

Ameliorating Climate Change Impacts on the Built Environment

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Abstract Climate change has been a serious hindrance to developing the built environment for decades, endangering the innovative ambition to achieve the Agenda 2030 Millennium Development Goals (MDGs). As a result, adaptation and mitigation strategies are attracting increasing interest on the world stage, and organizations are working together to provide a better built environment for human habitation. Through empirical research technique, this study provides adequate information that is lacking in past studies on how to attenuate the consequences of climate change on the built environment as an urban landscape and subsequent needs for human adaptability. This study's goals are as follows: (i) to explore the predictors of climate change indicators, and (ii) to suggest climate change mitigations and adaptation strategies. Logistic regression analyses of Statistical Package for the Social Sciences (SPSS) software package Version 22 (version 22), were used to explore the quantitative survey via descriptive analysis to obtain frequencies, percentages, mean scores, and standard deviations. Similarly, the consequences of climate change in the built environment, as determined by Principal Component Analysis, were explored. The study's outcome includes [i] important predictors of climate change, and [ii] Approaches for minimizing the effects of climate change. The study's findings revealed that reducing the consequences of climate change on the built environment will improve and safeguard the urban landscape for several decades to come. Parts of the study's recommendations include urgent actions toward integrating climate change

interventions into government decisions, initiatives, and management in Nigeria.

Keywords Climate Change, Built Environment, Mitigation, Adaptations, Nigeria

1. Introduction

Climate change remains to be the most prominent critical issue confronting countries around the globe today. As a result of this menace, the possible implications of built environments necessitate more attention in recent times. The vast variety of projected climate impacts on natural ecosystems and the current atmospheric concentrations of greenhouse gases (GHGs) constituted a significant threat in recent times [1]. Hence, as evidenced by increasing ocean temperatures, worldwide heavy snow, and rising average sea level, the climatic change system is indicating climate warming. Given this, numerous developing countries around the world remain vulnerable to the consequences of climate change, consequently, the global agenda continues to prioritize a sustainable future [2,3].

The issues emerged from a spike in the overall atmosphere's surface's average global temperature in the late nineteenth century [4]. Changes in the climate are characterized by an increase in globally averaged temperatures, while extenuating circumstances such as

natural occurrences and human behavior cause an upsurge in global average temperatures. There is also increasing evidence that several countries all across the world would feel the consequences of the effects of global warming, hence, several researchers have responded to the challenges to reduce the risks poses to society [1,3]. The construction project, public transportation, and energy industries account for around 70% of CO₂ emissions globally, accounting for a significant share of greenhouse emissions. Currently, between 75 and 50 million people in Africa are more vulnerable to the consequences of harsh weather [1].

Climate change issues such as global warming, threatening earth's atmosphere variance, pollutants substance influences, inundation, destructive rainstorm typhoons, rising ocean tiers, rising ocean temperatures causing depletion of sea organisms, strong winds, landslide, desertification, tidal wave, disintegration, pollution, and habitat destruction, among others, continue to threaten the world. Increasing the temperature and decrease in rainfall around the globe have either detrimental or favorable ecological consequences. Studies have raised concerns about the impact of climate change on the built environment as a human earth pressure [5,3]. The built environment has been documented kinds of literature to be capable of enhancing numerous development goals. Since it is an open place where residents gathered to recreate and interact with the neighborhood, hence, its contribution to health equity has been associated with the SDG goal. This brings about a quality, accessible, and safe environment.

In Nigeria, studies have shown that the country is already contending with a slew of environmental issues that have been connected to the built environment, climate change, and global warming [6]. According to research, between the years 2030 and 2050, there will be a climate change scenario that will culminate in roughly 250,000 deaths per year as a result of heat distress [27]. Climate warming has become a global issue that impacts both advanced and emerging countries. Meanwhile, regions with poor health infrastructures; primarily in developing countries will also be the least equipped to plan and adapt without intervention [5,27]. Equally, lowering the consequences of environmental hazards such as urban droughts, pollution, and flooding among others, have been exacerbated by climate change, creating significant obstacles for urban stakeholders and policymakers in achieving ecological sustainability and the SDGs [12]. Consequently, the need for environmental sustainability is subject to global warming challenges which form the major challenges facing humanity [5].

However, fewer studies have focused on adaptation techniques aiming at mitigating the impacts to reduce greenhouse gas emissions as collective actions in South-west, Nigeria. Addressing climate change for future environmental planning will ameliorate the future negative consequences as mitigation and adaptation are associated

with arrays of benefits for biodiversity conservation and peoples' well-being [10]. In Nigeria, like other countries, climate change is wreaking havoc on residents, which includes frequent droughts, and flooding, among others. Meanwhile, a focus on Nigeria's Southwestern zone is critical because of the peculiarities of the region as the nation's most densely urbanized region, and particularly because it is home to Africa's second or third largest populous cities (Lagos, Ibadan, and Ogbomosh). According to the literature, between 27 and 53 million people in Nigeria's coastal areas have been relocated as a result of sea level rise [12].

However, the gap in this study's context is attributable to the quantitative techniques that have been used to come up with reliable facts, conclusions, and recommendations for climate change mitigation and adaptation in Nigeria. Therefore, the focus of this empirical study is to identify how climate change has influenced the built environment as-built environment in South-West, Nigeria. The objectives are to (i) determine predictors of Nigeria's climate change in Southwestern, Nigeria; and (ii) determine the Climate Change Mitigation and Adaptations Strategies. Justification for the research work is vested in the changes in the climate, its mitigation, and adaptation intervention needed inclusiveness by the participation of the major players directly. This method documents the preventive measures in Nigeria climate change's study for prospects to enhance the health, and environmental conservation of Nigeria's built environment. The need to conserve, safeguard, and enhance the environment is a critical challenge for numerous countries, and it dominates deliberations and initiatives of government agencies and humanitarian organizations all over the world, including Nigeria. This study is therefore significant because of recent rapid urbanization and industrialization by highlighting the ways to integrate the preventing and managing steps taken in reaction to anthropogenic climate effects. Because of the present deteriorated form of the majority of the planet's habitats, restoration is key to realizing concerted efforts for adaptations and mitigations.

2. Reviews of Literature

2.1. Nexus of Climate Change and Population Growth

The built environment accounts for around 31% of worldwide CO₂ emissions, which encompasses emissions generated from automobiles as a result of transportation, energy usage, and land/building development. Climate change vulnerability continues to be a key hindrance to Africa's sustainable growth and development, as happens to be a threat to Agenda 2030 Millennium Development Goals, particularly in Africa. The Sustainable Growth Goals, reflect a broader strategy for economic growth and set out lofty targets for the main aspects of sustainable

development: economic development, civic participation, and ecological sustainability. According to United Nations [47], the Sustainable Development Goals (SDGs) connect areas of sustainable development by allowing appropriate knowledge of interactions among the social, economic, and environmental sustainability. Similarly, climate change is being caused by human-generated greenhouse gas emissions, which also will keep rising. Furthermore, emissions have increased in recent years, particularly between the years 2000 and 2010 [3,12]. Therefore, the rapid urbanization and expansion of cities in the 20th century accompanied this change in climate patterns. The changes in urban population and lifestyles have impacted greater energy demand, transportation, and infrastructure.

Nigeria began to progress faster than several other nations of comparable size, but the pace is expected to reduce in the future years, with the present rate of 2.62 percent predicted to drop to 2.04 percent by the Year 2050 [47]. Because of the increasing population, there are more necessities and a greater reliance on the environment. Nigeria's growing population has resulted in greater availability of agricultural areas, industrial and infrastructural development, and new human habitation, leading to a high urbanization rate. According to the United Nations [47], the population of residents living in the urban neighborhood is alleged to rise by 1.8 % annually between the years 2000 and year 2030. The significant proportion of industrialization and consequent city growth is put into perspective when compared to the expected total rate of population growth of less than 1%. Rapid urbanization, particularly the unchecked urban expansion combined with poor transportation, has had harmful effects on urban residents. Instances include the negative effects of automobiles on the natural surroundings and quality of life which has become a concern due to the current trend of the global environmental problem of climate change.

2.2. Effects of Climate Change Impact in Nigeria

In developing nations such as Nigeria, people's livelihoods have been harmed by climate change, which has resulted in more irregular weather conditions, and deteriorating coastlines, including the proliferation of diseases and pests transmitted through water. Studies have raised concerns about the impact of climate change on the built environment in Nigeria [5]. It was revealed that the Southern (coastal) towns, which are mostly the historic great cities of Abeokuta, Ikeja, Ondo, and Ibadan in southwestern Nigeria, are marked by heat stress, in the similar characteristic of several major cities worldwide. For instance, the environmental issues were evidenced by the devastating floods of the Year 2012 in Southern Nigeria, which washed away houses, farmland, agricultural goods, and properties. Similarly, researchers have iterated that the country is already contending with a slew of environmental issues such as global warming that have been connected to the built environment [15]. Others include climate change

indices such as unpredictability, flooding, drought, soil degradation, dense population, and deforestation [6].

The agriculture industry generates a little amount of Nigeria's GDP because it sustains the preponderance of the country's rural population. However, the climate change effect has been felt as agriculture being the dominant source of livelihood has suffered devastating socioeconomic consequences [7,8]. Rural people find it impossible to work on their farms due to irregular rainfall and severe drought. Therefore, climate change remains an unprecedented threat to food security, as residents in search of opportunities are forced to leave their rural settlements and migrate to urban areas; thereby posing a significant danger to food security.

The migration of rural dwellers to the urban centers has increased the strain on the city's existing systems because the bulk of these migrants is local farmers with limited skills and qualifications, they typically end up in the informal sector, settling in squalor and slum areas on the outskirts of urban where deprivation, congestion, instability, violence, and environmental destruction are common. As a result, cities become important producers of the greenhouse emissions of global warming [7,9]. Increased anthropogenic activities are also contributing to climate change which has some direct and indirect health consequences. According to the World Health Organization [10], climate change has an impact on humanity and natural factors, such as air quality, potable water, adequate nutrition, and a clean environment. Similarly, the organization also projected that the effects of climate change could be linked to at least 150,000 fatalities annually, which is attributed to flooding and illnesses associated with water. The number is anticipated to double by the year 2030. Natural catastrophes, meanwhile, have a severe influence on the local infrastructure while also triggering communal instability by restricting access to necessities like food, shelter, and health care. These climatic changes will aggravate heat-related mortality, the transfer of contagious diseases, and the destruction of the healthcare system.

2.3. Climate Change and Its Causes

Climate change consists of policies that aim to minimize emissions of greenhouse gases or increase carbon storage in the ground (sequestration). The most well-known of these worldwide environmental shifts are climate change and stratospheric ozone depletion. Odjugo [11] posits that climate change is the result of two distinct processes mainly: natural processes and human (anthropogenic) activities. Tectonic activity, orbital changes, ocean variability, and solar radiation are examples of natural processes. In his vein, human (anthropogenic factors) activities on environmental issues include activities such as releasing huge amounts of greenhouse gasses, depleting the earth's atmosphere, or lowering the number of CO₂ acquired from the ecosystem [12]. Industrialization,

coal-fired power plants, industrial emissions, urbanism, and agricultural practices are human activities that release enormous volumes of greenhouse gases. Human cultures, on the contrary, have a long history of tackling the negative impacts of climate change, which has left climatic cycles with significant fingerprints and scars on humanity's history.

The IPCC and WMO were founded in 1988 by the UNEP and often deliberated on the destructive effect of effects of climate change. The IPCC has reinstated that the world must reduce greenhouse gas emissions to negligible levels to avoid adverse effects of worldwide heating in the upcoming year 2050. Due to the unparalleled speed with which it has developed, global warming is indeed the cause of the world's deadliest environmental catastrophe. In addition, since 1880, the global mean temperature has increased by 0.85°C, the sea level rose by 19cm, as well as the Arctic is losing 1.07 million square kilometers of glaciers annually [1]. Floods and environmental disasters, which include flooding brought on by weather occurrences, are both prevalent worldwide, but the latter cause twice as much damage. Globally, weather-related disasters account for 70% of damages when only insurance costs are taken

into account. Figure 1 shows global major catastrophes associated with climate warming that occurred between the years 1980 and 2019.

The awareness of environmental health has expanded from harmful emissions to urban industrial emissions, which demands consideration of ecological footprint within the confines of global ecological viability [1]. One of a series of disruptive significant environmental phenomena is anthropogenic climate change, which reflects growing human dominance over the natural world. Major worldwide changes include the global spread of persistent organic pollutants. Climate change's effects can be seen all around the country, including rising sea levels, erosion, changing weather patterns, rising temperatures, and heavy precipitation that overwhelms current drainage systems, flooding crops and destroying houses and infrastructure [1]. Desert expansion, waterways draining up in Northern Nigeria, gullies degradation in the Southeastern portion of the country, sea level rise, and disasters in Southwest regions of the country are repercussions currently apparent in various parts of the country [14,15].

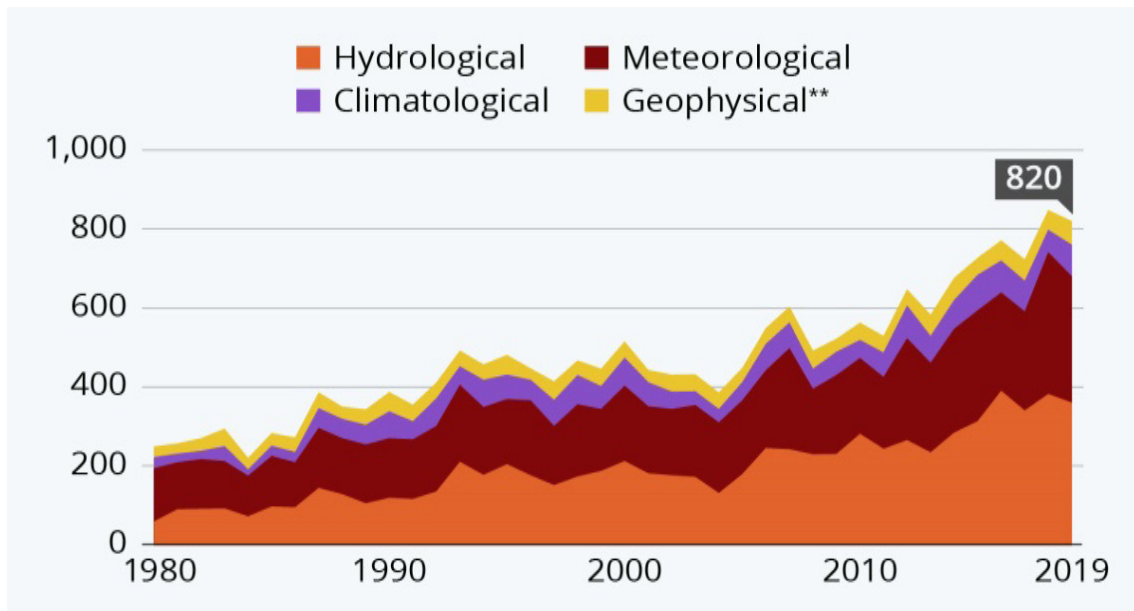


Figure 1. A synopsis of natural catastrophes documented on a worldwide scale from the years 1980 and 2019. Source: [13]

3. Method

3.1. Study Area

The South-Western region of Nigeria, which encompasses the six states of Lagos, Ogun, Oyo, Osun, Ekiti, and Ondo, is where the study was conducted (Figure 2 refers). This region is bordered on the east by Edo and Delta States, on the north by Kwara and Kogi States, on the west by the Republic of Benin, and the south by the Atlantic Ocean. As regards the 2006 demographic census, the region is situated between longitudes 20 31' and 60 00' east and latitudes 60 21' and 80 37' north, with a landmass of 76,852 km² and a demographic of 27,722,432; while the land area is roughly 166,361 km² [16,17]. Nigeria's tropical rainforest zone covers a large portion of the region. The typical annual rainfall varies from 1400 to 4000 mm, with temperatures ranging from 21 to 34 degrees Celsius. The Southwest of Nigeria is characterized by the tropical rainforest in the South and the tropical guinea savanna in the North.

3.2. Data Distribution, Collections, and Analysis

An empirical quantitative method comprising questionnaire surveys is applied to provide relevant and

sensitive proof of climate change's causes, climate change's implications, and strengthening mechanisms for environmental sustainability through mitigation and adaptations. Survey questionnaires were distributed to the respondents in the targeted states of Ekiti, Lagos, Ogun, Ondo, Osun, and Oyo respectively. The distributions were based on the stratified purposive sampling methods [18]. Collated questionnaires were analyzed by the Statistical Package for the Social Sciences (SPSS) software package Version 22. A pilot assessment was conducted early in August 2019 to pre-test the survey instrument in the research locations. The final questionnaire that was sent during the primary survey incorporated all of the feedback at the time and was later amended. Due to the lack of comprehensive directories of built environment experts in the study locations, convenience sampling techniques were relied on [19]. The main survey distributions were conducted between September and November 2019. A total number of two hundred and thirty-five (235) surveys were screened and analyzed. The response rate amounted to 78.30 percent, which was a justifiable percentage, which is quite good for the analysis [20]. When using a questionnaire method, however, a response rate of more than 30% was found to be a good and acceptable level in the literature [21].

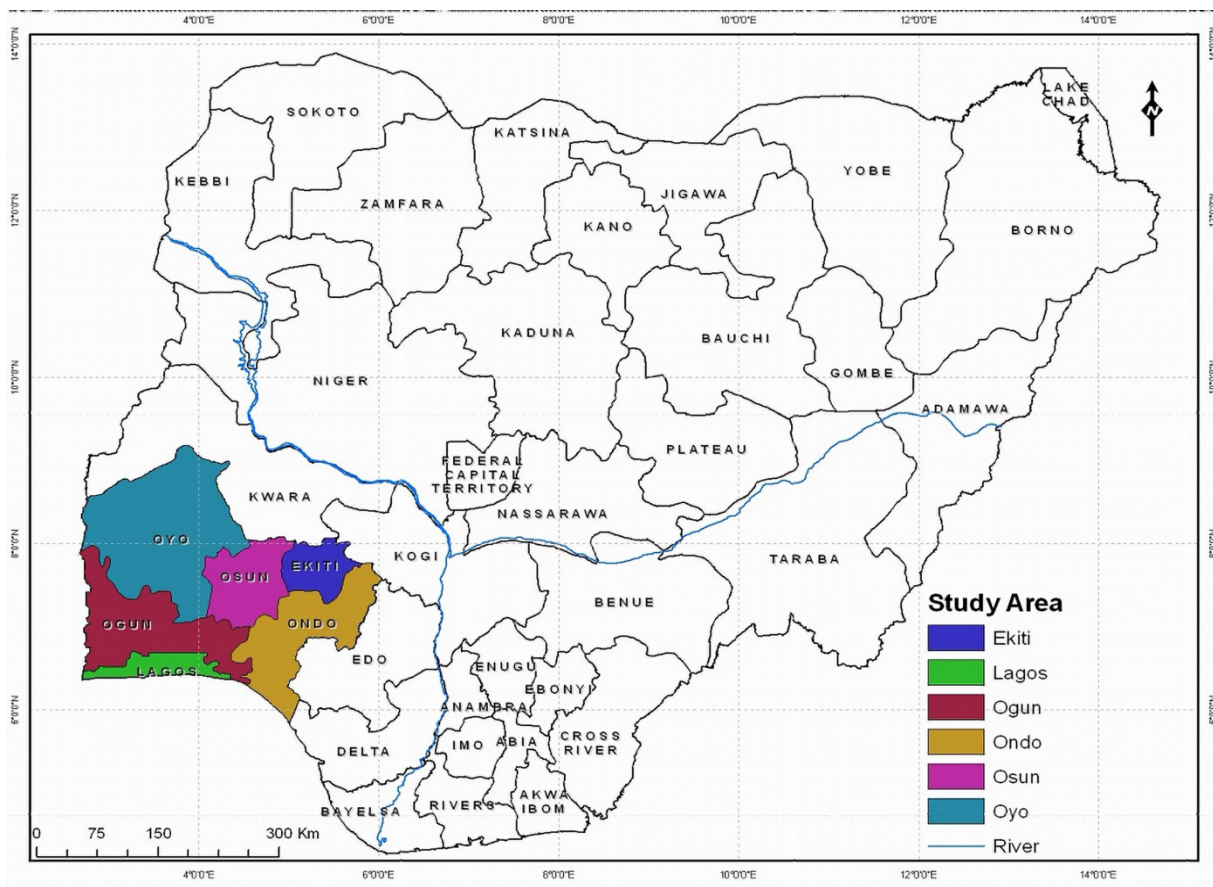


Figure 2. Case study areas of South-west, Nigeria

Meanwhile, demographic data for all respondents (n=235) were subjected to descriptive and comparative analyses. The survey includes demographic and socio-economic data, such as age, education, income, gender, areas of residency, and area of expertise. Participants' responses, were retrieved through a "5-point Likert scale" of "Strong agreement" on "5" to "Strongly disagree" on "1." As regards, all 49 dependents tested measurement variables of climate change indicators, predictors of negative impacts of environmental issues, and climate change mitigations and adaptations based on the past pieces of literature [22-24].

4. Results and Discussion

4.1. Results

The respondent's specialization is depicted in Figure 3, comprising the Environmentalists, Educationalists, Meteorologists, Professional designers, and Agriculturists, who are registered or unregistered with their professional bodies. Concerning marital status, 25.6 percent are single, 72.3 percent are married, and 2.1 percent are divorced/separated/widowed. A total of 40 (17.11%) of respondents were from Oyo state, while 38 (16.7%) were from Osun state. Ondo and Ekiti states had 25 (10.6 percent) and 25 (10.6 percent) respondents, respectively. However, 62 respondents (26.38 percent) were from Lagos State, while the remaining 45 (19.14 percent) were from Ogun

State. However, Graduates with an HND, BSC, or Master's Degree account for 45.5 percent of respondents, while 54.5 percent are professionally registered. In their chosen career, respondents have 45.7 percent (1-5 years of experience), 28.6 percent (6-10 years), and 25.7 percent (25.7 years) (10 years and above).

The findings of a descriptive statistical analysis of the climatic changes indicator in Table 1 indicate that climate change manifest through Land-degradation (Mean= 4.25, Std.= 0.52), biodiversity loss (Mean= 4.23, Std.= 0.26), Pollution (Mean= 4.07, Std.= 0.59), Drought (Mean= 4.04, Std.= 0.52), Deforestation or Desertification (Mean= 4.08, Std.= 0.46), Urbanization (Mean= 4.10, Std.= 0.63), Population growth (Mean = 4.09, Std. = 0.74), are all factors with relatively high mean scores. Contrarily, Transport disruption Mean = 3.67, Std = 0.64), Health challenges (Mean = 3.84, Std = 0.59), and Stratospheric ozone depletion (Mean = 3.08, Std.= 0.57) are factors with low mean scores. Regardless of their actual low average score, it is assumed that the characteristics happen to be climate change predictors.

Table 2 shows how Principal Component Analysis categorizes and highlights the most significant factors. These categorized factors become components of the variables that are employed in subsequent analyses. The finding showed that after evaluating 49 variables, four components converged after four iterations of rotation, accounting for 86.99 percent of the total variation. These parameters have percentages of variance of 26.45%, 21.22 percent, 18.63 percent, and 20.69 percent, respectively.

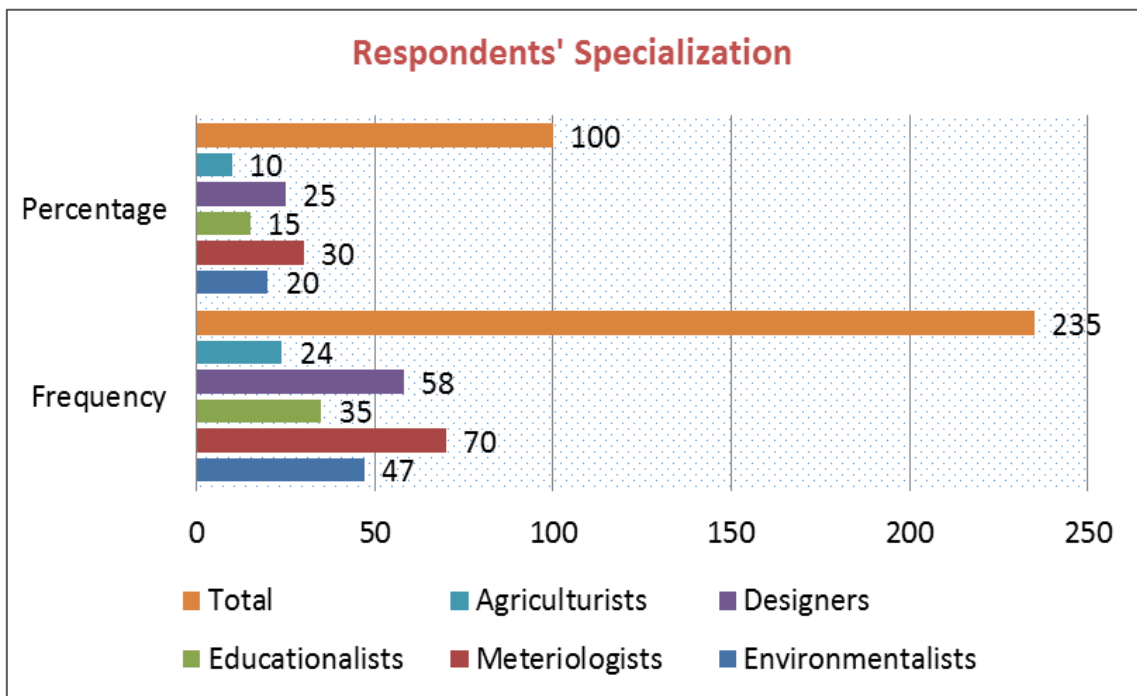


Figure 3. Respondents' field of specialization

Table 1. Descriptive Analysis of Predictors of Climate Change

Variables	N	Minimum	Maximum	Mean	Std. Deviation
i) Climate change manifests through Land-degradation (flood erosion)	235	1.00	5.00	4.2576	.52347
ii) Climate change manifests through Biodiversity loss	235	1.00	5.00	4.2300	.26048
iii) Climate change manifests through pollution (land, air & water)	235	1.00	5.00	4.0775	.59466
iv) Climate change manifests through Drought (water shortage)	235	1.00	5.00	4.0425	.52812
v) Climate change manifests through Deforestation / Desertification	235	1.00	5.00	4.0875	.46955
vi) Climate change manifests through Urbanization	235	1.00	5.00	4.1075	.63481
vii) Climate change manifests through Stratospheric ozone depletion	235	1.00	5.00	3.0800	.57380
viii) Climate change manifests through Health challenges	235	1.00	5.00	3.8450	.59477
ix) Climate change manifests through Population growth	235	1.00	5.00	4.0925	.74201
x) Climate change manifests through Transport disruption	235	1.00	5.00	3.6750	.64001

Table 2. The Principal Components analysis for the Demographic data and Climate Change Indicators

Variables	Components			
	1	2	3	4
Education level	.765			
Gender	.743			
Age	.702			
Career backgrounds	.789			
Environmentalists	.754			
Educationalists	.756			
Meteorologists	.659			
Designers	.786			
Agriculturists	.739			
Years of residency	.799			
Land-degradation (flood/ erosion)		.786		
Biodiversity loss		.729		
Pollution (land, air & water)		.779		
Drought			.761	
Deforestation / Desertification			.793	
Urbanization			.726	
Stratospheric ozone depletion				.704
Health challenges				.733
Population growth				.761
% variance explained	26.45%	21.22%	18.63%	20.69%

Principal Component Analysis was used to extract the data. In four iterations, the rotation converged.

The first factor is referred to as the respondents' demographics which consisted of various variables such as the education level, gender, age, education background, respondents' professional background, and years of residency. The second factor, which is named Predictors of Climate Change 2 (PCC2) encompasses variables such as Land-degradation, Biodiversity loss, and Pollution. Next to this is the third factor that encircles variables such as Drought, Deforestation or Desertification, and Urbanization. This factor is named Predictors of Climate Change 3 (PCC3). The fourth significant factor is coined Predictor of Climate Change 4 (PCC4) which refers to variables such as stratospheric ozone depletion, Health challenges, and Population growth.

As outlined in Table 3, the quantitative results of the descriptive analysis indicated that greening the environment or green Infrastructure (Mean= 4.96, Std. = 0.20); Pedestrianized environment (Mean = 4.90, Std = 0.50); Provision of stronger urban-rural connections (mean = 4.86, Std= 0.61). These are the factors with the greatest average overall mean. Next is the high average mean scores such as the Promulgation of law that discourages human activities impacts (Mean=4.79, Std= 0.74); Increasing the numbers of public spaces in the city environment (Mean=4.78, Std= 0.75); More enlightenment programs on the danger of the effects of environmental challenges (Mean=4.74, Std= 0.79); More researches on climate change (Mean=4.74, Std= 0.78); environmental cleanness via less use of paper and plastics nylons (Mean=4.73, Std= 0.87) that received the higher average variables.

4.2. Predictors of Climate Change Indicators

The outcome of this research is consistent with previous studies [25-27] which revealed that some variables cause a serious environmental imbalance in the ecosystem, resulting in environmental difficulties evidenced by climate change. This study has equally affirmed that desertification, deforestation, floods, erosion, urbanization, and overpopulation are examples of environmental difficulties caused by climate change and ecosystem degradation. Significant degradation and loss of natural ecosystems are evidence of climate change predictors as affirmed by Daramola & Eziyi [28] and Kjellstrom & Mercado [29] that the urban environmental challenges will remain dominant on the sustainability agenda around the globe, particularly in developing nations.

Biodiversity loss and increasing human demand for space and food are climate change-associated problems as concurred by past studies [24,30]. In the same vein, the destruction of ecosystems that offer products and services is a significant consequence for people's habitat. Given this, people's health has been threatened by climate change, lower supplies of drinkable water, contributed to the loss of habitat and weakened ecosystem services [24,31,32].

Nevertheless, as increasing population expansion continues to be an important public health problem in the twenty-first century, large health disparities have emerged in metropolitan regions. The fundamentals of environmental sustainability, economic growth, human development, and nature conservation, are all linked to urbanization. The industry sector and hazardous sewage have made a significant contribution to environmental pollution, including excessive noise, poor air quality, oil spills, soil pollution, and urban sprawl leading to the loss of greenery, as a result of rapid modernization and technological innovation in automotive and construction has been supported by the studies of [33,34].

Rapid urbanization in Nigeria, like many other third-world countries, has resulted in a scarcity of green landscaping in metropolitan areas [28,30]. As a result, pollution in cities, warm air islands, flooding, and degradation are all issues that need to be addressed [35]. While environmental problems are primarily caused by developmental processes, they equally have local, regional, and global implications. Consequently, global warming has become a been enlisted as part of the environmental health risks that humanity faces. In light of these findings, the adverse effects of global warming have a huge impact on inhabitants' living conditions. Increased CO₂ emissions, increased air pollution-related health impacts, increased temperature-related health effects, and increased mental-related health effects have the greatest impact [36,37]. Increases in dietary infectious-health impacts, increases in water and food-borne disease-associated health effects, increases in food production shortages, and increases in poverty or low economic activity have impacted negatively [24,27,38,].

4.3. Climate Change Mitigations and Adaptations

The study's second goal is to determine Climate Change Mitigation and adaptation, hence, this study has highlighted that greening the environment (green infrastructure) pedestrianized environment; provision stronger urban-rural connections are the mitigation and adaptations required for the climate change impacts. These inferred that incorporating green spaces, within the communities; reducing global carbon emission via less usage of motorized transport, and establishing more robust urban-rural links are the greatest determinants of mitigating and adaptations of climate change; human interventions; advocacy, or awareness of the significance of greening the environment are other variables [39,40]. In the same vein, the stratospheric layer's degradation should indeed be mitigated by was corroborated by the past study of Opoko [41] in which awareness of the depletion of the ozone layer through the ability to filter the contaminants from the air remains paramount.

The findings from this study elucidate further that a series of measures are best available for climate change

mitigations and adaptations which have critical roles to play in consolidating the SDGs and enhancing the built environment. The results also reveal that sustainable communities could be achieved by greening the environment and reduction in global carbon emissions via less usage of motorized transport while delivering clean energy sources is also one of the responsibilities that can be filled towards mitigating the effects of climate change and achieving the SDGs. As a result, when backed by effective government goals and procedures, the built environment can work as a catalyst for achieving the SDGs. Similarly, plants and trees serve as natural filters and thus reducing air pollution. By lowering the amount of carbon dioxide in the atmosphere, plants help to reduce global climate change. Trees and shrubs mitigate pollution levels by (i) trapping pollutants via their foliage; (ii) collecting dust and other dust particles on their leaves, thus lowering their inclusion in the air breathed; (iii) decrease in pollutant concentrations at the ground surface by lowering the temperature via transpiration; (iv) reduction in ozone concentrations at ground level by lowering the temperature via transpiration; (v) as previously stated, releasing oxygen improves the quality of the air for human consumption [42]. According to the findings of this study, greening a roadway by planting along the public right of way performs services such as providing shade from the sun, cooling the atmosphere in hot weather, and supplying fresh air all of the time. Trees help to minimize pollutants in the air and

water. When it comes to air pollution, every tree planted provides shade. This is accomplished with trees filtering and retaining particle materials such as dust and soil that can irritate the respiratory tract.

Trees help filter particulates from rainwater and potential pollutants from the human influence that enter soils, keeping them from reaching aquatic bodies. This affirmed that green areas and open spaces play a significant role in lowering emissions that contribute to global climate change. Enhanced activity in the green areas that are available and accessible to people from all walks of life can encourage contact with nature, social interaction, and physical activity such as walking, jogging, and cycling. The capacity of people to use active transportation such as walking and cycling is influenced by street layout, this has a massive effect on both climate issues abatement and public health. The road transportation industry is a key source of global CO₂ emissions, which contribute significantly to climate change. Alternative or renewable power will significantly reduce GHG emissions into the atmosphere. To mitigate human impact on the ecosystem and avoid catastrophic repercussions, developing and growing economies must follow suit. In this regard, technological advancements may surely play a big role in establishing realistic solutions to employ clean and renewable types of energy while minimizing greenhouse gas emissions and improving the value of the ecosystem as concurred with by Roaf, et al. [43] and Altomonte [44].

Table 3. Climate Change Mitigation and Adaptations: Quantitative Results from the Descriptive Analysis

Scale (α)	Codes	Responses From the Likert Scale										Statistics		
		SA "5"	Percentages	AG "4"	Percentages	N "3"	Percentages	SD "2"	Percentages	D "1"	Percentages	Total Number of Respondents ($\sum f$)	Average Mean Scores ($\sum f x / \sum f$)	Standard Deviation (SD)
Items														
Greening the environment / Green Infrastructure (incorporating parks, green spaces, and open spaces within the communities)	CCMA 1	225	95.75	10	4.26	00	00	00	00	00	00	235	4.96	0.20
Pedestrianized environment (Reduction in global carbon CO ₂ emission via less usage of motorized transport)	CCMA 2	221	94.04	10	4.26	00	00	02	0.85	02	0.85	235	4.90	0.50
Provision of stronger urban-rural connections	CCMA 3	218	92.77	09	3.83	02	0.85	03	1.28	03	1.28	235	4.86	0.61
The stratospheric layer's degradation should be mitigated by human impact.	CCMA 4	219	93.19	08	3.40	00	00	04	1.70	04	1.70	235	4.85	0.66
Advocacy/awareness of the significance of greening the environment	CCMA 5	214	91.06	11	4.68	01	0.43	05	2.13	04	1.70	235	4.81	0.70
Promulgation of law that discourages human activity impacts	CCMA 6	210	89.36	15	6.38	00	00	05	2.13	05	2.13	235	4.79	0.74
Increasing the number of public spaces in the city environment	CCMA 7	209	88.94	16	6.81	01	0.43	03	1.28	06	2.55	235	4.78	0.75
The layout of streets to accommodate active transportation such as walking and cycling	CCMA 8	198	84.26	30	12.77	00	00	05	2.13	02	0.85	235	3.78	0.64
Availability of climate data and statistics	CCMA 9	208	88.51	15	6.38	02	0.85	05	2.13	05	2.13	235	3.65	0.56
A much more enlightening curriculum on the dangers of environmental issues is needed.	CCMA 10	203	86.38	18	7.66	03	1.28	06	2.55	05	2.13	235	4.74	0.79
More research on climate change	CCMA 11	202	85.96	20	8.51	00	00	10	4.26	03	1.28	235	4.74	0.78
Environmental cleanness via less use of paper and plastics nylons	CCMA 12	207	88.09	14	5.96	00	00	06	2.55	08	3.40	235	4.73	0.87
Incorporate climate change curriculum in Tertiary education taught courses	CCMA 13	197	83.83	22	9.36	00	00	08	3.40	08	3.40	235	3.41	0.61
More budgetary allocation to fight the challenges of environmental degradation and its influences	CCMA 14	195	82.98	20	8.51	00	00	10	4.26	10	4.26	235	3.92	7.40
Alternative energy source	CCMA 15	189	80.43	26	11.06	02	0.85	10	4.26	08	3.40	235	3.01	0.78

5. Conclusion and Recommendation

Several significant knowledge gaps have been filled in this study, which has far-reaching implications on how vulnerabilities are handled. In Nigeria, this research has contributed to how climate change consequences are expected to be ameliorated, as well as public perceptions toward the climate change menace in the built environment. The most challenging tasks of our time are reducing greenhouse emissions and modifying communities to withstand the harsh environmental conditions expected as a consequence of global warming. This is intending to address both the complex needs of the environment and the needs of contemporary solutions for sustainable economies. Additionally, major climate change consequences projected to alter the future nature and operation of urban systems in Nigeria are described in this study. The new integrated approach is also geared toward combining environmental responsibility mandates with human impact mitigation strategies. Thus, an enhanced depiction of intra-urban floods at neighborhood, city, and watershed sizes, is urgently needed for the health and welfare of the citizens in Nigeria. To minimize the environmental impact in Nigerian cities, it will be necessary to (i) decrease energy consumption during various construction processes; (ii) encourage the use of low-carbon modes of travel; and (iii) adopt low-carbon energy generation technologies as supported by the host of past pieces of literature [37,45,46].

Prevention strategy adaptation aims to maintain the quality of life and municipal systems by reducing the negative effects of climate-related hazards, preventing those hazard events from turning into disasters. Examples of such measures include erecting flood walls and coastal defenses and installing energy-efficient air conditioning in public buildings. By making significant changes to the systems and fabric of the city, revolutionary adaptation addresses the underlying causes of climate risk and reduces the likelihood and severity of climate-related hazards. The construction of water, reusing systems, the adoption of building codes that demand high energy efficiency and cool roofs, or the expansion of the city's green infrastructure are all examples of transformative actions. These also include reducing urban heat and the risk of flooding and drought. With additional advantages for the city and its citizens, revolutionary adaptation methods provide the highest protection from climate risk and decrease the need for proactive and preventative efforts. Integrating the greener gateway initiatives into the district's planning and passing the necessary legislation to encourage the use of green building practices are further steps that may be taken to mitigate the effects of climate change.

In keeping with the 13 Sustainable Development Goals, this study's implication is vested in the need to consolidate the 2030 Agenda for Sustainable Development Goals (SDGs) which is a set of goals established by the United Nations (UN). The 3-Goals are (i) Goal No 11: The goals

focus on Sustainable Cities and Communities in creating inclusive, resilient, and safe environments (ii) Goal 13: to take proactive urgent action to combat the challenges associated with climate change; (iii) Goal 15: Life on Land: Preserve, rebuild, and enhance the healthy use of ecosystems. Streets that prioritize walking and cycling improve and reduce emissions that contribute to air pollution and climate change. While at the same time, a functional environment with green space facilities promotes healthy living [30]. This strategy remains a new approach to landscape and urban planning advancements, in South-west, Nigeria. It is equally, essential for developing nations like Nigeria to intensify advocacy on climate change by employing cutting-edge adaptive technology and funding research on climate change. Nigerian policymakers and other developing nations in Africa stand to benefit from this research work to help them determine policies that will reduce climate change while also having a significant positive impact on the economy and society.

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