

ARCHITECTURAL STRATEGIES FOR CURBING DEFORESTATION IN NIGERIA: A REVIEW

Obianuju M. Jonas¹, Kingsley E. Anih², Eziyi O. Ibem³, Peter E. Odoh⁴

^{1,2,3,4}Department of Architecture, University of Nigeria, Enugu Campus

Email: obianuju.jonas@unn.edu.ng¹, kingsley.anih@unn.edu.ng² (Corresponding Author),
eziyi.ibem@unn.edu.ng³, peter.odoh@unn.edu.ng⁴

Abstract

Deforestation has been having far-reaching adverse impacts on the natural ecosystem, biodiversity and contributes to climate change by depleting forest resources that help to absorb vast amounts of CO₂ and other greenhouse gases from the atmosphere. In recognition of the benefits of forests in contributing to nearly all the Sustainable Development Goals, world leaders from various countries, including Nigeria, at the United Nations yearly Climate Change Conference of Parties (COP) pledged to end deforestation, reverse forest loss and land degradation by 2030. Following from this, the different professions in the built environment and other sectors are reappraising their roles in combatting deforestation and contributing to the global sustainability agenda. Therefore, aim of this study is to examine the role of architecture in curbing or slowing down the rate of deforestation in Nigeria. The key research question this paper seeks to answer is: How can architecture contribute to slowing down the rate of deforestation in Nigeria in pursuant of the COP resolution of bringing global warming at 1.5°C target by the year 2030? This study was based on a systematic review of literature, anecdotal evidence and interactions with professionals in the built environment. The paper highlighted the causes and effects of deforestation on the built environment as well as strategies for preventing or mitigating its effects from the perspective of architecture. The findings revealed that agricultural practices are the major direct cause of deforestation while overpopulation and poverty ranked the major indirect cause of deforestation in Nigeria. Findings also showed that climate change and climate imbalance is the major effects of deforestation on the built environment. Strategies for checking or slowing down the rate of deforestation in Nigeria were identified with recommendations on how to reverse the trend through architectural design principles and practice in Nigeria.

Keywords: Architecture, Built environment, Climate Change, Deforestation, Forest, Sustainable Development Goals.

INTRODUCTION

Deforestation is a global problem, and its ramifications for climate change are undeniable. This is because forests which absorb vast amounts of the warming gas Carbon dioxide (CO₂) and other greenhouse gases in the atmosphere get depleted when forests are cut down. Their ability to pull greenhouse gases from the atmosphere is lost along with habitats for animals and birds, which can lead to extinction. CO₂ is the most prevalent greenhouse gas and absorbs thermal infrared radiation from the atmosphere (Gursharn & Beant, 2017).

In recognition of the benefits of forests, The International Year of Forests' was marked in the year 2011. This designation generated momentum, bringing greater attention to the forests

worldwide (Sumit et al, 2012). Forests contribute to nearly all the Sustainable Development Goals (SDGs) of the United Nations (UN) Global Sustainability Agenda. Explicitly, they are addressed in SDG 15, to protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forest, combat desertification, halt and reverse land degradation and loss of biodiversity (United Nations, n.d.). In the yearly United Nations Climate Change Conference of the Parties (COP), world leaders from various countries including Nigeria pledged to halt deforestation, reverse forest loss and land degradation by 2030. This is one of the strategies adopted to cap global warming at 1.5degrees Celsius target, eliminating about 14% of global emissions and enhance the capacity of forests to store more carbon (Georgina & Francesca, 202).

Forests cover almost a third of the earth's land surface (Sumit *et al.*, 2012). They provide carbon storage and deliver a lot of environmental and social benefits, such as timber and biomass resources, clean water, wildlife habitat, soil conservation recreation and long term economic benefits. (Malmsheimer *et al.*, 2011 and Sumit *et al.*, 2012). Penman *et al.*, (2003) defined forest as Land of more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 per cent, or trees able to reach these thresholds. Forests cover was just 4billion hectares (30% of land) in 2005, 36% of which are classified as primary forests. About two third of known land-based species are in forests, but are now going into extinction (Muhammad 2015). Approximately 8000 tree species which make 9% of the total number of tree species are under threat of extinction (Liaison, 2012). Unfortunately, forests and the biodiversity they contain continue to be under the threat from actions to convert the land to agriculture or unsustainable levels of exploitation (FAO & UNEP, 2020)

The term “deforestation” is used quite variably. The Food and Agriculture Organization of the United Nations (FAO) uses two different parameters in defining deforestation. First, based on land use, deforestation is defined as the conversion of forest land to another land use. Second, according to crown cover, deforestation is defined as the long term reduction of this parameter below a 10 per cent threshold. Both of these definitions can present problems for assessing deforestation on the ground - while the first requires a clear and unambiguous definition for forest, the second implies an arbitrary threshold. (Markku *et al.*, 2007).

The FAO (2020) estimates the annual rate of deforestation to be around 1.3 million km² per decade. Deforestation estimates in Nigeria stand at 178 Kha/year, with 14% of tree cover lost between 2002 and 2023 (Global Forest Watch 2024). It is estimated that deforestation is responsible for around 20% of greenhouse gas emissions and 1.5 billion tons of carbon is released every year by tropical deforestation (Canadell, 2007). Not only do these Greenhouse gasses harm the air we breathe but gradually damage the environment that we live in. Due to the release of CO₂ and it not being absorbed by trees, greenhouse gasses are increasing making the planet warmer (Canadell, 2007).

Following from these, the aim of this study is to examine the role of architecture in curbing or slowing down the rate of deforestation in Nigeria. The key research question this paper seeks to answer is: How can architecture contribute to slowing down the rate of deforestation in

Nigeria in pursuant of the COP resolution of bringing global warming at 1.5⁰C target by the year 2030? The objectives of this paper are to:

- 1) Examine the direct and indirect causes of deforestation in Nigeria,
- 2) Identify the effects of deforestation in the built environment, and
- 3) To identify the strategies for checking or slowing down the rate of deforestation in Nigeria from the perspective of architecture.

RESEARCH METHODS

This study is designed to investigate the rate of deforestation, causes, and its effect on the built environment. As earlier stated, the goal is to examine the role of architecture in curbing or slowing down the rate of deforestation in pursuant of the COP resolution of bringing global warming at 1.5⁰C target by the year 2030. In order to achieve this goal and address the research questions of the study, a comprehensive research approach was needed. A systematic review of research literature was considered to be appropriate and was consequently adopted. A systematic review can be explained as a research method and process for identifying and critically appraising relevant research, as well as for collecting and analyzing data from said research (Liberati *et al.*, 2009). The choice of this approach was based on the research question of the study and the fact that systematic review has been identified as an important scientific research tool that can be used to appraise, summarize, and communicate the results and implications of large quantity of research publications on a subject as Green (2005) explained in a paper on systematic reviews and meta-analysis. In addition, in a paper on Literature review as a research methodology, Hannah (2019) pointed out that systematic review aims at identifying empirical evidence that fits the pre specified inclusion criteria to answer a particular research question. Whittemore et al (2005) were of the opinion that systematic review combines the advantage of bringing together evidence from multiple empirical studies regarding a specific issue to inform research and practice.

The data presented in this paper is substantially secondary data obtained through a survey of the existing evidence-based literature on the research subject and reports from the United Nations Food and Agricultural organization (FAO) from 2001 to 2020. Comprehensive search of peer reviewed articles and conference papers were conducted between October 2021 and August 2024, using Scopus, Google Scholar, Science Direct, Research gate and other online database sources of literature.

The search algorithms combined text words such as; Global Deforestation, Deforestation in Nigeria, Impact of deforestation on the Built Environment, Architecture and Deforestation, Effects of Deforestation on Climate Change. Books, journal articles and conference papers were included in the searches because it is believed that academics and practitioners rely on books, journals and conference proceedings in the dissemination of research findings and acquisition of information on recent and emerging developments in their different areas of interest. In addition, the choice of the search criteria was based on the need to capture

relevant and current evidence-based literature on the subject. In all, a total of 224 items were obtained from the searches.

The initial screening of the articles involved the review of both the titles and abstracts of all the 224 articles by the researchers. This was done in order to identify those for which full texts should be sought and most likely to be eligible for inclusion. A total of 102 articles were considered potentially relevant to the subject under investigation. The selection of articles reviewed was based on evaluation criteria developed by the authors. The first was the degree of relevance of the article to the research questions of the study. Based on this, the articles were rated “1” for low relevance, “2” for medium relevance and “3” for high relevance.

Two parameters were used to assess the degree of relevance of the articles included in the review. First was the methodological adequacy of the studies reported in the articles (i.e. appropriate study design); and emphasis was given to case studies, surveys and reviews. The second was the key results of the studies. Articles reporting findings relevant to the research questions were included. Hence, the review covers articles rated “3” that is high relevance by the authors. The second criterion used in evaluating articles included in the review was the date of publication. This was to ensure that information and data on the current rate of deforestation were captured. Hence, a majority of articles included in the review are not more than ten years old. Again, this was a deliberate attempt to ensure that the most recent trend in deforestation as its effects on climate change was captured in the review.

A total of 74 works were reviewed as shown in the references section. The basic unit of data analysis was the individual articles as well as various reports from organizations operating under the United Nations (UN). Since the data are mainly qualitative in nature, content analysis was the primary method of data analysis.

RESULTS

Overview of Global Trend in Deforestation

Global Forest Resources Assessment (2020) reports that Africa had the highest annual rate of net forest loss in 2010–2020, at 3.9 million hectares, followed by South America, at 2.6 million hectares as seen in figure 1. The rate of net forest loss has increased in Africa in each of the three decades since 1990 (figure 1). It has declined substantially in South America, however, to about half the rate in 2010–2020 compared with 2000–2010. Asia had the highest net gain of forest area in 2010–2020, followed by Oceania and Europe. Nevertheless, both Europe and Asia recorded substantially lower rates of net gain in 2010–2020 than in 2000–2010. Oceania experienced net losses of forest area in the decades 1990–2000 and 2000–2010 (Global Forest Resources Assessment 2020). FAO and UNEP also recorded that six million hectares of land were lost from forest to agriculture since 1990 in the tropical domain (FAO & UNEP, 2020).

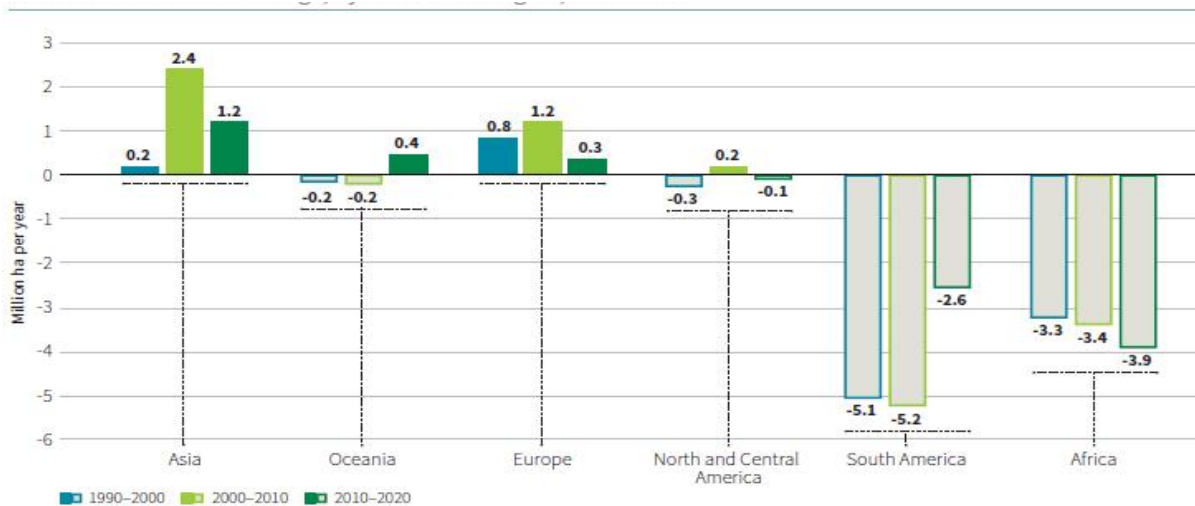


Figure 1: Annual forest net change, by decade and region, 1990-2020
 Source: FAO, (2020)

Deforestation is one of the factors that contribute to climate change. It was predicted that within the 21st century, the planets overall temperature will increase by 2 degrees Celsius and increase to 6 degrees by the end of the century. Statistics from a National Aeronautics and Space Administration (NASA) study on the temperature versus solar activity showed that there has been an increase in temperature and a decrease in solar activity within the last 60 years (figure 2) prompting the belief that it is not just the sun causing an increase in Greenhouse gasses. (Canadell, 2007).

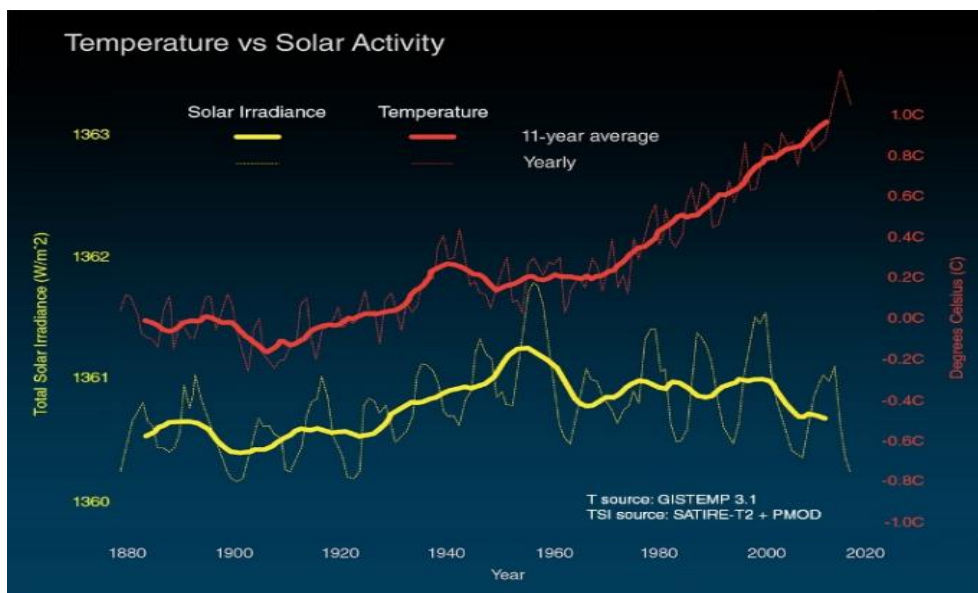


Figure 2: Graph from NASA comparing global surface temperature changes (red line) and the Sun's energy received by the Earth (yellow line) in watts (units of energy) per square meter from 1880 to 2020. The lighter/thinner lines show the yearly levels while the heavier/thicker lines show the 11-year average trends
 Source: Canadell, (2007)

Trend in Deforestation in Nigeria

Deforestation is a global problem and its negative impact on the climate is undeniable. Over the years, deforestation has posed a consistent threat to biodiversity in Nigeria. According to the revised statistics by The Food and Agriculture Organisation of the United Nations (FAO), between 2000 and 2005, Nigeria had the highest level of deforestation in the world, as 55.7% of the country's primary forests were lost. In 2020, the country lost 97.8 kilohectares of natural forest, which equated to 59.5 metric ton of CO₂ emissions. (Khalid, 2022). Substantiating this grim situation, the Nigerian Conservation Foundation (NCF) reported that Nigeria has lost over 96% of its natural forest cover and deforestation is at an alarming rate of 11.1% per annum. The Global Forest Resources Assessment (FRA 2015) predicts the likely forest area in Nigeria from the year 2020 to 2030 as seen in Table 1.

Table 1: Government target/aspiration for forest area from 2020 to 2030

Category	Forest area (000 ha)		Comments
	2020	2030	
Government target/ aspiration for forest area	13094	20713	25% in 2020 and 30% in 2030

Source: FRA (2015)

Due to the alarming rate of deforestation in the country, the Nigerian government has introduced policies to tackle this problem, such as the National Forest Policies of 1988 and 2006. Also, the federal government granted paramilitary status to the National Parks Service (NPS) to bolster the service's actions against poaching and trespasses. However, many of these policies have not been a resounding success (Khali, 2022). To achieve maximum desired results in curbing deforestation, the United Nations created another agency called United Nations Reducing Emission from Deforestation and Forest Degradation (UN-REDD). This agency is responsible for building the capacity of countries through man-power development and supporting with funding to enable countries to protect and improve their forested areas and to mitigate the effects of deforestation. (Kohon, 2018).

In 2021, Nigeria launched the REDD+ strategy towards reducing the problem of deforestation in the country with the support of the Forest Carbon Partnership Facility of the World Bank, the UN-REDD programme, as well as technical assistance from other bodies such as the FAO; the United Nations Development Programme (UNDP); and the United Nations Environment Programme (UNEP). The strategy seeks to curb climate change by bringing an end to the destruction of forests while promoting sustainable forest management. (Khali, 2022). With the Nigerian government's pledge at COP to end deforestation by 2030 (Georgina & Francesca, 2021), it becomes increasingly relevant that different professions in the built environment and other sectors reappraise their roles in combating deforestation and contributing to the global sustainability agenda.

Causes of Deforestation in Nigeria

In order to save forests, we need to know why they are being destroyed. Distinguishing between the agents of deforestation and its causes is very important in order to understand the major determinants of deforestation. Sumit *et al* (2012) refers to the agents of deforestation as

those slash and burn farmers, commercial farmers, ranchers, loggers, firewood collectors, infra-structure developers and others who are cutting down the forests. Also, causes of deforestation are the forces that motivate the agents to clear the forests.

Direct Causes

i. Farming and Expansion of agricultural land

Deforestation is proxied by the expansion of agricultural land. (Akpomrere *et al*, 2024; Anifowose & Ashiru 2019; Kohon, 2018; Gursharn & Beant 2017). FOA (2010) reports that agricultural expansion as the main driver of deforestation. This is because agricultural land expansion generally contributes around 60 percent of total tropical deforestation (Yusuf & Razaq, 2024; Mfon, 2014). Considering the fact that the fact that more than 80% of the Nigeria populace are into farming then one can understand the concern of environmentalists on agricultural induce deforestation in the country (Ogundele *et al*, 2016). Most farm lands are prepared through under brushing and felling as well as slash and burn activities which lead to deforestation in tropical forests. This practice is utilized during shifting cultivation and for plantations and has led to the permanent destruction of the rainforest (Maton 2015). The fact that plantations remove the timber pressure on natural forests does not translate eventually into less, but rather into more deforestation. Plantations can promote deforestation by constructing roads that improve access of the shifting cultivators and other land in the forest frontier (Sumit *et al* 2012). However, as the land degrades people are forced to migrate, exploring new forest frontiers thereby increasing deforestation (Maijama'a *et al*, 2020, Wilkie *et al.*, 2000; Amor & Pfaff, 2008).

ii. Logging and fuel wood

The high forests are the main source of logs in Nigeria. In order to meet this demand, timber dealers encourage unlawful and indiscriminate logging in naturally occurring forests (Akpomrere *et al*, 2024; Ogundele *et al*, 2016; Ogunwale, 2015). The most harmful type of logging is called "clear cutting" (Bennett 2017) as seen in Plate 1. Concerned environmentalist in 2017 drew the attention of Nigeria's Environment Minister to the massive illegal logging taking place in Gashaka Gumti National Park in Taraba state. Similarly, in Plateau state Nigeria, it was reported that a Chinese company had been granted a permit by the state government to log a protected area (Pandam Game Reserve) located in Qua'an Pan local government area (Kohon, 2018; Nanlong 2016). States like Cross Rivers have decided to ban logging and have opted for the importation of timber instead. This action aims at cushioning the effect of logging on the forest resources in the state (Charles 2017). People, especially those who live in rural areas where electricity and gas are unavailable also resort to use of firewood as a source of heat (Yusuf & Razaq, 2024; Maijama'a *et al*, 2020, Kohon, 2018; Gursharn & Beant, 2017). Increasing pump prices of petroleum products, particularly kerosene and cooking gas, have led to both urban and rural households to rely heavily on charcoal and fuel wood as their major sources of energy for cooking and lightening (Maijama'a *et al*, 2020).



Plate 1: Pictures of Cutting and Logging of Forest Trees

Source, Markku (2007)

iii. Mining and Mineral Exploration Activities

Mining is very intensive activity and very destructive as well. In Nigeria, several areas where mining activities take place appear to cause various environmental problems such as soil erosion, loss of biodiversity and cause an ecological imbalance within the environment. (Kohon, 2018). Mining as a lucrative activity promotes development booms which may attract population growth with consequent deforestation (Ogundele *et al*, 2016). The construction of roads, railways, bridges, and airports opens up the land to development and brings increasing numbers of people to the forest frontier. (Maijama'a *et al*, 2020, Sumit *et al* 2012).

The extraction of petroleum and minerals such as; crude oil, bayrite, tin, coal and many others, has led to the destruction of the forests and scarification of the landscape due to over exploitation (Yusuf & Razaq, 2024). In the cause of solid mineral exploration large factories such as the Ajaokuta steel mill in Kogi State, Nigeria have occupied previously forested areas Facilities such as oil well heads, major pipelines manifolds and flow stations have also been sighted in previously forested area Since the early 1950s when the Nigerian oil industry was developed, its activities have been responsible for crossing the deltas with oil and gas pipe lines thereby removing vegetation cover along their paths (Ogunwale, 2015).

iv. Fires

Fires are a major tool used in clearing the forest for shifting and permanent agriculture and for developing pastures. Fire used responsibly can be a valuable tool in agricultural and forest management but when abused it can be a significant cause of deforestation (Anifowose & Ashiru 2019; Ogundele *et al*, 2016) Setting intentional fires destroys vital parts of forests. When fire spreads to unintended areas, the protective forest canopy is destroyed (Bennett 2017). In similar situations hunters also set fire to forests to drive out wild animals. (Kohon,

2018). This has resulted in the permanent destruction of the rainforests and damage to the vegetation in the savannah (Ejidike & Ajayi 2013; Mfon 2014) as seen in Plate 2.



Plate 2: Forest Burnt Down By Fire

Source: Markku (2007)

v. Other forests products (Medicines, dyes, etc.)

There are also many other products of the forest apart from wood which when tapped uncontrollably could result to deforestation. Herbalists, rubber tappers, hunters and collectors of fungi, nuts, bamboo and berries can utilize these products. Other non-wood forest products also come in the form of medicinal compounds, dyes and fabrics (Gursharn & Beant, 2017). According to the World Health Organization, about 80 per cent of the world's population relies at least partially on traditional medicine for primary health care (Kohon 2018).

vi. Overgrazing

Overgrazing is more common in drier areas of the tropics where pastures degraded by overgrazing are subject to soil erosion. Over-grazing through excessive trampling of the surface of the soil by the animals can kill some plants or cause a reduction in their ability to undergo photosynthesis (Kohon 2018; Ogundele et al, 2016). Stripping trees to provide fodder for grazing animals can also be a problem in some dry areas of the tropics but is probably not a major cause of deforestation (Yusuf & Razaq, 2024). Animals remove the vegetation and wind finishes the job by blowing away the top soil, transforming grasslands into desert. (Maijama'a et al, 2020; Sumit et al 2012).

vii. Conflicts

In Nigeria especially in the north, violent conflicts between farmers and herdsmen have been increasing pressure on land resources (Chiagozie, 2018; Adepegba, 2017). A study on Plateau state identified that conflict induced migration is one of the factors responsible for environmental degradation. Sometimes when these conflicts occur, some people migrate to other communities for safety. As a result, forest products such as trees are in high demand to meet immediate energy needs (Kohon, 2018).

viii. Urbanization/industrialization and infra-structure

Expanding cities and towns require land to establish the infrastructures necessary to support the growing population which is done by clearing the forests (Akpomrere *et al*, 2024; Maijama'a *et al*, 2020; Anifowose & Ashiru 2019; Kohon, 2018; Gursharn & Beant, 2017; Ogundele *et al*, 2016; Sands, 2005). Tropical forests are a major target of infra-structure developments for oil exploitation, logging concessions or hydropower dam construction which inevitably conveys the expansion of the road network and the construction of roads in pristine areas (Sumit *et al* 2012). In Nigeria, sites presently occupied by Petrochemicals, Refineries, Fertilizer Companies and Liquefied Natural Gas Plants where sometime, naturally occurring forest ecosystems. (Ogunwale, 2015). The construction of roads, railways, bridges, and airports opens up the land to development and brings increasing numbers of people to the forest frontier.

ix. Pollution

In Nigeria, oil spillage particularly in the oil-rich Niger Delta, in the southern part of the country is one of the major man-made causes of environmental pollution. (Parke 2016; Ross 2016; Kent 2017). This has resulted to a devastation of the mangrove forests in the Niger Delta region of Nigeria since the discovery of oil (Aikhionbare 2015). The spillages usually occur as a result of pipeline vandalism, old rusted pipelines and petrol tanker accidents in various parts of the country. Apart from oil spillage in the Niger Delta, gas flaring is another pollutant that is causing havoc in areas where oil exploration activities have been taking place. This menace poses environmental, economic and health challenges, mainly to the inhabitants of such areas (Echewofun & Okeke 2017). Some negative impacts of oil spillage and gas flaring include contamination of surface water, ground water and contamination of the soil thereby leading to increased deforestation (Aikhionbare, 2015).

x. Tourism

National parks and sanctuaries beyond doubt protect the forests, but un-cautioned and improper opening of these areas to the public for tourism is damaging (Kohon, 2018). Unfortunately, the national governments of tropical and sub-tropical countries adopt tourism for easy way of making money sacrificing the stringent management strategies (Ogundele *et al*, 2016). Further, many companies and resorts who advertise themselves as eco-tourist establishments are in fact exploiting the forests for profit.

Indirect Causes

It is in a bid to bring about development irrational and unscrupulous logging, cash crops, cattle ranching, large dams, colonization schemes, the dispossession of peasants and indigenous peoples and promotion of tourism is carried out. Such development leads to overconsumption which is the basic underlying cause of deforestation.

i. Overpopulation and poverty

Scholars have attributed the rate of deforestation in Nigeria to the high rate of population growth (Maijama' *et al*, 2020; Kohon, 2018; Mmom & Mbee 2013). Population growth is directly related to increase in the demand for food". More people require more food and space which requires more land for agriculture and habitation. This in turn results in more

clearing of forests (Kohon, 2018; Smith *et al* 2011). FAO and other intergovernmental bodies believe that poverty and overpopulation are the main causes of forest loss. Poverty is a major cause of population growth and environmental degradation and reversely, population growth is the major cause of poverty and environmental degradation such as pollution and deforestation. (Muhammad & Riffat, 2015).

ii. Land rights, land tenure and poor government policies

Cultivators at the forest frontier often do not hold titles to land (absence of property rights) and are displaced by others who gain tenure over the land they occupy. This means they have to clear more forest to survive. The policy of government on deforestation represents what to do or not to do regarding the prevention of the loss of forest cover and land use conversions among other necessary needs (Yusuf & Razaq, 2024). Poorly defined tenure is generally bad for people and forests. In many countries government have nominal control of forests but are too weak to effectively regulate their use. This can lead to a tragedy of the commons where forest resources are degraded. (Ahmed & Aliyu, 2019; Sumit *et al* 2012).

iii. Corruption and political cause

The FAO (2001) report identified forest crime and corruption as one of the main causes of deforestation and warned that immediate attention has to be given to illegal activities and corruption in the world's forests in many countries (Ogundele et al, 2016). Illegal forest practices may include the approval of illegal contracts with private enterprises by forestry officers, illegal sale of harvesting permits, under-declaring volumes cut in public forest, underpricing of wood in concessions, harvesting of protected trees by commercial corporations, smuggling of forest products across borders and allowing illegal logging, processing forest raw materials without a license (Sumit *et al* 2012).

The causes of deforestation, as reviewed from literature, were reviewed and presented in Table 2 below.

Table 2: Causes of deforestation as identified in Literature

CAUSES OF DEFORESTATION	SOURCES	NUMBER OF AUTHORS	RANKING
<i>Direct causes</i>			
Farming and Expansion of Agricultural land	Akpomrere et al, 2024; Yusuf & Razaq, 2024; Maijama'a et al, 2020; Anifowose & Ashiru 2019; Kohon, 2018; Gursharn & Beant, 2017; Ogundele et al, 2016; Maton 2015; Mfon 2014; Wilkie <i>et al.</i> , 2000; Sumit et al 2012; FOA,2010; Amor & Pfaff, 2008	13	1
Logging and fuel wood	Akpomrere et al, 2024; Yusuf & Razaq, 2024; Maijama'a et al, 2020; Kohon, 2018; Bennett 2017; Charles 2017; Gursharn & Beant, 2017; Ogundele et al, 2016; Nanlong, 2016; Ogunwale, 2015; Markku, 2007	12	2
Urbanization/ industrialization and	Akpomrere et al, 2024; Maijama'a et al, 2020; Anifowose & Ashiru 2019; Kohon, 2018; Gursharn	9	3

infrastructure	& Beant, 2017; Ogundele et al,2016; Ogunwale, 2015; Sumit et al 2012; Sands 2005.		
Fires	Anifowose & Ashiru 2019; Kohon, 2018; Bennett 2017; Ogundele et al,2016; Ejidike and Ajayi 2013; Mfon 2014; Markku 2007	7	4
Mining and mineral exploration activities.	Yusuf & Razaq, 2024; Maijama'a et al, 2020; Kohon, 2018; Ogundele et al,2016; Ogunwale, 2015; Sumit et al 2012;	6	5
Overgrazing	Yusuf & Razaq, 2024; Maijama'a et al, 2020; Kohon 2018; Ogundele et al,2016; Sumit et al 2012	5	6
Pollution	Parke 2016; Ross 2016; Echewofun & Okeke 2017; Kent 2017; Aikhionbare 2015	5	6
Other forests products (Medicines, dyes, etc.)	Kohon, 2018; Gursharn & Beant, 2017;	3	7
Conflicts	Chiagozie, 2018; Kohon, 2018; Adepegba 2017;	3	7
Tourism	Kohon, 2018; Ogundele et al,2016.	2	8
Indirect Causes			
Overpopulation and poverty	Maijama'a et al, 2020; Kohon, 2018; Naik 2016; Muhammad & Riffat, 2015; Mmom and Mbee 2013, Smith et al 2012.	6	1
Land rights, land tenure and poor government policies.	Yusuf & Razaq, 2024; Ahmed & Aliyu, 2019; Sumit et al 2012	3	2
Corruption and political cause	Yusuf & Razaq, 2024; Ogundele et al,2016; Smith et al 2012	3	2

Source: Author's compilation (2026)

Effects of Deforestation on the Built Environment

i. Climate Change and Climate Imbalance

Climate change is occasioned by a broad range of human activities which harm the environment and the totality of life on the planet earth (Atoyebi & Caleb, 2021). Deforestation as one of the drivers of climate change has a widespread and far-reaching effect on the environment. Climate change contributes to global warming which occurs from increased atmospheric concentrations of carbon dioxide, a major greenhouse gases (GHG) leading to net increase in the global mean temperature as the forests are primary terrestrial sink of carbon (DBG 2023; Akuru et al., 2017). Forests are the “lungs” of the planet. They take in carbon dioxide and release oxygen and water vapor in the air. Deforestation reduces the number of trees available in a particular area and leads to an increase in carbon dioxide (CO₂) in the atmosphere (Yusuf & Razaq, 2024). Carbon dioxide is injurious to the health of both humans and animals when it gets into the atmosphere. This could result in the death of plants and animals (Mfon, 2014; Kohon, 2018; Sumit et al, 2012), and enhances the Greenhouse Effect, which contributes largely to global warming (Mfon 2014). Climate projections for the coming decades reveal a significant increase in temperature over all the ecological zones (Akande et al., 2017). It is predicted that there will be a temperature increase

of 0.4 to 1°C over the time period 2020-2050 due to climate change, and an increase of up to 3.2°C by 2050 under a high climate change scenario (Olapido, 2010; Federal Ministry of Environment-FEM, 2014). Such heightened temperatures will have negative impacts on agriculture and food security (Akande *et al.*, 2017). The hot weather also has a direct effect on the thermal comfort of buildings making the indoor space uncomfortable except with the introduction of other artificial means to cool down the temperature.

ii. Disruption of Water Cycle and Loss of soil resources.

Deforestation disrupts the global water cycle as trees play a crucial role in the water cycle by absorbing the rain water as well as releasing water vapour into the atmosphere. When part of the forest is removed, the area cannot hold as much water creating a drier climate. (Sumit et al 2012) The statistics available have shown that the Sahara desert which is common in the northern parts of Nigeria has already encroached into the southern parts as a result of deforestation (Kohon, 2018). When a large number of trees are removed from an area, it causes soil erosion since there is no vegetation to reduce the impact of hard rain on the soil and there are no roots to hold the soil in place (Gursharn & Beant, 2017). Deforestation can result into watersheds that are no longer able to sustain and regulate water flows from rivers and streams. The downstream flow causes soil erosion thus also silting of water courses, lakes and dams (Sumit et al 2012).

iii. Flooding

As the climate becomes more extreme due to deforestation (among other causes), the occurrence and strength of floods and droughts increases (Gursharn & Beant, 2017). Flooding can occur when the lack of trees allow for the soil to become fully saturated with water earlier in the season that results in additional precipitation to run off. Deforestation increases flooding mainly for two reasons. First, with a smaller 'tree fountain' effect, soils are more likely to be fully saturated with water. The 'sponge' fills up earlier in wet season, causing additional precipitation to run off and increasing flood risk. Second, deforestation often results in soil compaction unable to absorb rain. Locally, this causes a faster response of stream flows to rainfall and thus potential flash flooding (Chomitz *et al.*, 2007). Moreover deforestation also decrease dry season flows. The long term effect of deforestation on the soil resource can be severe. Clearing the vegetative cover for slash and burn farming exposes the soil to the intensity of the tropical sun and torrential rains. Forest floors with their leaf litter and porous soils easily accommodate intense rainfall. The effects of deforestation on water availability, flash floods and dry season flows depend on what happens to these countervailing influences of infiltration and evapotranspiration (Sumit *et al* 2012)

iv. Decreased biodiversity and habitat loss

The most known consequence of deforestation is its threat to biodiversity. It is estimated that the Earth's biodiversity is going extinct 0.1%, or approximately 200 species per day, every year. (Youmatter.2020). The World Wildlife Fund defines biodiversity as a huge variety of animals and plants on our planet living and depending on each other in the place they are found (Kohon 2018). In fact, forests represent some of the most veritable hubs of biodiversity. From mammals to birds, insects, amphibians or plants, the forest is home to many rare and fragile species. 80% of the Earth's land animals and plants live in forests. Nigeria is endowed

with rich biodiversity which provides a source of food, raw materials, medicines, commercial and domestic products, aesthetics and cultural value. (Fifth National Biodiversity Report 2015; Kohon, 2018). The Fifth National Biodiversity Report (2015) also states that “Nigeria’s wildlife is rapidly declining due to habitat loss and increased pressure from hunters, poachers and bush burning”. Hundreds of thousands of species are killed as they lose their habitats due to forest fires, cutting down of trees etc. (Gursharn & Beant, 2017).

v. Economic losses on indigenous communities.

Many communities rely on forests for their livelihoods, culture and subsistence. Deforestation threatens their way of life. Healthy forests support the livelihoods of 1.6 billion people globally, one billion of whom are among the world’s poorest (Sumit *et al*, 2012). The tropical forests destroyed each year amounts to a loss in forest capital valued at US \$ 45 billion. By destroying the forests, all potential future revenues and future employment that could be derived from their sustainable management for timber and non-timber products disappear. (Sumit *et al*, 2012).

vi. Social consequences

Deforestation has many social consequences and the long term impact is often devastating. The arrival of civilization for indigenous communities usually means the change or destruction of their traditional life-style, the breakdown of their social institutions and displacement from their ancestral area. The intrusion of outsiders destroys traditional life styles, traditional/ Indigenous architecture, customs and religious beliefs. The effect gets intensified with infrastructural development like construction of roads which sometimes results into frontier expansion often associated with social and land conflicts (Sumit *et al*, 2012).

vii. Loss of Ecological Services

Sumit *et al*, (2012) is of the opinion the most immediate social impact of deforestation occurs at the local level with the loss of ecological services provided by the forests. Forests afford the built environment and humans valuable services such as erosion prevention, flood control, water treatment, fisheries protection and pollination functions that are particularly important to poorer countries that rely on natural resources for their everyday survival. By destroying the forests, we risk our own quality of life, gamble with the stability of climate and local weather, threaten the existence of other species and undermine the valuable services provided by biological diversity.

The Effects of Deforestation on the Built Environment is captured in Table 3 below.

Table 3: Effects of deforestation on the built environment as identified in the Literature

Effects Of Deforestation	Sources	Number of Authors	Ranking
Climate change and climate imbalance	Yusuf & Razaq,2024; DBG 2023; Atoyebi & Caleb, 2021; Kohon, 2018; Akande et al., 2017; Akuru et al., 2017; FEM, 2014Mfon, 2014; Sumit et al, 2012; Olapido, 2010	10	1
Decreased biodiversity and habitat loss	Youmatter 2020; Kohon, 2018; Sumit et al, 2012; Fifth National Biodiversity Report, 2015; Gursharn and Beant, 2017	5	2
Disruption of water cycle and loss of soil resources	Kohon, 2018; Gursharn and Beant, 2017; Sumit et al 2012	4	3
Flooding	Gursharn and Beant, 2017; Sumit et al 2012; Chomitz <i>et al.</i> , 2007	4	3
Economic losses on indigenous communities	Youmatter 2020; Sumit et al, 2012	2	4
Social consequences	Sumit et al, 2012	1	5
Loss of ecological services	Sumit et al, 2012	1	5

Source: authors' compilation (2026)

Architectural Strategies for Checking of Deforestation.

It is imperative to know that there is no such thing as a small or insignificant act when it comes to defeating deforestation. It has adverse effects on each living beings' life, thus it is an important issue to be discussed. This discussion is in line with the third objective of this study, which is to suggest strategies for preventing or mitigating the effects of deforestation on the built environment from the perspective of architecture. Hence, the following steps could be taken by architects in Nigeria to slow down and possibly bring to stop deforestation and its adverse effects on the environment, in pursuant of the COP resolution of bringing global warming at 1.5°C target by the year 2030?

- i. Architects should lead by example and spread awareness (Ogundele et al, 2016). They should get involved by educating their families, friends, clients, colleagues and the general public on what deforestation is and why it is happening, the causes and consequences of deforestation, and what solutions individuals, consumers and organizations can adopt to mitigate it. Students of Architecture and other environmental sciences should also be taught about deforestation and its impact on the climate.
- ii. Planning of sites should be in line with the natural environment (organic design). Hence, pulling down of trees should be discouraged and planting of economic trees encouraged.
- iii. Architects in Nigeria should adopt Biophilic Design principles by making deliberate effort to adequately introduce natural elements such as trees in their designs and make it a salable brand to clients.
- iv. Architects should ensure that in the cause of construction, for every tree that is cut, two to three trees should be planted in its place. We have reached such a critical point that to curb the deforestation in Nigeria, many more trees need to be planted.

- v. Minimize the usage of wood for construction, furniture and other products. Architects should go for alternative materials. For instance, steel panels and steel scaffolds can be used in place of wooden panels for form work, and forest materials for scaffolds. The use of concrete electric poles should be encouraged while of wooden electric poles discouraged. Under Soil House is one of the alternative design solutions for deforestation issues.
- vi. Regulatory bodies such as Architects Regulatory Council on Nigeria (ARCON) should work in collaboration government approval agencies to ensure that adequate green areas are provided on the site plan and carry out routine checks in neighborhoods to ensure that the trees are actually planted. Policy, legislative and regulatory measures to enforce strict laws against deforestation should be adopted to prevent government from encroaching into such spaces (Ogundele et al, 2016)
- vii. Under Soil House is one of the alternative design solutions for deforestation issues. It is an underground residence, planning of design to respond the survival of human life and nature. Humans no longer eliminate green areas but can live side by side with trees. Therefor with the application of this undersoil house (Figure 4), where there is a house (underground) there are trees (on the surface) (Farouk et al, 2018).



Figure 4: Concept Illustrations of Under Soil House Design

Source: Farouk et al, (2018)

- viii. Youth Coppers particularly graduates of Architecture and other environmental sciences should get involved with tree planting campaign during their service year.
- ix. Architects should encourage the growing of more climate resistant trees and fast-growing varieties of wood trees for commercial uses for building construction, making of furniture, pencils, paper etc.
- x. Architects should make deliberate efforts to purchase construction materials from companies that are committed to reduce deforestation.
- xi. The bidding and tender process involves a lot of documentation and paper work. Rather than hard copies, soft copies of these documents can be submitted (e-tendering)

and e- project management). This will go a long way to reduce the consumption of paper which is a forest product.

- xii. There is a need for job creation for the locals to have other means of livelihood other than just cutting forests. Architects should employ the services of locals in the construction process.

DISCUSSION

This study gave an overview of the world deforestation as well as deforestation in Nigeria with relevant current data to show the extent of deforestation. From findings of this review, three objectives were considered important for further discussion.

The first objective highlighted the causes of deforestation as identified in the literature. The causes of deforestation are the forces that motivate the agents to clear the forests. They could be direct causes such as agriculture, logging, fires, mining activities, urbanization, tourism, pollution, overgrazing and the use of forest products for medicines and dyes. The indirect causes identified include overpopulation and poverty, Land rights, land tenure and poor government policies and Corruption and political cause. Findings revealed that among the direct causes of deforestation in Nigeria, farming and expansion of agricultural land ranked the topmost reason for deforestation in Nigeria. This is also in line with findings from FAO and as highlighted by several other authors. Overpopulation and poverty ranked the highest indirect cause of deforestation as presented from the ranking of the literature reviewed.

The second objective highlighted the effects of deforestation on the built environment as identified in the literature. The study revealed that Climate change and climate imbalance, decreased biodiversity and habitat loss, disruption of water cycle and loss of soil resources, flooding, economic losses on indigenous communities, social consequences and loss of ecological services are the major effects of deforestation on the built environment. Climate change and climate imbalance ranked as the major effect of deforestation on the built environment.

The paper attempted to answer the key question of this research which is; how can architecture contribute to slowing down the rate of deforestation in Nigeria in pursuant of the COP resolution of bringing global warming at 1.5⁰C target by the year 2030? This question was addressed in the third objective by suggesting strategies for preventing or mitigating the effects of deforestation from the perspective of architecture. The architects, other professionals in the built environment and other sectors need to reappraise their roles in combating deforestation and contributing to the global sustainability agenda. This cycle would continue for the coming years unless necessary steps are taken to prevent deforestation. If major steps towards afforestation/reforestation are not taken, then even the great adaptability of human beings may not be enough to cope up with the harsh climate of the future.

CONCLUSION

In conclusion, addressing deforestation requires a multifaceted approach that integrates sustainable practices such as the strategies highlighted for curbing deforestation through architectural practices, community engagement, and innovative policy measures. By promoting reforestation initiatives, enforcing stricter regulations on logging, and supporting sustainable agricultural practices, humans can significantly reduce the pressures on our forests. Furthermore, empowering local communities through education and economic incentives can foster a sense of stewardship and responsibility toward the environment. Collaboration among governments, professionals in the built environment, NGOs, and the private sector is essential to create a unified front against deforestation. Ultimately, by prioritizing the health of our forests, we not only preserve biodiversity but also ensure the well-being of future generations. The path to curbing deforestation is challenging, but with commitment and cooperation, it is an attainable goal that benefits both people and the planet.

REFERENCES

- Abere, S. A., & Opara, J. A., (2012). Deforestation and Sustainable Development in the Tropics: Causes and Effects. *Journal of Educational and Social Research*, Vol: 2 (04),105-109.
- Adepegba, A. 2017. *Herdsmen killings: Benue youths barricade road, kill 6*. Online. Punch, 21 April.
- Ahmad, S. S., & Abbasi, Q., (2011). Assessment of Forest cover decline in Pakistan. *International Journal of Environmental Science*, 02 (01). 220-227
- Ahmed, Y.A. & Aliyu, I. (2019). Climate Change Induced Challenges on Deforestation: The Needs to induce Mitigation Measures in Nigeria. *Analele Universitatii din Oradea, Seria Geografie*, 29(2) 64-76.
- Aikhionbare, I. (2015). Deforestation in Nigeria: 7 Causes, 5 Effects and 6 Ways to Stop It. Online. Info Guide Nigeria, 7 November.
- Akande, A., Costa, A. C., Mateu, J., & Henriques, R. (2017). Geospatial analysis of extreme weather events in Nigeria (1985–2015) using self-organizing maps. *Advances in Meteorology*, Article 8576150. <https://doi.org/10.1155/2017/8576150>
- Akpomrere, O.R., Ekruyota, G.O., Idama, O., Tachere, O.Z. & Uguru, H. (2024). Deforestation Challenges in the Niger Delta Region: a Case Study on the Electrical and Communication Sectors. *Open Access Journal of Science Research*. 2(2), 8-18. DOI: 10.5281/zenodo.11190070
- Akuru, U. B., Onukwube, I. E., Okoro, O. I., & Obe, E. S. (2017). Towards 100% renewable energy in Nigeria. *Renewable and Sustainable Energy Reviews*, 943–953. <https://doi.org/10.1016/j.rser.2016.12.123>
- Ali, T., Shahbaz, B., & Suleri, A., (2006). Analysis of Myths and Realities of Deforestation in North West Pakistan: Implications for Forestry. *International Journal of Agriculture and Biology*. 08 (01). 107-110

- Amor, D. & Pfaff, A. (2008). *Early history of the impact of road investments on deforestation in the Mayan forest*. Working Paper, Nicholas School of the Environment and Sanford School of Public Policy, Duke University, Durham, NC, USA.
- Anifowose O. And Ashiru O.,(2019). Challenges of Deforestation in Nigeria: An Ethical Perspective. *Nnamdi Azikiwe Journal of Philosophy*, 11 (1), 2019
- Atoyebi, O. M., & Caleb, E. (2021). *Climate crises: The Nigerian Climate Change Act 2021 – Nigeria’s antidote to the global climate crises*. Omaplex Law Firm. <https://omaplex.com.ng/climate-crises-the-nigerian-climate-change-act-2021/>
- Bartleby. (2021). *The causes of deforestation in Nigeria*. <https://www.bartleby.com/essay/The-Causes-Of-Deforestation-In-Nigeria-PCYFAAGB6Q6>
- Bennett, L. (2017). *Deforestation and Climate Change*. The Climate Institute. 3-10.
- Canadell, P. (2007). *Slowing deforestation key to climate fight, experts say*. China Climate Change Info-Net. <https://en.ccchina.org.cn/Detail.aspx?newsId=34735&TId=97>
- Charles, E. 2017. *Cross River to Import Timber from Cameroon*. Daily Trust, 8 February.
- Chiagozie,U. (2018). *How Climate Change Is Provoking Clashes Between Herdsmen And Farmers In Nigeria*.
- Colchester, M. & Lohmann, L. (1993). *The Struggle for land and the fate of forest*. Zed books, London.
- DGB Group. (2023, March 7). *Deforestation in Nigeria: Causes, effects and solutions*. Green Earth. <https://www.green.earth/blog/deforestation-in-nigeria-causes-effects-and-solutions>
- Ejidike, B. N. & Ajayi, S. R.,(2013). A Trend in Wildlife Conservation Practices in Nigeria. *International Journal of Biodiversity and Conservation*, 5(4), 185-191.
- Farouk I. A., Hena S. F., M. Syaom B., & Indah S., (2018). Alternative Solution For Deforestation: Under Soil House As Architecture Experimental Design. *EDP Sciences*. 1-5
- FAO, (2001). Global Forest Resources Assessment 2000-Main Report. *Forestry Paper 140*. Rome, Italy.
- FOA, (2010). Global Forest Resources Assessment, 2010-Main Report. *FAO Forestry Paper 163*. Rome, Italy.
- FAO. (2020). *Global Forest Resources Assessment 2020: Main report*. Rome.
- FAO and UNEP (2020). *The state of the world’s forests 2020. Forests, biodiversity and people*. Rome. <https://doi.org/10.4060/ca8642en>
- Food and Agriculture Organization of the United Nations. (2015). *Global Forest Resources Assessment 2015: Country report – Nigeria*.
- Federal Ministry of Environment (Nigeria). (2014). *Second National Communication of the Federal Republic of Nigeria to the United Nations Framework Convention on Climate Change (UNFCCC)*.

- Rannard, G., & Gillett, F. (2021). *COP26: World leaders promise to end deforestation by 2030*. BBC News. <https://www.bbc.com/news/science-environment-59088498>
- Green, S. (2005). Systematic Review and Meta-analysis. *Singapore Medical Journal*, 46 (6), page 270-274
- Gursharn S. & Beant S. (2017). Deforestation and Its Impact on Environment. *International Journal of advance research in science and engineering*. 06. 262-268
- Hannah S. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research* 104 (2019) page 333–339
- Houghton, R. A.(2005). Tropical deforestation as a source of greenhouse gas emissions. In: *Tropical deforestation and Climate change*, eds. Moutinho, P. and Schwartzman, S. Page 13-20. Amazon Institute for Environmental Research, Belem Brazil.
- Humphreys, D. (2006). *Forest Politics*. Earthscan Publications Ltd., London.
- Kohon, H. S. (2018). *Deforestation In Nigeria: A Critical Assessment Of The Church Of Christ In Nations' (Cocin) Community Development Programme (CCDP) On Ecology In Panyam District, Mangu Local Government Council, Plateau State*. researchspace.ukzn.ac.za
- Khalid, R. (2022, January 17). *Challenges facing policies against deforestation in Nigeria*. Earth.Org. <https://earth.org/challenges-facing-policies-against-deforestation-in-Nigeria/>
- Joint Liaison Group of the Rio Conventions. (2012). *The Rio Conventions: Action on forests*. <https://www.unclearn.org/resources/library/the-rio-conventions-action-on-forests/>
- Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta analyses of studies that evaluate health care interventions: Explanation and elaboration. *Annals of Internal Medicine*, 151, W–65.
- Levang, P. (2002). People's Dependencies on Forests. In Technical Report, Phase I 1997-2001. ITTO Project PD 12/97 Rev. 1 (F) - Forest, Science and Sustainability: the Bulungan model forest, 109-130. CIFOR, Bogor Indonesia.
- Maijama'a R., Musa K.S., Saleh Z. M., Garba A., (2020). Assessing the Drivers of Deforestation in Nigeria: Evidence from Fully Modified Ordinary Least Squares. *International Journal of Research and Innovation in Social Science (IJRISS)* |Volume IV, page 466-473, Issue VI, June 2020|ISSN 2454-6186.
- Malmsheimer, R.W., Bowyer, J. L., Fried, J.S., Gee, E., Izlar, R. L., Miner, R. A., Munn, A., Oneil, E., and Stewart, W. C., (2011). Managing Forests because Carbon Matters: Integrating Energy, Products, and Land Management Policy. *Journal of Forestry*, Vol: 109(7), 7–50.
- Markku K., Daniel M., Frances S., Arild A., Sven W. & Laura G. (2007). *Do Trees Grow On Money? The Implications of Deforestation*. Research for policies to promote REDD. Center for International Forestry Research (CIFOR), Situ Gede, Bogor Barat 16115, Indonesia.
- Mather,A.S. (1991). *Global Forest Resources*. International Book Distributors, Dehra Dun.

- Mawalagedara, R., & Oglesby, R. J. (2012). The climatic effects of deforestation in South and Southeast Asia. In P. Moutinho (Ed.), *Deforestation around the world*. IntechOpen. <https://doi.org/10.5772/34101>
- Maton, S. (2015). Environmental Dimensions of Global Warming: Ways of Mitigating the Impact. *International Journal of Innovative Research and Development*, 5(1), 205- 211.
- Mfon, P. (2014). Forest Resources of Cross Rivers State: Their Potentials, Threats and Mitigation Measures. *Journal of Environmental Science, Toxicology and Food Technology*, 8(6), 64-71.
- Mfon, P. (2014). Challenges of Deforestation in Nigeria and the Millennium Development Goals. *International Journal of Environment and Bioenergy*, 9(2), 76-94.
- Mmom, P. C. and Mbee, D. M. (2013). Population Pressure and Forest Resources Depletion in Gele-Gele Forest Reserves of Edo State, Nigeria. *International Journal of Physical Geography*, 1(3), 31-42.
- Muhammad T. and Riffat, A. (2015). An Overview of Deforestation Causes and Its Environmental Hazards in Khyber Pukhtunkhwa. *Journal of Natural Sciences Research* ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online).
- Nanlong, M. T., (2016). *War over game reserve: Community Dares Plateau Govt on Deforestation*. Online. Vanguard, 1 April,
- Ogundele A. Oladipo O. and Adebisi, O.,(2016). Deforestation in Nigeria: The Needs for Urgent Mitigating Measures. IIARD *International Journal of Geography and Environmental Management* ISSN 2504-8821 Vol. 2 No.1 2016
- Ogunwale, A.O. (2015). Deforestation and Greening the Nigerian Environment. International Conference on African Development Issues (CU-ICADI) 2015: *Renewable Energy Track*. 226-233
- Oladipo, E. (2010). Towards enhancing the adaptive capacity of Nigeria: A review of the country's state of preparedness for climate change adaptation. *Heinrich Böll Stiftung*. <https://ng.boell.org/en/2013/10/14/towards-enhancing-adaptive-capacity-nigeria-review-countrys-state-preparedness>
- Omokhua, G., & Koyejo, A. (2009). Impact Of Deforestation On Ecosystem: A Case Study Of The Fresh Water Swamp Forest In Onne, Niger Delta Region, Nigeria. *Journal of Agriculture and Social Research (JASR)*, 8(2). <https://doi.org/10.4314/jasr.v8i2.43349>
- Philip, M., Oluyemi A.A, Glory. M, Tokunbo O., Sammy U. U. And Taiwo. A.A.(2014). Challenges of Deforestation in Nigeria and the Millennium Development Goals. *International Journal of Environment and Bioenergy*, 2014, 9(2): 76-94
- Putz, F. E.; Blate, G. M.; Redford, K. H.; Fimbel, R. and Robinson, J. (2001). Tropical Forest Management And Conservation Of Biodiversity: An overview. *Conservation Biology* 15: 7-20.
- Raloff, J. (1989). Where Acids Reign. *Science News* July 22. 56-58.
- Repetto, R. (1990). Deforestation in the Tropics. *Scientific American* April, p. 37.

- Sands, R. (2005). *Forestry in a Global Context*. CABI Publishing.
- Sumit C., Ghosh S. K., Suresh C.P., Dey, A.N. and Gopal S. (2012). Deforestation: Causes, Effects and Control Strategies. *Global Perspectives on Sustainable Forest Management*, ISBN: 978-953-51-0569-5, InTech,
- United Nations. (2016). *The sustainable development goals: 17 goals to transform our world*. <https://doi.org/10.18356/69725e5a-en>
- World Resources Institute. (2021). *Nigeria deforestation rates and statistics*. Global Forest Watch. <https://www.globalforestwatch.org/>
- Wilkie, D.; Shaw, E.; Rotberg, F.; Morelli, G. and Auzels, P.(2000). Roads, Development and Conservation in the Congo Basin. *Conservation Biology* 14:1614-1622.
- Wittemore, R., and Knafl, K., and Gray, E.N. (2005). The Integrative Review: Updated Methodology. *Journal of Advanced Nursing*, 52 (5), 546-533.
- Yusuf A. A. and Razaq A. O. (2024). The Challenges of Deforestation and Management in Nigeria: Suggestions for Improvement. *Ghana Journal of Geography* Vol. 16 (1), 2024, 193-220.