for urbanization and industrialization has tremendously increased over the years resulting in various environmental factors threatening buildings and causing environmental degradation.

Environmental factors according to [9], are used to describe some implications of human activities and how they affect the buildings and its surrounding layout. More commonly, environmental factors refer to effects of human activities on the ecosystem, habitat, and the natural world [10]. At the simplest form, this includes the study of interactions and activities among all forms of the environment on building lifecycles. Environmental factors which may become threats to houses and the occupants may not be limited to air pollution, water pollution, radioactive pollution and mold contamination. [11] stated that there is an increase in the rate of building collapse, declining health and significant loss of lives and properties as a result of environmental factors such as storms, snow, water encroachment, flood, tsunami on most buildings around the world today. Other environmental factors that may become threats to buildings include: acidification of lakes and rivers, deposition of air pollutants on land and surface water bodies, mining of all categories and logging/forestry[12]. Most agriculturists have also reported that some type of fertilizers have some adverse effect on the soil by rendering the soil weak and barren thereby making them prone erosion [13]. A building basically is required to provide comfort and protection from all external hazards but sometimes the diverse pressure from the environmental factors poses a major threat to its expected load bearing capacity.

The threat of environmental factors on buildings manifest in diverse forms and degrees which includes, accelerated deterioration, risk of failure, collapse and increased running cost. [14] listed some of the threats resulting in environmental factors to include dust, smoke, acidic rain

and flood which drastically affects the building envelop. Climate agents also contributes immensely to the deterioration of building fabrics [15]. In a developing country like Nigeria, the review of literature and anecdotal evidence reveal that between 2010 and 2019, over 81 incidences of collapsed buildings have been reported in her major towns and cities leading to several fatalities and this has been traced to the threat caused by environmental factors such as illegal mining activities, uncertified borehole drilling activities and unregulated deforestation [16]. The Nigeria Construction and Infrastructure Summit Group estimates that the country loses between 2.03tn and 3.05tn annually to infrastructure deficit from building failure because the magnitude of overall damage posed by environmental factors [17]. This menace caused by environmental factors can be handled by improved maintenance on the building structure and its environment. The building designers should be well informed of the threats posed by environmental factors and developed possible ways that the building structure can withstand these threats. It is also appropriate to inform the building users of the expected weaknesses and possible maintenance measures to ensure continuous functionality.

With the current rate at which the earth's resources are being depleted, there is a growing urgency to restructure the construction industry globally so as to minimize the ugly threats posed by environmental factors on buildings. In response to this, sustainable construction was recently proposed as a way of making the construction processes, activities and practices more economically, socially and environmentally responsive [9]. This was motivated by the goal of securing the future generations ability to meet their needs through the application of sustainable development principles to meet the present needs. With the rising awareness of the need for sustainability, especially in the construction industry, it is important for Nigeria to keep pace with this global

movement by adopting sustainable construction practices. Since no research has been carried out on reducing the threats of environmental factors to buildings, especially in Nsukka Urban of Enugu State, this research therefore analyses the effects of environmental factors on buildings, and therefore proffers remedial measure to these effects.

## **STATEMENT OF THE PROBLEM**

Recent studies have shown that environmental factors are becoming a major threat to the general wellbeing of buildings and occupants in Nigeria. The drastic increase of apocalyptic fires, floods, devastating strong winds and increasing greenhouse emissions are impacting on buildings negatively. High temperatures and heat waves are causing internal building temperatures to increase and this result in heat stress, health problems, and loss of productivity for those who inhabit the buildings. More humid weather affects buildings in warm weather climates, as sea level rise could permanently inundate homes, workplaces, or service centers. Flooded coastal health centers could hamper delivery of critical health services amongst many other effects. These effects pose major threats to buildings and have economic implications to buildings especially with respect to cost of maintenance of the affected buildings, cost of rehabilitation and reconstruction of these buildings. The effects of environmental factors will also warrant a change in the design of future buildings to accommodate the impact of these environmental factors.

Buildings in Nsukka and Enugu State, Nigeria, being a part of the global community is not immune to the threats posed by these environmental factors. Nigerian climatic condition is tropical, which is basically influenced by two winds; South-West wet monsoon which blows across the Atlantic ocean (which brings with it rainfall) and the North-East wind which blows across Sahara desert (which brings along; dust, dry season and harmattan). The

increasing frequency and intensity of these environmental factors, and the associated natural disasters, bear negative impacts on the buildings and her occupants. Therefore, it is vital to switch to more sustainable methods of construction to mitigate the environmental impact on buildings. Therefore, this study sought to ascertain ways of reducing the threats of environmental factors to buildings, especially in Nsukka Urban.

### **PURPOSE OF THE STUDY**

The main purpose of the study was to find our ways of reducing the threats of environmental factors to buildings in Nsukka Urban of Enugu, Nigeria. Specifically, the study sought to ascertain the following:

1. The environmental factors that pose threats to buildings
2. The major threats that these environmental factors pose to buildings and the occupants
3. The measures to adopt in mitigating the threats posed by the environmental factors on buildings

### **RESEARCH QUESTIONS**

The study was guided by the following research questions:

1. What are some of the environmental factors that pose major threats to buildings?
2. What are the major threats that these environmental factors pose to buildings and the occupants?
3. What are the measures to be adopted in mitigating the threats posed by the environmental factors on buildings?

### **LITERATURE REVIEW**

#### **Building Construction in Nigeria**

According to [14], the four most important external environmental factors that affect building conditions include community issues, weather conditions, economic situation (such as economic boom or meltdown) and government policy. The environmental factors that have been

identified to pose major threats to buildings have been divided into two groups; the physical factors and the technological factors [18]. Technology is an aspect of the environment that should be considered in developing strategic plans. [19] maintained that the appropriate construction technology can be measured by the availability of locally made plant and equipment, skilled manpower resources, extent of local material resources and the degree of utilization of such local construction resources. However, the building construction industry in Nigeria following the oil boom in 1970's was characterized by the development projects which required the construction technology and resources from developed countries. The lack of technological know-how and the shortage of managerial manpower were considered to be one of the major problems and constraints facing the nation. The situation has improved but there is still lack of basic knowledge of production methods and design techniques for machinery which constitute a serious constraint to rapid industrialization of the country. The situation is aggravated by acute shortage of managerial manpower, epileptic power supply, use of substandard materials, poor monitoring and lack of strong legislative laws to guide construction practices.

As at present, the country still remains a net importer of technical manpower, virtually most spare parts are imported and most investment in research and development are made abroad, except those sponsored by the government in public owned institutions. The physical factors on the other hand, comprises of environment within which a building project is sited. Building locations may impact considerably on house development as construction projects are always affected by physical influences [20]. The geographical location of a project, ground conditions and weather patterns are the most common examples of physical factors. They are unpredictable and as such, management actions have not been able to prevent their occurrence. Nevertheless, [21]



opined that builders should take significant consideration of physical factors when planning and designing building projects in order to mitigate its adverse effects on the houses and occupants. [18] identified causes of building failure as due to natural occurrences such as earthquakes, tornadoes, floods etc. [22], looked at some of the physical factors that contribute to building failure as due to man's negligence in some vital areas in construction such as soil investigation, incorporating design for extra loads, stress from winds, earthquakes, uneven terrain, use of substandard materials, poor monitoring and overall poor workmanship.

### **Building resilience Houses to withstand Environmental Factors**

Studies show that by 2050, 1.6 billion people living in more than 970 cities will be regularly exposed to extreme high temperatures [23]. Coupled with the 'urban heat island effect' which makes cities warmer than the surrounding rural area, this puts urban dwellers at high risk. Communities can create urban forests and green spaces to reduce heatwaves in cities. Also trees, shrubs and other plants can be planted to cool the surrounding environment by offering shade and releasing water through their leaves. Structural designs can also help reduce heat inside buildings [24]. In Vietnam, traditional housing designs such as the optimum orientation of buildings, high-rise rooms, and large openings improve ventilation. Trombe walls, heavyweight structures of concrete, stone, or other heavy material that capture solar heat are used in China, Chile, and Egypt. Green roofs and reflective surfaces can also reduce temperatures in and around buildings [25].

Also, cyclones and storms are expected to become more frequent and stronger with climate change. They can affect buildings in many ways, such as blowing off roofs and damaging the structures and foundations of the building. To mitigate this damage, communities can build round-shaped houses

and consider optimum aerodynamic orientation to reduce the strength of the winds [26]. Roof design also plays an important role. Strong connections between foundations and the roof are critical to building wind-resilient houses. Roofs with multiple slopes can stand well in strong winds, and installing central shafts reduces wind force and pressure to the roof by sucking in air from outside [27]. Roofs that cover balconies or patios can also be designed to break during strong winds to prevent additional structural damage to the essential parts of the house. This is called frangible architecture or 'planning for damage' approach.

Adapting to cold and temperate climates requires capturing heat and minimizing heat loss. Insulations in roofs, walls, ceilings, and double-glazed windows help to minimize heat loss and lead to more energy efficient buildings [28]. In colder regions, Trombe walls can absorb heat by day and radiate it out by night when it is colder. Water has a high capacity to store heat and can be used in "water walls"; that instead of concrete, contain drums of water to store heat [29]. Buildings should be also be oriented to maximize sun exposure, and external surfaces of walls should be painted dark. Green roofs that support plant growth on rooftops are used in many cities around the world and have been shown to provide insulation and reduce the energy demand for cooling during summer and heating during winter.

### **Nsukka Urban**

Nsukka is a town and a local Government Area in Enugu State, Nigeria. It shares a common border as a town with Eden, Opi (archaeological site) and Obollo Afor on the North. Nsukka town is known as the site of the University of Nigeria, the first indigenous Nigerian University founded by the late Dr. Nnamdi Azikiwe in 1960. It lies in the Udi Hills at an Elevation of 1,410ft and (430m). It is an agricultural town. Nsukka's ancient wars in the 18<sup>th</sup> and 19<sup>th</sup> century had one of the best fighting forces

in what is present day Enugu-North Senatorial District, which they employed in waging war against their neighbors in order to gain more territories for the rising population and for other purposes. According to population [30], Nsukka has a population of 309,633. This has to a large extent contributed to rapid human activities including the construction of buildings for human habitation and other circular activities. The landscapes are being depleted as well as other environmental factors. [31] reports that there is wide spread practice of open defecation, uncertified digging of boreholes and irregular dumping of refuse along the streets of the community. These activities pose major environmental threats to build facilities and also to the people staying within these environments [32]. The effects of environmental factors on building have become a major issue in recent times as it causes worry and discomfort for building occupants. Some of the threats include dust from timber sheds, smoke, acidic rain, flood, loss of life, constant bulldozing of landscapes thus leading to damaged buildings, building collapse/failure and landslide. These attendant factors increase the cost of designing, constructing buildings and maintenance.

## **METHODOLOGY**

The study adopted survey research design. A survey research design, according to [33] is the process of conducting research using survey that researchers send to survey respondents. In survey study, views and facts are collected through questionnaire, interviews among others, analyzed and used for answering research questions. The data collected from survey is then statistically analyzed to draw meaningful research conclusions. The survey research design was appropriate for this study because it aimed at analyzing the threat of

environmental factors to buildings, and proffer remedial measures to these effects.

The study was conducted in Nsukka Urban of Enugu State, Nigeria. The population for the study was 186 correspondents. The population comprised of 62 building occupants/residents within Nsukka Urban, 21 architects, 47 builders, 34 quantity surveyors and 22 engineers who are all active building practitioners within the Nsukka urban and also registered in the Enugu State Ministry of Housing. The sample for the study was 186 respondents. A structured questionnaire titled: reducing the threats of environmental factors to buildings, was used for data collection and was on 5-point Likert scale. The structured questionnaire had 49 items developed for collecting data in accordance with the research questions. The instrument was in three sections A-C. A centered on environmental factors that pose threats to buildings, B dealt with the major threats that these environmental factors pose to buildings and the occupants while C centered on the measures to be adopted in mitigating the threats posed by the environmental factors on buildings. The instrument was face validated by three experts. These were experts from Enugu State Ministry of Housing. The internal consistency reliability coefficient of 0.86 was obtained for the questionnaire using Cronbach alpha technique. Out of one hundred and ninety two copies of the questionnaire administered to the respondents with the help of three research assistants, only 188 copies were duly retrieved, which represent 97.92 percent return rate.

Data collected were analyzed using the mean for answering the research questions. Any item with mean of 3.50 was regarded as accepted while any one with mean below 3.50 was regarded as rejected.

## RESULTS

**Table 1. Mean and Standard Deviation of the respondents on the environmental factors that pose threats to buildings**

| S/N | Items  | Mean. | S.D  | Remarks. |
|-----|--|-------|------|----------|
| 1   | Dusts, air and water pollution   | 3.69  | 0.68 | Accepted |
| 2   | Large scale wildfires  | 3.47  | 0.23 | Rejected |
| 3   | Large-scale deforestation  | 3.61  | 0.66 | Accepted |
| 4   | Climate change and global warming  | 3.56  | 0.59 | Accepted |
| 5   | Bush burning and Soil degradation  | 3.79  | 0.78 | Accepted |
| 6   | Acidic rain and excessive rainfall   | 3.58  | 0.62 | Accepted |
| 7   | Oil spillage   | 3.44  | 0.22 | Rejected |
| 8   | Factory and industrial waste toxins  | 3.62  | 0.56 | Accepted |
| 9   | Flooding and Soil erosion  | 3.65  | 0.61 | Accepted |
| 10  | Overgrazing and exposure of soil surface   | 3.63  | 0.66 | Accepted |
| 11  | Emission of greenhouse gases   | 3.54  | 0.75 | Accepted |
| 12  | Generation of non-biodegradable wastes   | 3.77  | 0.78 | Accepted |
| 13  | Unregulated disposal of wastes in water channels/water bodies  | 3.51  | 0.82 | Accepted |
| 14  | Ozone layer depletion  | 3.66  | 0.62 | Accepted |
| 15  | Urban sprawl   | 3.30  | 0.18 | Rejected |
| 16  | Depletion of landscapes by open defecation, mining activities, illicit digging of wells, boreholes and other land degradation activities | 3.67  | 0.62 | Accepted |

*Key: S.D – Standard deviation*

Researchers in this section, investigated the environmental factors that pose threats to buildings especially in Nsukka Urban of Enugu State, Nigeria. Data in Table 1 revealed that 13 items out of the 16 items all have their mean value ranged from 3.51 to 3.79. This shows that the mean value of each item was above cutoff point of 3.50, indicating that respondents accepted the items as the environmental factors that pose

threats to buildings especially in Nsukka Urban of Enugu State, Nigeria. Similarly, the standard deviation of these items ranged from 0.59 to 0.78 indicating that the respondents were close to one another in their opinion. However, the respondents did not accept items, 2, 7 and 15 as the environmental factors that pose threats to buildings in Nsukka Urban of Enugu State, Nigeria.

**Table 2. Mean and Standard Deviation of the respondents on the major threats that these environmental factors pose to buildings and the occupants**

| S/N | Items  | Mean. | S.D  | Remarks. |
|-----|--|-------|------|----------|
| 1   | Overheating of buildings due to increased exposure to higher heat from the sun   | 3.61  | 0.68 | Accepted |
| 2   | Prevalence of damp and mould which can lead to allergies, respiratory problems, nausea, vomiting and general ill-health of building occupants                          | 3.55  | 0.56 | Accepted |
| 3   | Building failure, drowning and injury of occupants due to floodwaters  | 3.61  | 0.68 | Accepted |
| 4   | Increased risk of infectious diseases especially water borne such as cholera and gastrointestinal diseases.  | 3.54  | 0.53 | Accepted |
| 5   | Building collapse due to illegal mining activities near residential houses, landslides and strong winds.   | 3.72  | 0.75 | Accepted |
| 6   | Water pollution due to contamination by fertilizers and unregulated dumping of refuse in water channels that supply water to houses such as tap, wells and reservoirs. | 3.52  | 0.61 | Accepted |
| 7   | Cracks, depletion of building walls and paints due to acidic rains   | 3.40  | 0.22 | Rejected |
| 8   | Accidental house burning due to unregulated bush burning near residential houses   | 3.66  | 0.54 | Accepted |
| 9   | Poor waste disposal near houses and homes makes occupants prone to diseases and rodents attacks  | 3.63  | 0.66 | Accepted |
| 10  | Damages to doors, windows, roofs and other parts of building due to strong winds and bad weather conditions  | 3.60  | 0.60 | Accepted |
| 11  | Respiratory tract infection to occupants and the defacing of building walls due to overexposure of houses to dust elements   | 3.50  | 0.68 | Accepted |
| 12  | Erosion that threatens building foundation due to illicit digging of boreholes and water wells in residential areas.   | 3.73  | 0.70 | Accepted |
| 13  | Erosion that threaten building foundations due to illicit bush burning that depletes and make the soil weaker.   | 3.54  | 0.62 | Accepted |
| 14  | Open defecation can promote the spread of diseases and infection on residents and causes a degradation of landscapes of built environments                             | 3.58  | 0.61 | Accepted |

This section investigated the major threats that environmental factors pose to buildings and occupants especially in Nsukka Urban

of Enugu State, Nigeria. Data in Table 2 revealed that 13 items out of the 14 items all have their mean value ranged from 3.50 to

3.72. This shows that the mean value of each item was above cut-off point of 3.50, indicating that respondents accepted the items as the major threats that environmental factors pose to buildings and occupants in Nsukka Urban of Enugu State, Nigeria. Similarly, the standard deviation of

these items ranged from 0.53 to 0.75 indicating that the respondents were close to one another in their opinion. However, the respondents did not accept item, 7 as an environmental factor that pose threats to buildings and the occupants in Nsukka Urban of Enugu State, Nigeria.

**Table 3. Mean and Standard Deviation of the respondents on the measures to be adopted in mitigating the threats posed by the environmental factors on buildings**

| S/N | Items   | Mean. | S.D  | Remarks. |
|-----|---|-------|------|----------|
| 1   | Minimal disturbance or reduced destruction of landscapes and site condition   | 3.54  | 0.68 | Accepted |
| 2   | Use of non-toxic and recycled/recyclable material to reduce the amount of toxic waste produced in the society   | 3.57  | 0.63 | Accepted |
| 3   | Efficient use of water and water recycling operations   | 3.61  | 0.66 | Accepted |
| 4   | Use of energy-efficient and eco-friendly equipment and systems  | 3.53  | 0.59 | Accepted |
| 5   | Use of renewable energy   | 3.59  | 0.78 | Accepted |
| 6   | Installation of improved indoor air quality equipments for human safety and comfort in buildings  | 3.58  | 0.62 | Accepted |
| 7   | Planting trees and shrubs as wind breakers near our houses and homes to reduce the speed of wind  | 3.61  | 0.52 | Accepted |
| 8   | Planting trees and shrubs near the houses and homes to block dusts and protect the occupants from dust related health challenges  | 3.62  | 0.56 | Accepted |
| 9   | Installations of Insulations systems in roofs, walls, ceilings, and double-glazed windows which help to minimize heat loss and lead to more energy efficient buildings.   | 3.55  | 0.61 | Accepted |
| 10  | Installation of Trombe walls in colder places, to absorb heat by day and radiate it out by night when it is colder.   | 3.53  | 0.66 | Accepted |
| 11  | Frangible architecture can be adopted where roofs with multiple slopes can stand well in strong winds, and installing central shafts reduces wind force and pressure to the roof by sucking in air from outside.  | 3.54  | 0.75 | Accepted |
| 12  | Green roofs that support plant growth on rooftops can be used to provide insulation and reduce the energy demand for cooling during hot and heating during cold season.   | 3.77  | 0.78 | Accepted |
| 13  | Communities can build round-shaped houses and consider optimum aerodynamic orientation to reduce the strength of the winds.   | 3.51  | 0.82 | Accepted |
| 14  | A cost-effective, nature-based way to address flooding is to plant trees or other vegetation around buildings. The roots of the plants will act like sponges to recharge groundwater, and during heavy rainfall, the roots allow water to penetrate the soil and reduce the risk of flooding. | 3.66  | 0.62 | Accepted |
| 15  | Communities can create urban forests and green spaces to reduce heat waves  | 3.55  | 0.58 | Accepted |
| 16  | Most housing designs such as the optimum orientation of buildings, high-rise rooms, and large openings can improve ventilation  | 3.52  | 0.68 | Accepted |
| 17  | Legislation on land use divisions such as creating land for industrial buildings, residential buildings, commercial buildings and educational buildings   | 3.56  | 0.65 | Accepted |
| 18  | Creating green areas such as parks, tree planting and forest reserves   | 3.55  | 0.58 | Accepted |
| 19  | Adequate and regular environmental cleaning exercise to clear up the refuse dumps across the cities.  | 3.59  | 0.54 | Accepted |

This section investigated the measures to be adopted in mitigating the threats posed by the environmental factors on buildings especially in Nsukka Urban of Enugu State, Nigeria. Data in Table 3 revealed that all the 19 items have their mean value ranged from 3.51 to 3.77. This shows that the mean value of each item was above cutoff point of 3.50, indicating that respondents accepted all the items as the possible ways of mitigating the threats posed by the environmental factors on buildings in Nsukka Urban of Enugu State, Nigeria. Similarly, the standard deviation of these items ranged from 0.52 to 0.82 indicating that the respondents were close to one another in their opinion.

## DISCUSSION OF FINDINGS

The results of the study revealed that dusts, air, water pollution, bush burning and unregulated disposal of wastes in water channels are some of the environmental factors that pose major threats to buildings and the occupants. These findings agree with the finding of [34] who stated that irregular disposal of factory/industrial waste toxins and the generation of non-biodegradable wastes constitute major challenges to the overall general wellbeing of houses and their occupants. This is also in line with [35], who stated that large scale deforestation, mining activities, overgrazing by herdsmen and the negative effects climate change/global warming are all



threats to building elements and surroundings.

The study identified that overheating of buildings due to increased exposure to higher heat from the sun, prevalence of damp and mould which can lead to allergies, respiratory problems, nausea, vomiting and general ill-health of building occupants are some of threats that environmental factors pose to buildings and the occupants. [36], supported this by stating that damages caused to houses by external forces include damages to doors, windows, roofs and other parts of building due to strong winds and erosion that threatens building foundation which are mostly triggered by illicit digging of boreholes and water wells in residential areas. [37] also stated that poor waste disposal near houses and homes makes occupants prone to diseases and rodents attacks.

Similarly, the results presented in Table 3 reveals the possible ways of mitigating the threats posed by the environmental factors on buildings. Among them include; planting trees, shrubs near the houses, homes to block dusts and protect the occupants from dust related health challenges and also the installations of insulation systems on the roofs, walls, ceilings; installation of double-glazed windows to minimize heat loss which leads to more energy efficient buildings. This is also in line with [38], who stated that environmental threats to houses can be reduced by planting trees and shrubs as wind breakers near the houses and homes to reduce the speed of wind. [39] also pointed that architects and builders can adopt sustainable construction in building projects such as frangible architecture which can be adopted where roofs with multiple slopes can stand well in strong winds, thereby reducing the amount of pressure against the building elements.

## **CONCLUSION**

The aim of this research was to analyze the threat of environmental factors to buildings, and proffer remedial measures to these effects The study therefore identified the

ways of reducing the threats of environmental factors to buildings especially in Nsukka Urban of Enugu State, Nigeria. These findings of this study add to a growing body of literature on our understanding of how environmental factors affects the built environment around the world and what needs to be done to address the situation.

## **RECOMMENDATIONS**

Based on the findings of this study, the researchers presented the following recommendations for consideration:

1. Communities with the help of local government can create urban forests and green spaces by planting trees, shrubs and other plants to reduce heatwaves and to cool the surrounding environment by offering shade and releasing water through their leaves.
2. Builders and other building practitioners should adopt sustainable construction practices such as installation of rainwater harvesting and recharge systems in buildings that capture water on the roofs of buildings which can be used to store water during drought and reduce flood risk during heavy rains.
3. The roots of the plants act like sponges to recharge groundwater, and during heavy rainfall, the roots allow water to penetrate the soil and reduce the risk of flooding. Therefore, building stakeholders should be enlightened and encouraged to plant small trees, flowers or other vegetation around buildings in order to help in controlling droughts and flooding.
4. The community with the help of the local government should regulate and control the activities of stakeholders involved in mining activities, digging of wells, boreholes, bush burning and other environmental activities that pose a threat to the built environment.
5. The government at all levels should provide adequate waste disposal channels to address the challenge of

irregular waste disposals that litter the environment.

6. The community with the help of the government should provide mobile toilet facilities to address the challenge of open defecation.
7. Building construction practitioners should adopt the installation of green roofs that support plant growth on rooftops which have been shown to provide insulation and reduce the energy demand for cooling during hot and heating during colder seasons.
8. The government at all levels should formulate regulations and policies that support sustainable construction practices among the building practitioners.

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