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EFFECT OF CLIMATE CHANGE ON SUSTAINABLE DEVELOPMENT IN NIGERIA

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Abstract: This study examined the effect of climate change on sustainable development in Nigeria. The specific objectives are to, examine the effect of agriculture on sustainable development in Nigeria and evaluate the effect of water resources on sustainable development in Nigeria. The study adopts a survey research design. A structured questionnaire design with a five-point Likert scale was used to collect data for the study. The data was analyzed using structural equation modeling. The result revealed that at a 5% level of significance, agriculture has a statistically significant effect on sustainable development in Nigeria given that [$\beta_1 = 0.276$] and [p-value = 0.011] and at a 5% level of significance water resources have a statistically significant effect on sustainable development in Nigeria given that [$\beta_2 = 0.614$] and [p-value = 0.000]. We concluded that climate change has a significant positive effect on sustainable development in Nigeria. We recommended the adoption of climate-smart agricultural techniques among farmers. This includes promoting drought-resistant crop varieties, implementing conservation agriculture practices, and integrating agroforestry systems.

Keywords: Change, Climate, Development, Effect, Sustainable

1.1 Introduction

Climate change stands as one of the most pressing challenges of the 21st century, significantly impacting ecosystems, societies, and economies globally. Defined by shifts in long-term weather patterns, climate change is propelled primarily by human activities, notably the emission of greenhouse gases such as carbon dioxide and methane. These emissions, predominantly stemming from industrial processes, deforestation, and the burning of fossil fuels, have led to unprecedented alterations in the Earth's climate system. The consequences of climate change are far-reaching and multifaceted, manifesting in rising global temperatures, more frequent and severe extreme weather events, shifts in precipitation patterns, and accelerating sea-level rise. Beyond environmental ramifications, climate change poses significant threats to socioeconomic stability, human health, biodiversity, and food security on a global scale.

At the heart of this global issue lies the intricate relationship between climate change and sustainable development. Sustainable development, characterized by the pursuit of economic prosperity, social equity, and

environmental integrity, is inherently intertwined with the dynamics of climate change. The adverse effects of climate change, such as rising temperatures, extreme weather events, and sea-level rise, not only threaten the delicate balance of ecosystems, but also undermine the very foundations of sustainable development efforts worldwide. Nigeria, as a prominent African nation with a diverse range of ecological landscapes and a burgeoning economy, grapples with the far-reaching effects of climate change that pose a substantial threat to its sustainable development aspirations.

The implications of climate change in Nigeria manifest in a myriad of ways, profoundly affecting the country's socio-economic fabric. The nation experiences a spectrum of climate-related challenges, including but not limited to increased temperatures, erratic rainfall patterns, rising sea levels along its coastal areas, desertification in the northern regions, and a heightened frequency of extreme weather events. These factors collectively exert profound pressure on various sectors critical to Nigeria's sustainable development, such as agriculture, water resources, health, infrastructure, and livelihoods.

The pursuit of sustainable development in Nigeria encompasses the intertwined goals of economic growth, social well-being, and environmental stability. However, climate change poses a significant obstacle to achieving these objectives. The agricultural sector, which is the backbone of the economy and a source of livelihood for many Nigerians, is particularly vulnerable to changing weather patterns, affecting food security and the nation's economy as a whole. Additionally, shifts in climate have far-reaching implications for water resources, health outcomes, urban infrastructure, and energy systems, all of which are pivotal components in Nigeria's developmental agenda. This research endeavors to comprehensively examine the extensive effect of climate change on the sustainable development landscape in Nigeria. It aims to explore the diverse sectors and regions affected by climate change and assess the consequential challenges faced by the nation in achieving its sustainable development goals.

1.2 Statement of the problem

Nigeria, like many other nations, grapples with the formidable challenge of reconciling the pursuit of sustainable development with the pervasive impacts of climate change. As Africa's most populous country and one of its largest economies, Nigeria faces a unique set of vulnerabilities exacerbated by the changing climate. The detrimental effects of climate change, including extreme weather events, shifting precipitation patterns, and rising temperatures, threaten to undermine the country's efforts to achieve sustainable development goals across various sectors. From agriculture and water resources to health, infrastructure, and energy, the repercussions of climate change reverberate throughout Nigerian society, posing profound risks to socioeconomic stability and environmental integrity. In this context, the problem statement focuses on understanding the specific ramifications of climate change on sustainable development in Nigeria, identifying key challenges, vulnerabilities, and opportunities for effective mitigation and adaptation strategies tailored to the country's needs and circumstances.

1.3 Aim and Objectives of the study

The aim of the study is to examine the effect of climate change on sustainable development in Nigeria. The specific objectives are to,

i. Examine the effect of agriculture on sustainable development in Nigeria.
ii. Evaluate the effect of water resources on sustainable development in Nigeria.

1.4 Hypotheses of the study

i. Agriculture has no significant effect on sustainable development in Nigeria.
ii. Water resources have no significant effect on sustainable development in Nigeria.

Review of Related Literature

2.1 Conceptual Review

Climate Change

Climate is the average of the weather conditions at a particular point on the Earth. Typically, climate is expressed in terms of expected temperature, rainfall, and wind conditions based on historical observations. "Climate change" is a change in either the average climate or climate variability that persists over an extended period (Riedy, 2016). Climate change refers to an increase in average global temperatures. Natural events and human activities are believed to be contributing to an increase in average global temperatures. This is caused primarily by increases in greenhouse gases such as Carbon Dioxide (CO_2) (Olaniyi, Ojekunle and Amujo, 2013). Climate change is characterized based on the comprehensive long-haul temperature and precipitation trends and other components such as pressure and humidity levels in the surrounding environment. Besides, the irregular weather patterns, the retreating of global ice sheets, and the corresponding elevated sea level rise are among the most renowned international and domestic effects of climate change (Abbass et al., 2022).

Climate change can be a natural process where temperature, rainfall, wind, and other elements vary over decades or more. For millions of years, our world has been warmer and colder than it is now. However today we are experiencing rapid warming from human activities, primarily due to burning fossil fuels that generate greenhouse gas emissions (UN, 2015).

Nigeria is the eighth-largest oil supplier in the world and the ninth-largest deposit of gas. The Nigerian national economy would be massively affected by a sustainable reduction of fossil energy consumption. Nigeria is practically a monoeconomy: about 80% of the government income, 90-95% of the export earnings, and more than 90% of the foreign exchange revenues evolve from the oil sector. However, during the last years, the government of Nigeria tried to diversify. Special attention is nowadays paid to gas, which emerges in the joint production of oil. So far, the gas has mainly been flared (75%), simply due to the lack of technical facilities to make use of it (Olaniyi, Ojekunle and Amujo, 2017).

Nigeria's climate has been changing, evident in temperature increases; variable rainfall; rise in sea level and flooding; drought and desertification; land degradation; more frequent extreme weather events; affected freshwater resources, and loss of biodiversity (Elisha et al., 2017). The durations and intensities of rainfall have increased, producing large runoffs and flooding in many places in Nigeria (Enete, 2014). Rainfall variation is projected to continue to increase. Precipitation in southern areas is expected to rise and rising sea levels are expected to exacerbate flooding and submersion of coastal lands (Akande et al., 2017). Droughts have also become a constant in Nigeria, and are expected to continue in Northern Nigeria, arising from a decline in precipitation and a temperature rise (Amanchukwu et al., 2015).

Agriculture

The agricultural sector contributes some percentage of the Nigerian Gross National Product and the majority of the rural populace is employed in this sector. The dominant role of agriculture makes it obvious that even minor climate deteriorations can cause devastating socioeconomic consequences. Over 70 percent of the country's population is engaged in agriculture as their primary occupation and means of livelihood (Onwutuebe, 2019; Shiru et al., 2018). Agricultural produce in Nigeria is mostly rain-fed. Unpredictable rainfall variation makes it difficult for farmers to plan their operations (Anabaraonye et al., 2019; BNRCC, 2011). Higher temperatures, lower rainfall, droughts, and desertification reduce farmlands, lower agricultural productivity, and affect crop

yields. Increased rainfall intensity in the coastal region, sea level rise, flooding, and erosion of farmland will also lower agricultural production (Ogbuabor and Egwuchukwu, 2017).

Agriculture provides a range of environmental and ecosystem services that are essential to Green Growth, including mitigation of greenhouse gases through carbon sequestration. Although direct greenhouse gas emissions from agriculture account for about 10%-12% of the total, the agricultural sector has the potential to offset emissions from other sectors. It is estimated that increasing the removal of atmospheric CO_2 through carbon sequestration in soil and vegetation sinks in agriculture has the potential to offset up to 20% of global fossil fuel emissions. However, this depends on enhanced soil management and cultivation as carbon sequestered in soils can be released back into the atmosphere through inappropriate farming practices (Stevens, 2011).

Because agriculture accounts for 37% of total land use (68% if the use of land for forests is included), the sector plays a key role in the preservation of ecosystems, which provides the basis for Green Growth. Agriculture affects the natural environment by providing for the management of land and water resources, habitat protection, flood control, biodiversity maintenance, and shaping and protecting landscapes. Agricultural land management has been a positive force for the development of plant varieties, animal habitats, woodlands, and wetlands. Attempts to place a monetary value on the environmental services provided by agriculture underline its rising importance in ecological and economic terms (Stevens, 2011).

Water Resources

Water resources and ecological biodiversity are intimately interrelated and interdependent. Both provide a wide range of functions and have intrinsic value as well as provide for the sustenance of human populations. Degradation of water quality, depletion of water resources, and loss of aquatic biodiversity are prominent features of the environmental/geographical landscape diversity requiring urgent attention at global and national scales (Alkins-Koo et al., 2004). The groundwater or surface water quality is a function of natural influences and human activities either severally or collectively. Without human influences, water quality would be influenced only by natural processes such as weathering of bedrock minerals; atmospheric processes involving evapotranspiration; deposition of dust and salt by wind; natural leaching of organic matter and nutrients from soil; hydrological factors leading to run-off; and biological processes in the aquatic environment that may bring about changes in the physical and chemical composition of water. Thus, water in the natural environment may contain dissolved substances as well as non-dissolved particulate matter. Minerals and dissolved salts are necessary components of good quality water as they help maintain the health and vitality of organisms that rely on this ecosystem service (Khatri and Tyagi, 2014).

The quality of both surface water and groundwater is affected by natural and anthropogenic factors. The natural factors that affect water quality in rural and urban areas are similar. The composition of surface water and groundwater is dependent on e.g. geological, topographical, meteorological, hydrological, and biological factors. It varies with seasonal differences in weather conditions, run-off volumes, and water levels (Khatri and Tyagi, 2014). For instance, the impact of seasonal dynamics on the bacteria community was analyzed in this study. Changes in seasons have an impact on bacteria population and composition as a result of multiple environmental pressures and this has been proven by various studies exploring the impact of seasonal changes on bacteria communities in diverse ecosystems (Wang et al., 2019).

Sustainable Development

Stoddart (2011) defines sustainability as the efficient and equitable distribution of resources intra-generationally and inter-generationally with the operation of socio-economic activities within the confines of a finite ecosystem. Ben-Eli (2015), on the other hand, sees sustainability as a dynamic equilibrium in the process of interaction

between the population and the carrying capacity of its environment such that the population develops to express its full potential without producing irreversible adverse effects on the carrying capacity of the environment upon which it depends. According to Reyes (2001), development is understood as a social condition within a nation, in which the needs of its population are satisfied by the rational and sustainable use of natural resources and systems. Todaro and Smith (2006) also define development as a multi-dimensional process that involves major changes in social structures, attitudes, and institutions, as well as economic growth, reduction of inequality, and eradication of absolute poverty.

Sustainable Development has also been defined as "a process of social and economic betterment that satisfies the needs and values of all interest groups, while maintaining future options and conserving natural resources and diversity" (IUCN,1980). The most frequently used definition of Sustainable development is from the Brundtland Report "Sustainable development is the development that meets the needs of the present (people) without compromising the ability of future generations to meet their own needs". In other words, it is improving the quality of life of the present generation without excessive use or abuse of natural resources so that they can be preserved for the next generation (Bhosale, 2015). The concept of sustainable development is based on the concept of development (socio-economic development in line with ecological constraints), the concept of needs (redistribution of resources to ensure the quality of life for all), and the concept of future generations (the possibility of long-term usage of resources to ensure the necessary quality of life for future generations) (Klarin, 2018).

Sustainable development is a dynamic process. To continually meet the needs of the present generation means that there must be continued economic growth. Economic growth in turn must ensure that minimum damage must be done to the environment. The major resources that determine the well-being and quality of human life are shelter, air, water, energy, food, raw materials, and the environment. These basic resources must be exploited in such a manner that the needs of future generations will not be compromised while satisfying the needs of the present generation (Olaniyi, Ojekunle, and Amujo, 2013). The overall goal of sustainable development (SD) is the long-term stability of the economy and environment; this is only achievable through the integration and acknowledgment of economic, environmental, and social concerns throughout the decision-making process (Emas, 2015).

Nigeria Climate Change

Climate change in Nigeria is evident from temperature increase, and rainfall variability (increasing in coastal areas and decline in continental areas). It is also reflected in drought, desertification, rising sea levels, erosion, floods, thunderstorms, bushfires, landslides, land degradation, more frequent, extreme weather conditions, and loss of biodiversity (Olaniyi et al., 2019). All of which continue to negatively affect human and animal life and also the ecosystems in Nigeria (Dada, and Muhammad, 2014). However, depending on the location, regions experience climate change with significantly higher temperatures during the dry seasons while rainfalls during rainy seasons help keep the temperature at milder levels. The effects of climate change prompted the World Meteorological Organization, in its 40th Executive Council 1988, to establish a new international scientific assessment panel called the International Panel on Climate Change (IPCC) (Ogele, 2020). The 2007 IPCC's fourth and final Assessment Report (AR4) revealed that there is a considerable threat of climate change that requires urgent global attention (Ogele, 2020).The report further attributed the present global warming to largely anthropogenic practices. The Earth is almost at a point of no return as it faces environmental threats, which include atmospheric and marine pollution, global warming, ozone depletion, the dangers of pollution by nuclear and other hazardous substances, and the extinction of various wildlife species (Bunyavanich et al, 2003).

The escalation of climate variability in Nigeria has led to heightened and irregular rainfall patterns, exacerbating land degradation and resulting in more severe floods and erosion. As one of the top ten most vulnerable countries to the effects of climate change, Nigeria has experienced a worsening of these environmental challenges. By 2009, approximately 6,000 gullies had emerged, destroying infrastructure in both rural and urban areas of the country. Few comprehensive reports provide useful evidence of the various impacts of climate change experienced in Nigeria today (Maddison, 2007; Labatt and White, 2012). The vast majority of the literature provides evidence of climate change holistically and this does not help in providing sustainable solutions to the impacts experienced (Ataro, 2021). However, the agricultural sector should be given more focus especially the existence in diverse regions where large farming is not dominantly practiced. More deliberations should concentrate on other mitigation and adaptation measures in literature, which often take the form of recommendations, rather than examples of what has already been achieved (Haider, 2021). This topical discourse is likely due to the need for much greater implementation of mitigation and adaptation measures in ensuring Nigeria produces more food all through the year round to feed the growing population. In addition, while there is some discussion about necessary capacity building at the individual, group, and community levels to engage in climate change responses, there is also more or less attention given to higher levels of capacity building at the state and national levels (Haider, 2021).

2.2 Theoretical Review

The Modernization Theory

The Modernization Theory of development distinguishes between two main categories of society in the world, namely the traditional and modern societies. The theory, according to Tipps (1976), argues that traditional societies are entangled by norms, beliefs, and values, which are hampering their development. Therefore, to progress, traditional societies must emulate the culture of modern societies, which is characterized by the accumulation of capital and industrialization, which are compatible with development. In essence, this theory seeks to improve the standard of living of traditional societies through economic growth by introducing modern technology (Huntington, 1976). This theory is criticized for not taking into account Sen's (1999) view of development regarding freedoms and self-esteem. The Dependency Theory, based on Marxist ideology, debunks the tenets of the Modernization Theory and asserts that industrialization in developed countries rather subjects poor countries to underdevelopment because of the economic surplus of the poor countries being exploited by developed countries (Webster, 1984). The theory, however, fails to clarify the dependency of the less developed countries on the metropolis in terms of how the developed countries secure access to the economic surplus of the poor countries.

The Anthropogenic Global Warming Theory

The UK Met Office (1998) describes the AGW hypothesis as the first theory of climate change, which contends that human emissions of greenhouse gases, principally carbon dioxide (CO_2), methane, and nitrous oxide, are causing a catastrophic rise in global temperatures. The mechanism whereby this happens is called the enhanced greenhouse effect. Energy from the sun travels through space and reaches the earth. The earth’s atmosphere is mostly transparent to the incoming sunlight, allowing it to reach the planet’s surface where some of it is absorbed and some is reflected as heat into the atmosphere. Certain gases in the atmosphere, called greenhouse gases, absorb the outgoing reflected or internal thermal radiation, resulting in the earth’s atmosphere becoming warmer than it otherwise might be. Water vapor is the major greenhouse gas, responsible for about 36-90% of the greenhouse effect, followed by CO_2, methane, and ozone (Ogwuabor and Egwuchukwu, 2017).

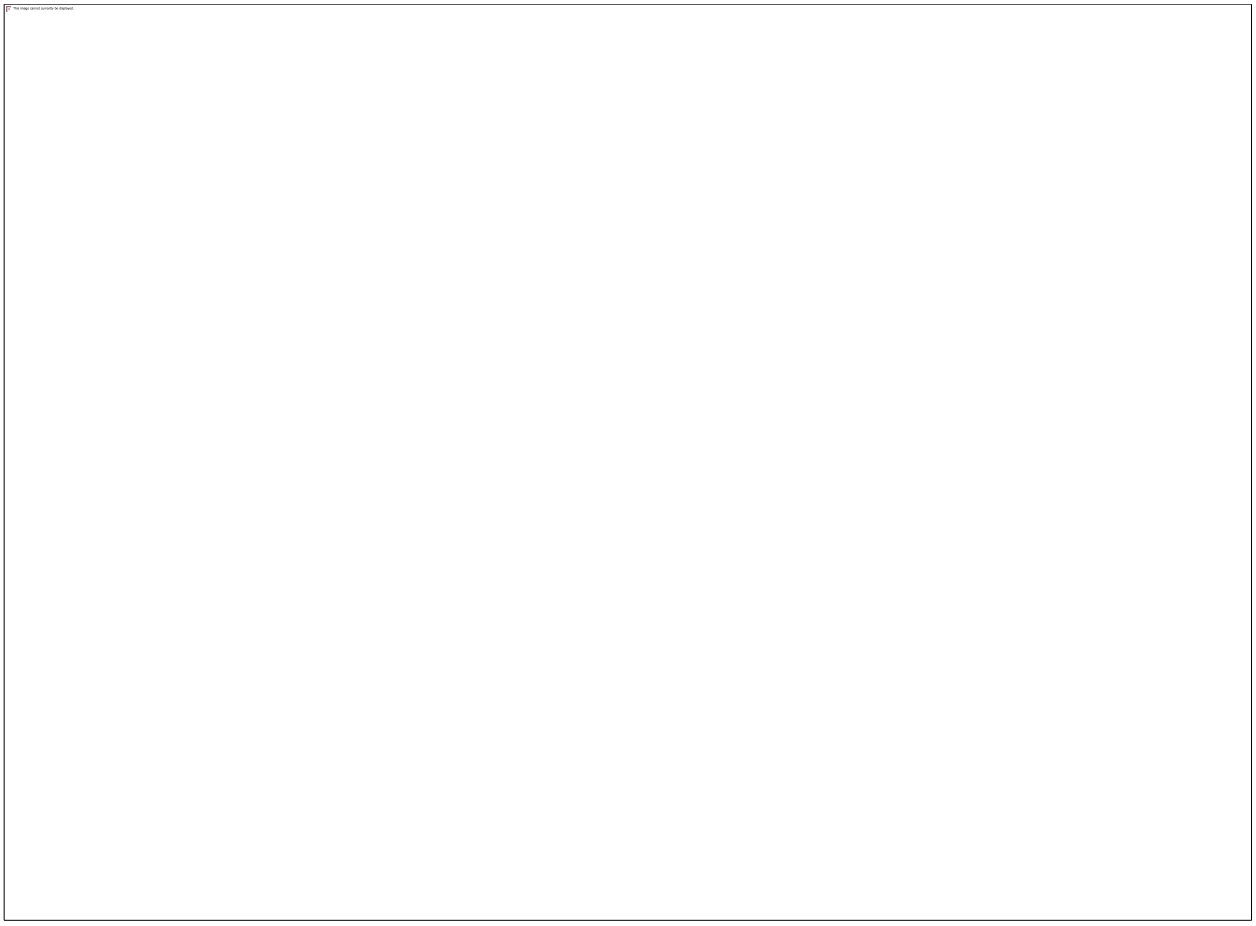
During the past century, human activities such as the burning of wood and fossil fuels as well as the burning of forests are thought to have increased the concentration of CO_2 in the atmosphere by approximately 50%. Proponents of the AGW theory believe that man-made CO_2 emission is responsible for floods, droughts, severe weather, crop failures, species extinctions, spread of diseases, ocean coral bleaching, famines, and hundreds of other catastrophes. According to them, all these disasters will become more frequent and more severe as temperatures continue to rise so only large and rapid reductions in human emissions will save the planet from these catastrophic events (Ogbuabor and Egwuchukwu, 2017).

3.0 The Research Method

3.1 The Study area

The study area is Nigeria. It is located between latitudes $4^0 – 14^0$ north of the Equator, and longitudes $3^0 – 15^0$ East of Greenwich Meridian. It is situated on the western coast of Africa. It is between the Bight of Benin to the fringes of the Sahara Desert between Cameroon and Benin Republic. Nigeria has a landed area of 923,768 km2 with a coastline of 853 km. The National Population Census conducted in 2006 in Nigeria shows the entire population of 140,431,790 people making Nigeria the highest population in Africa. In 2012 an estimate of about 170,123,740 people was produced and it makes Nigeria the 7th most populated country in the world and the most populated black nation in the world.

There is wide variation in the climate of Nigeria due to the physical setting. In the south, it is a sub-equatorial climate while in the north, it is tropical continental. The vegetation consists of forests in the south savannah grassland in the north, a middle belt, and Sudan savanna. The drainage consists of two major rivers and other smaller ones and lakes. It is important here to state that the two major rivers and their tributaries in both the south and the North are important for agriculture as they supply water for irrigation for the production of a variety of food crops, cash crops, and market garden crops.



This study adopts a survey research design, which involves systematically planning and implementing a study to collect data from a sample of individuals using standardized questionnaires or interviews. The structural equation modeling was adopted which specifically considered the confirmatory factor analysis (CFA). Ethical considerations are paramount, including obtaining informed consent and safeguarding participant confidentiality. The population of the study is the staff of business organizations in southeast, Nigeria. However, in this study, the total number of staff that makes up the study population is large and undeterminable; this therefore necessitates the sampling techniques and sample determination used below. It is not possible to study the entire population of staff in private and public organizations in southeast Nigeria because of the undeterminable size of the population. However, simple random sampling was adopted and the researcher therefore determined the sample size used from the population of staff which is not known. The Godden (2004) formula was used to calculate the sample size as shown below:

$$n = \frac{Z^2 * Q(1 - Q)}{e^2}$$

Where n = sample size for infinite population
Z = desired confidence interval 90% (1.645)
Q = population proportion (expressed as decimal) (assumed to be 0.3 (30%)
e = Margin of Error at 5% (0.05)
Where n =?
Therefore,
Q = 0.3 = 30%

Z = 1.645 = (0.9 or 90%)
e = 0.05

$$n = \frac{(1.645)^2 * 0.3 * 0.7}{(0.05)^2}$$

$$n = \frac{2.7060 * 0.21}{0.0025} = 227.304$$

Hence the sample size is 227.

Method of Data Collection and Research Instrument

This study obtains information through the primary and secondary sources. The questionnaire was used as an instrument of data collection.

Model Specification

$Y = \alpha + \beta x + \pi$

Y = (Dependent variable) = Sustainable development

α = constant

βx = (independent Variable) = Agriculture, and water resources

π = Error term

Hence,

Y = (Y)

$\beta x = (X_1, X_2)$

Where:

Y= Sustainable development (SD)

X_1 = Agriculture (AG)

X_2 = Water Resources (WR)

Results and Discussion

For this study we examined the data using PLS-SEM to assess the effect of climate change on sustainable development in Nigeria: Evidence from Business organizations in Southeast Nigeria. We report results using a level of significance at p<.05.

Table 1: Kaiser-Meyer-Olkin Test

	MSA
Overall MSA	0.746
AG1	0.653
AG2	0.788
AG3	0.793
AG4	0.752
AG5	0.653
AG6	0.708
AG7	0.844
SD1	0.872
SD2	0.829
SD3	0.831
SD4	0.783

Table 2: Bartlett's Test

X^2	df	P	
891.078		136.000	< .001

Table 1: Kaiser-Meyer-Olkin Test

	MSA
SD5	0.704
SD6	0.549
WR1	0.785
WR2	0.909
WR3	0.550
WR4	0.743

In the context of the Kaiser-Meyer-Olkin (KMO) test, as shown in Table 1, "MSA" usually stands for "Measures of Sampling Adequacy." The KMO test is used to assess the sampling adequacy for factor analysis, and the Measures of Sampling Adequacy are part of this assessment.

The Measures of Sampling Adequacy (MSA) are computed for each variable in your dataset. They represent the proportion of variance in that variable that can be explained by other variables in the dataset. Essentially, MSA measures how well each variable correlates with the other variables in the dataset. When interpreting the MSA values: High MSA: A high MSA value (typically above 0.6 or 0.7) indicates that the variable correlates well with the other variables in the dataset, suggesting that it is suitable for inclusion in factor analysis. A Low MSA: A low MSA value (usually below 0.5) suggests that the variable may not correlate well with the other variables in the dataset, indicating that it may not be suitable for inclusion in factor analysis. Obviously from the above table 1 we can say that the datasets is very suitable for factor analysis.

Table 2 is Bartlett's test of sphericity, which yielded a chi-square value of 891.078 with a probability value (p-value) of less than 0.001, indicating significant evidence against the null hypothesis. This result suggests that the variables in the dataset are not independent and that there are significant correlations among them. Therefore, the data is considered suitable for further analysis, such as factor analysis, as the strong evidence against the null hypothesis indicates that the correlation matrix is significantly different from an identity matrix, supporting the presence of meaningful relationships among the variables.

Table 3: Component Loadings

	RC1	RC2	RC3	Uniqueness
SD2	0.794			0.380
WR1	0.766			0.461
SD4	0.761			0.485

Table 3: Component Loadings

	RC1	RC2	RC3	Uniqueness
SD1	0.678			0.371
AG7	0.675			0.540
SD3	0.672			0.453
SD5	0.615			0.643
WR2	0.582			0.516
AG6	0.572			0.715
AG1		0.900		0.320
AG3		0.729		0.444
AG2		0.720		0.366
AG5		0.683		0.527
AG4		0.423		0.661
WR3			0.998	0.054
SD6			0.989	0.072
WR4				0.680

Note. Applied rotation method is promax.

Table 4: Component Characteristics

	Unrotated solution			Rotated solution		
	Eigenvalue	Proportion var.	Cumulative	SumSq. Loadings	Proportion var.	Cumulative
Component 1	5.253	0.309	0.309	4.377	0.257	0.257
Component 2	2.398	0.141	0.450	2.616	0.154	0.411
Component 3	1.660	0.098	0.548	2.318	0.136	0.548

Table 4 is the component characteristics showing the eigenvalues of 5.253, 2.398, and 1.660 for components 1, 2, and 3, respectively, indicate varying degrees of explanatory power in a factor analysis. Component 1, with the highest eigenvalue, explains the most variance in the data and represents the dominant underlying pattern or

structure among the variables. Component 2, with a lower eigenvalue but still significant, captures a secondary pattern in the data, contributing additional understanding beyond what component 1 explains. Component 3, with the lowest eigenvalue, represents a smaller, more nuanced pattern in the data that is not captured as strongly by the previous components. Collectively, these eigenvalues suggest that the factor analysis identifies distinct patterns within the data, with each component contributing differently to understanding the overall structure.

Fig 1: Scree Plot

Table 5: Construct Validity and Reliability

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Sustainable development	0.748	0.756	0.828	0.492
Agriculture	0.818	0.836	0.892	0.733
Water resources	0.747	0.755	0.855	0.664

Table 4 is the results of Cronbach's Alpha coefficients for three distinct variables, which include sustainable development, agriculture, and water resources. The result reveals a strong internal consistency within each variable. With coefficients of 0.818 for agriculture, 0.747 for water resources, and 0.748 for sustainable development, all fall well above the conventional threshold of 0.7, indicating high reliability. This suggests that the items within each variable closely align and consistently measure the intended constructs. Specifically, the high coefficient for agriculture underscores the robustness of the items assessing agricultural concepts, indicating a strong correlation among them. Similarly, the coefficients for water resources and sustainable development, though slightly lower, still demonstrate satisfactory levels of internal consistency, suggesting that the items within this variable reliably measure their respective constructs.

These findings affirm the reliability and validity of the questionnaires used to assess sustainable development, agriculture, and water resources. The high Cronbach's Alpha coefficients indicate that the items within each variable effectively capture the underlying constructs, providing us with dependable measures for evaluating these

critical areas. This implies that the data collected from these questionnaires can be confidently used for analysis and decision-making processes related to sustainable development, agriculture, and water resource management.

The Relationship Between Agriculture; Water Resources and Sustainable Development.

Fig 2: Measurement model

Figure 2 shows the factor loading of individual items and confirms the confirmatory factor analysis. To evaluate the discriminant validity of the 3 variables used in the study, Heterotrait-and Monotrait (HTMT) and Fornell Cornell analysis were executed.

Table 6: Discriminant Validity (HTMT)

	Agriculture	Water Resource	Sustainable development
Agriculture	1		
Water Resources	0.235	1	
Sustainable development	0.500	0.655	1

Table 7: Fornell-Larcker Criterion

	Agriculture	Sustainable development	Water Resources
Agriculture	0.578		
Sustainable development	0.509	0.763	
Water resources	0.504	0.689	0.677

***[Note: values in italic/bold represents square root of AVE] ***

Table 6 shows the results of the heterotrait-monotrait (HTMT) ratios for the correlations between Agriculture and Sustainable Development (0.500), Agriculture and Water Resources (0.235), and Water Resources and Sustainable Development (0.655) suggest varying degrees of discriminant validity among the constructs. The moderate HTMT ratio between Agriculture and Sustainable Development indicates a moderate level of discriminant validity, implying they are related but distinct constructs. Conversely, the low HTMT ratio between Agriculture and Water Resources indicates good discriminant validity, suggesting these constructs measure different aspects. However, the high HTMT ratio between Water Resources and Sustainable Development raises concerns regarding the potential overlap between these constructs, indicating a need for further investigation to ensure their distinctiveness within the research model.

Summary of Structural Model

The paths suggested in the research framework are reflected in the structural model. The R^2 and path significance of a structural model are used to evaluate it. The strength of each structural path is determined by the R^2 value for the dependent variable, which should be equal to or greater than 0.1 (Briones Penalver et al., 2018). (Falk & Miller, 1992). The results in Table 8 show that the three R^2 values (Sustainable development) are over 0.1. Hence, the predictive capability is established. The observed R^2 of (0.619) in Table 3.2.1 for the hypothesis that 61.9% of the variation in sustainable development was caused by the integration of agriculture and water resources. In addition, the model fit was assessed using SRMR. The SRMR was 0.003 which is below the required value of 0.10 indicating acceptability model fit (Hair et al 2016).

Table 8: Goodness of Fit Test

	R-Square	Adjusted R-Square
Sustainable development	0.619	0.578

Table 9: Hypotheses testing results

Hypothesis		Beta	Std.Dev	T Statistic	P-Values	2.5%	97.5%
H_{01}	Agriculture -> Sustainable development	0.276	0.293	2.546	0.011	0.092	0.503
H_{01}	Water resources -> Sustainable development	0.614	0.616	6.119	0.000	0.411	0.796

Hypotheses were tested to ascertain the significance. Hypothesis evaluates whether the predictor variable has a significant impact on sustainable development (SD). The results revealed that Agriculture and water resources have a statistically significant effect on sustainable development in Nigeria respectively as shown in Table 9. Therefore, at a 5% level of significance agriculture and water resources were statistically significant given that [$\beta_1 = 0.276$; $\beta_2 = 0.614$] and [p-value = 0.011; p-value = 0.000] respectively. This implies that a unit increase in agriculture and water resources will cause a corresponding unit increase in sustainable development in Nigeria.

Fig 3: Path coefficient plot for Agriculture and Sustainable development

Fig 3: Path coefficient plot for Water Resources and Sustainable development

5 Conclusion

In conclusion, the effect of climate change on sustainable development in Nigeria, particularly in the realms of agriculture and water resources, cannot be overstated. As one of Africa's most agriculturally dependent nations, Nigeria's socio-economic progress is intricately tied to the performance of its agricultural sector. However, rising temperatures, erratic rainfall patterns, and extreme weather events driven by climate change pose significant challenges to agricultural productivity, food security, and rural livelihoods. Moreover, the scarcity and uneven distribution of water resources exacerbate these challenges, affecting agricultural production and access to clean water for drinking, sanitation, and industrial purposes. Climate change-induced alterations in rainfall patterns and melting glaciers further strain Nigeria's already stressed water resources, leading to heightened competition and potential conflicts over access and usage.We concluded that climate change has a significant positive effect on sustainable development in Nigeria.

Recommendation:

Given the profound effect of climate change on sustainable development in Nigeria, with agriculture and water resources emerging as pivotal sectors, a comprehensive and coordinated approach is imperative to address these challenges effectively. Here are some recommendations:

i. Encourage the adoption of climate-smart agricultural techniques among farmers. This includes promoting drought-resistant crop varieties, implementing conservation agriculture practices, and integrating agroforestry systems. Government incentives and support programs can facilitate the adoption of these practices, coupled with capacity-building initiatives and extension services to ensure widespread implementation.
ii. Implement integrated water resource management strategies that prioritize efficiency, sustainability, and equity. This involves promoting rainwater harvesting techniques, rehabilitating watersheds, and enhancing water storage capacity through the construction of dams and reservoirs. Furthermore, investments in water purification and distribution systems are essential to ensure access to safe and clean water for all Nigerians.

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