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Experts profiling on a healthier built environment: Lowering the threat of climate change

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ABSTRACT

BACKGROUND AND OBJECTIVES: There are indications that climate change and its consequences are already creating threats to the built environment in Nigeria. These environmental threats have negative implications for healthy, well-being, and urban sustainability. This empirical study aim to identify how climate change has influenced the built environment in Nigeria's South-Western region, considering the following objectives: to explore the reasons for climate change in South-western, Nigeria, to determine the consequences of environmental issues on inhabitant health in South-western, Nigeria; and to critically determine the key measures of climate change mitigation and adaptation to enhance the environmental sustainability of the Southwestern region of Nigeria.
METHODS: An empirical quantitative method comprising 300 questionnaires survey was administered, and 235 were retrieved and used as a sample population for the research analysis. The distribution of questionnaires was based on the convenience sampling methods among professionals within the built environment. The internal consistency was assessed using Cronbach's alpha (α), and the analysis was performed using the Statistical Software program; SPSS for Windows, version 22.
FINDINGS: The results from descriptive analysis revealed that Land-degradation, biodiversity loss, pollution, deforestation, urbanization, health challenges and population growth are predictors factors of climate change with mean scores of 4.2576, 4.2300, 4.0775, 4.0875, 4.1075, 3.8450 and 4.0925 respectively. Furthermore, the research showed a causal linkage relationship of climate change and the factors of land degradation, biodiversity, pollution and deforestation of ($p<0.001$). Generally, the results affirm that the predictors of climate change are attributed to the factors of land degradation, biodiversity loss, pollution, urbanization and deforestation in the region.
CONCLUSION: The research gives an understanding about the impacts of climate change in the south west region, Nigeria and remains a veritable document to government and policy maker towards the prevention and mitigating measures on climate change impacts. The outcome of the research has revealed negative impacts of environmental issues on inhabitants' health through air pollution, temperature related effects and mental related infectious diseases. The climate change mitigation and adaptations results agreed that greening the environment/ green infrastructure, provision of stronger urban-rural connections and promulgation of law that discourages human activities impacts are few among the items recommended in mitigating and combating the impacts of climate change in South-western Nigeria.

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INTRODUCTION

Climate change is referred to as an alteration in the environment that can be traced back to human behavioral patterns, either overtly or covertly that modifies the creation of the global atmosphere (Friedlingstein *et al.,* 2019; Bouba and Li, 2022; Frimawaty *et al.,* 2023; Dionysius and Vasudevan, 2023). Climate change has been evidenced by the increase in ocean temperatures, heavy snow, rising average sea levels, strong winds, landslides, desertification, tidal wave, disintegration, pollution, and habitat destruction among others (Thomas, 2020; Van der Waal and Thijssens, 2020; Sivakumar *et al.,* 2022; Payus and Sentian, 2022; Samimi *et al.,* 2023) From another perspective, the construction project, public transportation, and energy industries account for around 70% of carbon dioxide (CO_2) emissions globally, also accounting for a significant share of greenhouse emissions and global climate change (Thomas, 2020; Soeprobowati *et al.,* 2023). Climate change remains the most prominent critical issue confronting countries around the globe in recent times (World Health Organization, 2021; Arredondo-Trapero *et al.,* 2023). Therefore, efforts are ongoing by scholars on the need to document the implications and remedies of climate change. It has equally been noted that the climate impacts on natural ecosystems and the current atmospheric concentrations of Greenhouse Gases (GHGs) constituted a significant threat (Intergovernmental Panel on Climate Change, 2014; Thomas, 2020). According to research, between the years 2030 and 2050, there will be a global climate change scenario that will culminate in roughly 250,000 deaths per year as a result of heat distress (World Health Organization, 2021). A recent review has enumerated that 6% of Nigeria's geographical area is thought to be susceptible to extreme weather occurrences, making it one of the most vulnerable countries to the effects of climate change (World Bank, 2019). However, the impacts are felt by the unpredictability of flooding, drought, and soil degradation (Heubes *et al.*, 2013), heavy downpours (Ibitoye and Eludoyin, 2010), dense population, and deforestation (Odey *et al.,* 2018). Other effects of climate change in Nigeria include a large rise in rural-urban migration as well as a decreased watershed (Cattaneo and Massetti, 2019).These are some of the environmental hazards that occur often time, which have threatened harmonious relationships between people and their environment. As indicated in Fig. 1, urban population growth is projected to exceed rural population growth in the next decades. Rapid urbanization, particularly unchecked urban expansion may likely encroach into earmarked open green spaces and may reduce sequestration, therefore increasing the carbon footprint of settlements (Zakka *et al*., 2017). The poor transportation system has 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.

According to estimates, Nigeria's population

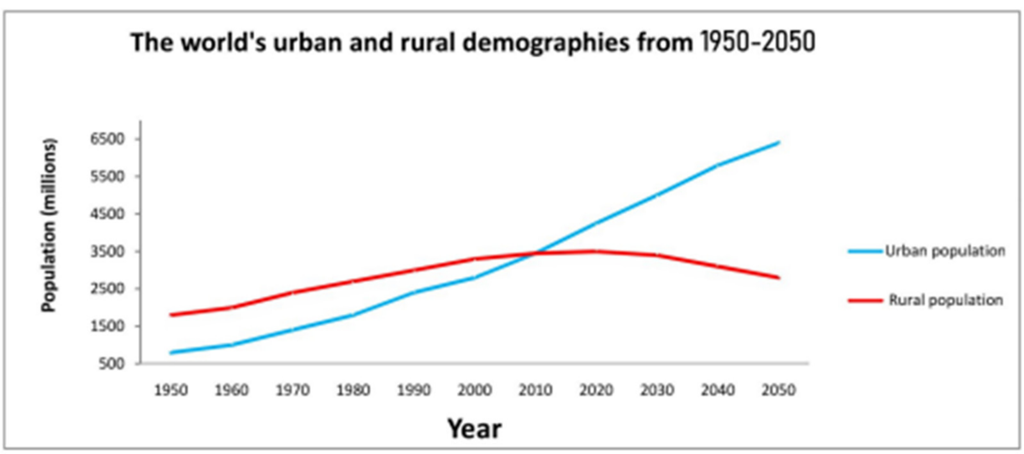

Fig. 1: The world's largest urban and rural demographics from the year 1950 to the year 2050. (Cohen, 2001)

Table 1: Several indicators of Nigeria's urban and population growth (Kumar *et al*., 2016; IPCC, 2014)

Variables	Specifics	Rate
Land-use	Deforestation	4000 km2/year
	Reforestation	10 km2/year
	Forested area (2008)	10.8%
Urban Population	Annual growth	3.8%
	Urban Population in 2004, 2010	45%, 48.9%
Rural Population	Annual growth	1.8%
Total population	The population density in 2004, 2009	137.6, 167.5 persons/km^2
	Annual growth	2.5%
Total fossil fuel emission	Year 1951	460 000 tons
	Year 1980	18 586 000 tons
	Year 2008	26 113 000 tons

would reach 206 million by 2020 and 264 million by 2030, hitting the 300 million mark by 2036 (World Population Review, 2022). Without mincing words, Nigeria's fast-growing human population has resulted in greater challenges in the primary sector of agriculture, industrial sector, and infrastructural development (Olatunji *et al*., 2021) and new forms of human habitation. The rapid urbanization and expansion of Nigerian cities have been accompanied by changes in climatic patterns in recent times. Other impacts are felt in the peoples' lifestyles; greater energy demand, transportation, and other essential infrastructural facilities. Table 1 demonstrates several indicators of Nigeria's land use, population, and fossil energy production. Almost all of the 36 States capitals in Nigeria are highly populated, including the Federal Capital, Abuja with about 1000 people per square kilometer). The degradation and fossil energy production has increased dramatically, with only 10.8% of the land area with forest. Balogun and Daramola (2019) revealed that a typical Nigerian metropolitan city may generate a considerable heat island of between 0.5 – 2.5°C during the day. Some political leaders of recent time pushed for municipal greening projects that involved planting plants in previously completely built-up regions in Nigeria (Oludare *et al*., 2021). The primary land-use systems supported massive deforestation for urban growth, which has been shown to have an impact on the local climate.

Climate change vulnerability continues to be a key hindrance to Africa's sustainable growth and development, as it happens to be a threat to Agenda 2030 Millennium Development Goals particularly in Africa. The Sustainable Development Goals (SDGs) 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 (Geissdoerfer *et al*., 2017). The Sustainable Development Goals connect areas of sustainable development (UN-Habitat, 2008; UNEP, 2014), allowing appropriate knowledge of interactions among social, economic, and environmental sustainability (Glaser, 2012; Van der Waal and Thijssens, 2020). Based on previous assertions, fewer studies have focused on adaptation techniques aiming at mitigating the impacts of climate change as collective actions in South-west, Nigeria. To address this global threat, the professional views, the causes and effects of climate change, adaptations and mitigation strategies deserve investigation. This will provide a better future approach to environmental planning and ameliorate the negative consequences. The gap in this study's context is attributable to the quantitative techniques focusing on reliable facts, for combating climate change impacts in south west, Nigeria. The Justification for this research is vested in the adaptation intervention feedback needed by the major players who are professionals. Their involvement in this study includes feedback through survey questionnaires on the study's keywords. This research document gives a clear perspective on, Impacts of climate change in the South-western region, of Nigeria and will remain a veritable document for the prevention and application of mitigating measures on climate change to enhance the environmental quality of the built environment. Therefore, this empirical study aims to identify how climate change has influenced and impacted the built environment in Nigeria's Southwestern region. The objectives were: (i) to explore the reasons for climate change in Southwestern, Nigeria; (ii) to determine the consequences of environmental issues on inhabitant health in Southwestern, Nigeria; and (iii) to critically determine the key measures of climate change mitigation and adaptation to enhance the environmental sustainability of the Southwestern zone of Nigeria. The current study was carried out in the South- West Region States of Ekiti, Lagos, Ondo, Ogun, Osun , and Oyo in Nigeria, in the year 2019 to 2022.

MATERIALS AND METHODS

Data collection, Distribution and Analysis

An empirical quantitative method comprising questionnaire surveys was applied to provide relevant and sensitive proof of climate change's causes; implications; and strengthening mechanisms for environmental sustainability through mitigation and adaptations. These encompass one-on-one survey distribution conducted among key stakeholders who are inhabitants of the case study areas. This study draws on the population survey participants who were adult residents in the municipality (aged ≥18 years old). However, the respondents cut across the environmentalist, educationalists, meteorologists, professional designers, and agriculturists. A total number of 300 survey questionnaires were distributed to the respondents in the targeted states of Ekiti (50 numbers), Lagos (50 numbers), Ogun (50 numbers), Ondo (50 numbers), and Osun (50 numbers), and Oyo (50 numbers) respectively. The survey distributions were done between November and December 2019, in the study areas; and were based on the convenience sampling methods supported by a similar study by Akinola *et al.,* (2020). This is considered appropriate due to the lack of detailed lists of professionals in the built environment in the regions. For satisfactory data gathering and removal of bias; stratified random sampling was still used, which involves classifying the professionals before performing a random selection across the strata. Out of the distributed survey, a total number of two hundred and thirty- five (235) surveys were retrieved and suitable for analysis.

Data analysis

The response rate amounted to 78.30 percent, which was a justifiable percentage, which is quite good for the analysis (Crano *et al.,* 2014). The internal consistency was assessed using Cronbach's alpha (α), and the analysis was performed using the Statistical Software program; SPSS for Windows, version 22. The data reliability measure for all the variables exceeded Cronbach's Alpha coefficient (α) of 0.6 which demonstrated reliable values Cronbach and Shavelson (2004) and George and Mallery, (2021) affirmed that scores within the range of 0.6-0.7 are acceptable. The test assisted in the clarity and level of the application of the questionnaire instrument. 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. Aside from the demographics data, answers to a set of 49 dependents tested measurement variables that elicited respondents' opinions on self-rated predictors of climate change indicators, predictors of negative impacts of environmental issues on inhabitants' health, and climate change mitigations and adaptations among others were outlined based on the past literature of Morecroft *et al.* (2019) and Berrang-Ford *et al.,* (2019). For participants' responses, the criteria were scored on a "5-point Likert scale" ranging from "Strong agreement" of "5" to "Strongly disagree" of "1."

The 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 per 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 Square Kilometers (KM^2) and a demographic of 27,722,432; while the land area is roughly 166,361 KM^2. (Agboola

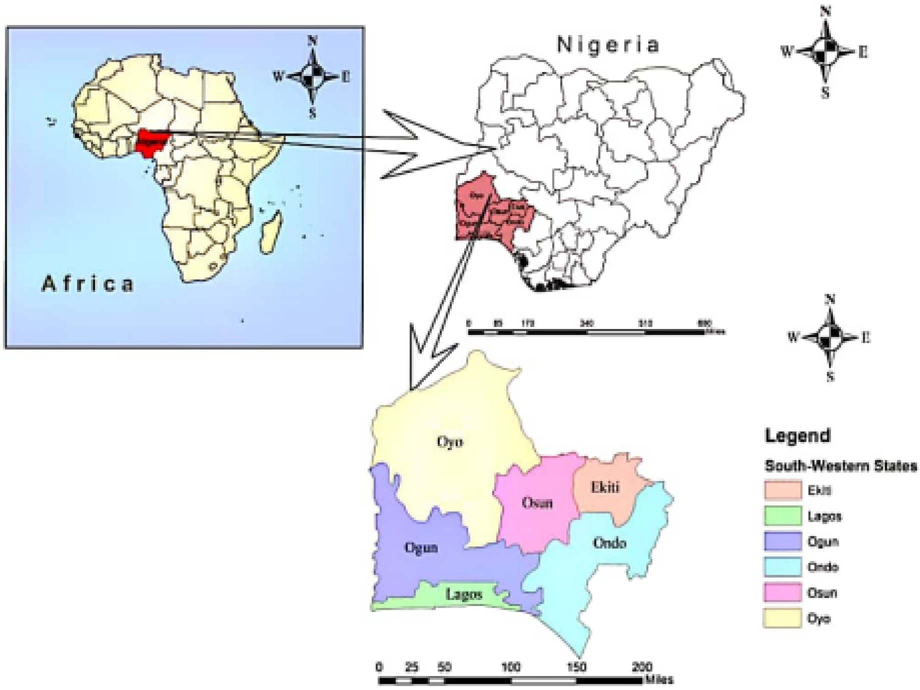

Fig. 2: Geographic location of the study area (South West States, Nigeria)

et al., 2018; Faleyimu and Oyebade, 2012).

The sub-equatorial rainforest in the southwest of Nigeria is characterized by warm, humid zones (Agboola *et al.,* 2018), the zone is the low-wet climate of the tropics, while the warm humid zone covers places such as the coasts, forests, and transitional regions. Furthermore, environmental issues were reflected in the devastating floods of 2012 in Southern Nigeria, which washed away houses, farmland, agricultural goods, and properties. The states of Oyo, Osun, Lagos, Ondo, Ogun, and Ekiti make up the regional zone of south-west Nigeria as shown in Fig. 2. In the official gazette of Nigeria's 2006; population (P) census figure of the study region was estimated to be around 27,581,992, with a gender balance of 51% for males and 49% for females. With an average population density of 481 people per square kilometer and an annual population growth (PG) rate of 2.6%, the population was estimated at 37,531,330 by 2018 (20% of Nigeria's total population) as iterated by Ogunleye *et al.,* (2018).

RESULTS AND DISSCUSIONS

The findings of a descriptive statistical analysis of climatic changes indicators in Table 2; indicate that climate change manifest through Land-degradation (LD) (Mean= 4.25, Std.= 0.52), Biodiversity Loss (BDL) (Mean=4.23, Standard deviation (Std)=0.26), Pollution (Mean= 4.07, Std.= 0.59), Drought (D) (Mean= 4.04, Std.= 0.52), Deforestation / Desertification (DF) (Mean= 4.08, Std.= 0.46), Urbanization (Urb) (Mean= 4.10, Std.= 0.63), Population growth (PG) (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 (SOD) (Mean = 3.08, Std. = 0.57) are factors with low mean scores. Regardless of their actual low average score, it is affirmed that the characteristics happen to be climate change predictors.

The descriptive analysis results in Table 3 revealed the highest mean scores of negative impacts of environmental issues on inhabitants' health in air pollution-related health effects (Mean= 4.81, Std.= 0.55), temperature-related health effects (Mean= 4.85, Std.= 0.52), mental-related infectious diseases (Mean= 4.94, Std.= 0.23), nutritional infectious diseases (Mean= 4.83, Std.= 0.41), and increase in

Table 2: Descriptive Analysis of predictors of climate change

S/N	Minimum (Min.)	Number of respondents (N)	Min.	Maximum **(Max)**	Mean	S.D.
1	Climate change manifests through Land-degradation (flood erosion)	235	1.00	5.00	4.2576	.52347
2	Climate change manifests through Biodiversity loss	235	1.00	5.00	4.2300	.26048
3	Climate change manifests through pollution (land, air and water)	235	1.00	5.00	4.0775	.59466
4	Climate change manifests through Drought (water shortage)	235	1.00	5.00	4.0425	.52812
5	Climate change manifests through Deforestation/Desertification	235	1.00	5.00	4.0875	.46955
6	Climate change manifests through Urbanization	235	1.00	5.00	4.1075	.63481
7	Climate change manifests through Stratospheric ozone depletion	235	1.00	5.00	3.0800	.57380
8	Climate change manifests through Health challenges	235	1.00	5.00	3.8450	.59477
9	Climate change manifests through Population growth	235	1.00	5.00	4.0925	.74201
10	Climate change manifests through Transport disruption	235	1.00	5.00	3.6750	.64001

Table 3. Descriptive Analysis of the Evidence of Negative Impacts of Environmental Issues on the Inhabitants of Built Environment

S/N	Variables	N	Min.	Max.	Mean	S.D..
1	Increase in Air pollution-related health effects	235	1.00	5.00	4.8130	.55317
2	Increase in Temperature-related health effects	235	1.00	5.00	4.8550	.52690
3	Increase in Mental-related infected infectious diseases	235	1.00	5.00	4.9404	.23726
4	Increase in Nutritional infectious diseases	235	1.00	5.00	4.8347	.41503
5	Increase in Water and foot Borne related diseases	235	1.00	5.00	4.7586	.70005
6	Increase in shortage of food production	235	1.00	5.00	3.8218	.60409
7	Increase in the low level of economic activities	235	1.00	5.00	3.8519	.51919
8	Increase in emissions of CO_2	235	1.00	5.00	3.8727	.42299

water and foot borne related diseases (Mean= 4.75, Std.= 0.70). A lower mean scores were recorded for an increase in shortage of food production (Mean= 3.82, Std.= 0.60); an increase in the low level of economic activities (Mean= 3.85, Std.= 0.51); an increase in emissions of Co_2 (Mean= 3.87, Std.= 0.42). The results of the Multiple Linear Regression Analysis in Table 4 indicate that predictors of negative impacts of climate change are vested solely on (i) an increase in air pollution-related health effects, (ii) an increase in temperature-related health effects, (iii) an increase in mental-related health effect, (iv) increase in nutritional infectious health-related effects, (v) increase in water and food-borne related health effects, (vi)increase in shortage of food production, (vii) increase in poverty/low level of economic activities, (viii) increase in deaths. Therefore, the emerged equation is that predictors of Negative Impacts of climate change on inhabitant's conditions = 0.035 + 0.688 (Increase in Air pollution-related health effects) + 0.686 (Increase in Temperature-related health effects) + 0.601 (Increase in Mental-related health effects) + 0.427 (Increase in Nutritional infectious-health related effects) + 0.431 (Increase in Water and foot Borne related health effects)+ 0.428 (Increase in shortage of food production)+ 0.410 (Increase in the low level of economic activities) + 0.698 (Increase in emissions of CO_2).

Table 5 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

Table 4: Coefficients for the predictors of negative impacts of climate change on inhabitants' conditions

	Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. error	Beta		
1	(constant)	.035	.076		0.214	.312
	Increase in Air pollution-related health effects	.688	.057	.683	8.652	.004
	Increase in Temperature-related health effects	.686	.048	.607	7.581	.000
	Increase in Mental-related health effects	.601	.051	.406	9.522	.000
	Increase in Nutritional infectious-health-related effects	.427	.066	.481	9.833	.000
	Increase in Water and foot Borne related health effects	.431	.059	.434	12.572	.000
	Increase in shortage of food production	.428	.053	.367	12.876	.000
	Increase in the low level of economic activities	.410	.062	.389	11.768	.000
	Increase in emissions of Co_2	.698	.056	.387	12.536	.000

Dependent Variable: Opinions of the built environments' inhabitants

Table 5: 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 (floor/ 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

rotation, accounting for 86.99 percent of the total variation. These parameters have percentages of variance of 26.45%, 21.22%, 18.63%, and 20.69%, respectively.

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

Table 6: The association between climate change predictor and impacts on built environment's inhabitants

The dependent Variable		LD	BDL	Pollution	Drought	Deforestation/ DF	Urb	Stratospheric ozone depletion
Impacts on public space's users	Pearson Correlation	0.801**	0.845**	0.825**	0.705**	0.765**	0.985**	0.715**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	235	235	235	235	235	235	235

**Correlation is significant at the 0.01 level (2-tailed)

Table 7. The casual relationship between the impacts of climate change on various built environmental elements

Casual interactive items	*F*	df2	Sig. p-value
Climate change causes land-degradations in the built environment.	3.423	235	0.001*
Climate change causes biodiversity loss in the built environment.	4.239	235	0.002*
Climate change causes all forms of pollution of the built environment.	206.532	235	0.001*
Climate change causes drought in the built environment.	5.632	235	0.001*
Climate change causes deforestation / desertification in the built environment.	11.054	235	0.001*
Climate change causes urbanization in the built environment.	105.045	235	0.001*
Climate change causes stratospheric ozone depletion in the built environment	4.645	235	0.001*

Significant at 0.001* levels (2-tailed). p≤0.001

(Intergovernmental Panel on Climate Change, 2014) encompasses variables such as land degradation, biodiversity loss, and pollution. Next to this is the third factor that encircles variables such as drought, deforestation/desertification, and urbanization. This factor is named predictor 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. Table 6 shows the connections between both variables in a Bivariate Pearson Correlation. Predictors of climate change as the independent variables and the impacts on the built environment's users as the dependent variable. The results revealed that the impacts on built environment's users have a strong relationship with the various predictors of climate change like the land-degradation (r = 0.801**, P < 0.01), biodiversity loss (r = 0.845**, P < 0.01), pollution (r = 0..825**, P < 0.01), drought (r = 0.705**, P < 0.01), deforestations/desertification (r = 0.765**, P < 0.01), urbanization (r = 0.985**, P < 0.01), and stratospheric ozone depletion (r = 0.715**, P < 0.01). Hence, the results affirm that the predictors of climate change are attributed to land degradation, biodiversity loss, pollution, drought, deforestations/desertification, urbanization, and stratospheric ozone depletion; and that these have impacts on the built environment's users.

Table 7 indicated the causal relationship between the impacts of climate change on various built environment elements such as land degradation; biodiversity loss; pollution; drought; deforestation/ desertification; urbanization and stratospheric ozone depletion. The causal linkages led to these relationships as follows: Climate change → land-

Table 8: Coefficients a for the Predictors of Climate change Indicators

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	S.E.	Beta		
1	(constant)	-620	.089		-9.40	.890
	Land degradation (LD)	.331	.037	.559	8.652	.004
	Biodiversity loss (BDL)	.386	.059	.605	6.831	.000
	Pollution (P)	.393	.064	.504	8.744	.000
	Drought (D)	.425	.073	.458	8.523	.000
	Deforestation / Desertification (DF)	.486	.057	.474	10.772	.000
	Urbanization (URB)	.448	.073	.497	11.876	.000
	Stratospheric ozone depletion (SOD)	.783	.071	.469	10.968	.000
	Population growth (PG)	.576	.059	.497	11.536	.000

Table 9: Model summary [b] model for the predictors of climate change

Model	R.	R. Square	Adjusted R. Square	Std. Error of the Estimates	Change Statistics				
					R. Square Change	F Change	df1	df2	Sig.F Change
1	.861	.766	.734	.39233	.769	258.670	5	368	.000

Table 10: Climate Change Mitigation and Adaptations: Quantitative Results from the Descriptive Analysis

Items	Code	Statistics	
		Mean Score	S.D.
Greening the environment/Green Infrastructure (incorporating parks, green spaces, and open spaces within the communities)	CCMA 1	4.96	0.20
Pedestrianized environment (Reduction in global carbon Co2 emission via less usage of motorized transport)	CCMA 2	4.90	0.50
Provision of stronger urban-rural connections	CCMA 3	4.86	0.61
The depletion of the ozone layer should be ameliorated by human influences	CCMA 4	4.85	0.66
Advocacy/awareness of the significance of greening the environment	CCMA 5	4.81	0.70
Promulgation of law that discourages human activity impacts	CCMA 6	4.79	0.74
Increasing the number of public spaces in the city environment	CCMA 7	4.78	0.75
The layout of streets to accommodate active transportation such as walking and cycling	CCMA 8	3.78	0.64
Availability of climate data and statistics	CCMA 9	3.65	0.56
More enlightenment programs on the danger of the effects of environmental challenges	CCMA 10	4.74	0.79
More research on climate change	CCMA 11	4.74	0.78
Environmental cleanness via less use of paper and plastics nylons	CCMA 12	4.73	0.87
Incorporate climate change curriculum in Tertiary education taught courses	CCMA 13	3.41	0.61
More budgetary allocation to fight the challenges of environmental degradation and its influences	CCMA 14	3.92	7.40
Alternative energy source	CCMA 15	3.01	0.78

degradation ($p < 0.001$); climate change → biodiversity loss ($p < 0.001$); climate change → pollution ($p < 0.001$); climate change → drought ($p<0.001$); climate change → deforestations/desertification ($p<0.001$); climate change → urbanization ($p < 0.001$); climate change → stratospheric ozone depletion ($p < 0.001$). The results indicated that all the hypotheses are acceptable; implying that causal relationships between climate change and the built environment are statistically valid. In other words, the built environment suffers from the negative consequences of climate change features such as land degradation, biodiversity loss, pollution, drought, deforestation/desertification, urbanization, and stratospheric ozone depletion. To further substantiate these are Table 8 and 9 indicating the predictors of climate indicators and the Model for the predictors of climate change respectively.

Table 10 indicates the quantitative results from the descriptive analysis of climate change mitigation and adaptations. The results indicated that greening the environment / 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 a law that discourages human activities impacts (Mean=4.79, Std= 0.74); increasing the numbers of public spaces in the built environment (Mean=4.78, Std= 0.75); more enlightenment program 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.

The outcome of this research has revealed the ten (10) most predicted climate change indicators. This is consistent with previous studies by Kadir (2006) 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. In the light of above findings, the adverse effects of global warming have a huge impact on inhabitants' living conditions. Increased CO_2 emissions, increased air pollution-related health impacts, increased temperature-related health effects, and increased mental-related health effects as the greatest impact as equally opined by Federici *et al.*, (2015). Increases in dietary infectious-health impacts, increases in water and foot-borne disease-associated health effects, increases in food production shortages, and increases in poverty/low economic activity have impacted negatively as supported by (Agbebaku, 2020). This study has shown that (i) residents' health is severely impacted by carbon emissions, and as a result of high levels of industry and urbanization, rising carbon emissions pose a bigger threat to the health of the population; (ii) that health problems have resulted from the conflict between nature conservation and economic expansion, which has been exacerbated by rapid industrialization as corroborated by Hanmin *et al.*, (2021). Climate change would aid the transmission of several infectious diseases as well as local food productivity, according to this study. Consequently, a significant rise in the human population is having a negative influence on human health. This is in line with previous findings by (Pedersen *et al.*, 2021). This study identified fifteen (15) crucial climate change mitigation and adaptation strategies. Hence, greening the environment; pedestrianized environment; provision stronger urban-rural connections are among the mitigation and adaptations required for the climate change impacts. These inferred that incorporating green spaces, within the communities; reducing global carbon emissions via less usage of motorized transport, and establishing more robust urban-rural links are the greatest determinants of adaptation strategies to climate change (Ezeabasili and Okonkwo, 2013). In the same vein, the stratospheric layer's degradation should indeed be mitigated by human interventions; advocacy and creating awareness on the significance of greening the environment are other variables. This was corroborated by the past study of McPherson (2007) in which awareness of the ozone-depleting substances 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. In support of this is the notion of Caglar and Ulug (2022) that opined that the SDGs have made the transition to a low-carbon economy more feasible, while economies are moving toward the 2030 and 2050 targets by raising environmental consciousness. 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 is in agreement with Anthun *et al.* (2019) that 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. These consequently improve a variety of health outcomes as concurred with the past studies of Sugiyama *et al.* (2018). According to this study's findings, access to public green spaces is linked to social health indicators such as community identity and interpersonal networks as equally opined by (Arnberger and Eder, 2012).

CONCLUSION

This research has contributed substantially to the study of climate change consequences towards modifying the built environment and the functionality of the human settlements, as well as the perception of experts towards a shift. The interaction and synergy between climate change and human settlements must be a priority for government at all levels. A focus on this research shows how climate change has influenced the built environment in South western region of Nigeria, and has revealed the negative impacts of environmental issues on climate change which includes the following: land degradation, biodiversity loss, land air, water air and water pollution, temperature-related health effects and mental related infectious diseases and increase in the emission of $Co_{2.}$ Based on findings as revealed by this research, the climate change mitigation and adaptation strategies using the ten (10) most predicted climate change indicators remain very viable and effective in the quest towards combating the impacts and consequences of climate change.

SUGGESTIONS

Following the climate change mitigation and adaptation analysis of the research, the following suggestions were put forward:

- Greening the environment using the natural green infrastructure in communities open spaces and the development of parks.
- The need for reduction of dependence on automobile motorized transportation to help reduce the Co_2emission level within the human settlements.
- Provision of strong urban-rural connections and the increase in creating advocacy and awareness of the significance of greening the environment.
- The need for more budgetary allocation to mitigate the challenges of environmental degradation and its influences

Future study

There is a link between ecosystem vulnerability and efforts toward achieving mitigation and adaptation goals. As a result, further evaluation of the effectiveness of alternative ecological systems becomes imperative. An additional comprehensive assessment is required for future interventions. Habitat intervention strategy becomes extremely difficult to measure, and monitoring and control will have to progress in lockstep with human experience.

AUTHORS' CONTRIBUTIONS

O.P. Agboola conceptualized the research from the proposal stage. He developed the methodology approach and Literature materials that were reviewed in accordance with the research work. He prepared the initial draft which was later reviewed. He further carries out data analysis and put together all the results for the original manuscript. S.D. Zakka and S.A. Olatunji developed the research instrument and they were directly involved in data collection and compilation. They later reviewed the original manuscript and developed a draft in accordance to this journal template.

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CONFLICTS OF INTEREST

The authors declare that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

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ABBREVIATIONS

BDL	Biodiversity Loss
CCMA	Climate Change Mitigation and Adaptation
CO_2	Carbon dioxide
DF	Desertification
D	Drought
GHGs	Green House Gases
GT	Green Technology
KM^2	Square Kilometre
LD	Land Degradation
Max.	Maximum
Min.	Minimum
N	Number of respondents
P	Population
PG	Population Growth
PCC	Predictors of Climate Change
SDGs	Sustainable Development Goals
Std	Standard Deviation
SOD	Stratosphere Ozone Depletion
SPSS	Statistical Package for the Social Sciences
UN	United Nations
Urb	Urbanization

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