Abuja Journal of Economics & Allied Fields, Vol. 12, No. 5, December, 2023.
Print ISSN: 2672-4375 Online: 2672-4324

Climate Change and Human Health in Nigeria

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ABSTRACT

This study examined the impact of climate change on human health in Nigeria. Life expectancy and infant mortality rate were used as proxies for human health while climate change was indexed using carbon emission, forest depletion, nitrous oxide emissions, fossil fuel energy, C02 emission, and greenhouse gas emissions. Auto-Regressive Distributed Lag model (ARDL) was employed as the estimation technique. The results show adverse significant effects of climate change on human health in Nigeria. It was concluded that climate change has significant untoward effects on human health in Nigeria. Therefore, policymakers need to design and implement policies to reduce climate damage through economic activities to lessen the harmful effects of climate change on human health in Nigeria.

Key words: *Climate change, human health, ARDL*
JEL CLASSIFICATION: C2, C3, I1, Q54

1. Introduction

Climate change has been recognised to have ranging impacts on health. The increasing recognition of the process of climate change has led to a growing interest in the assessment of the potential mechanisms by which changes in climate could influence health. Such health effects are influenced by factors such as socioeconomic development and by the degree to which effective adaptation measures are implemented. Climate change is a continuous variation for a decade or more and includes a shift in the incidence and degree of random weather events and the slow but uninterrupted increase in global average surface temperature. Mboera et.al. (2011) observed that climate change is a clear ecological threat of the 21st century that needs measures to minimize its impacts. The transmission routes of climate-related health risks are the effects of short-term weather changes on food harvests, water flows, and patterns of infectious diseases and the movement of populations (McMichael, Woodruff and Hales, 2006). Thus, individuals' patterns of health risks and population health profiles are modified by changes in climatic conditions. The United Nations Framework Convention on Climate Change (UNFCCC) ascribed climate change to human activity that changes the composition of the universal atmosphere. Climate change has a number of immediate and long-term impacts on the fundamental determinants of human health (Mboera et.al., 2011). A number of potential human health effects have been associated either directly or indirectly with worldwide climate change and exposure to the risks associated with climate change may worsen ongoing socio-economic crises.

Atmospheric concentrations of greenhouse gases (GHGs), carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and chlorofluorocarbons (CFCs) have increased through human activities since the industrial revolution (Haines, Kovats, Campbell-Lendrum and Corvalan, 2006). For instance, the World Resources Institute Climate Analysis Indicators Tool (WRI CAIT), observed that Nigeria's 2014 GHG emissions were primarily from the land-use change and forestry (LUCF) sector as well as the energy sector which accounted for 38.2% and 32.6% of the country's total emissions (USAID, 2019). Waste, agriculture, and industrial processes (IP) contributed 14.0%, 13.0%, and 2.1% of total emissions each. Nigeria's First Biennial Update Report (BUR1) to the UNFCCC, in 2018, which includes a GHG inventory for the years 2000 to 2015, shows that in 2015, the combined emissions from agriculture, forestry, and other land use (AFOLU) were the leading source of GHG emissions (66.9%), followed by energy (28.2%), waste (3.0%) and industrial processes and product use (IPPU) (1.9%) (USAID, 2019). Nigeria's energy emissions increased to 32% from 1990 to 2014, due to other fuel combustion. Other smaller sources of emissions from electricity and heat generation, transportation, manufacturing and construction have also increased (USAID, 2019). The photochemical reactions of these greenhouse gases with the ozone, the greenhouse effect, have led to the depletion of the protective ozone layer which has far-reaching effects on man and life on earth.

Studies have assessed the potential impacts of climate change in isolation from other environmental changes, however, climate change will be experienced against a background of other global changes such as population growth, urbanization, land use changes and depletion of freshwater resources that have implications for health and which could, interact with climate change to magnify the impacts. Furthermore, empirical studies on the consequences of climate change have focused more on risks to economic conditions, vulnerable industries, physical property, environmental pleasantness and iconic ecosystems (McNutt and Ramakrishnan, 2020). Nonetheless, climate change has had far-reaching effects on people's health for several years; of which the increasing recognition of the process of climate change has led to the growing concern in examining the latent mechanisms of the effects of climate change on health. According to Jonathan and Emmanuel (2017), the effects of climate change are important for Nigeria given the high level of temperature, poor adaptation capacity, and lack of an early warning system. Thus, this study examines the effect of climate change on life expectancy and mortality in Nigeria to provide evidence for policy intervention on the negative effects of climate change on the health of Nigerians. The remaining part of the study is divided into four sections. Section two contains a literature review while section three provides the methodology of the study. Section four covers data analysis and discussion of results while section five concludes.

2. Literature Review

Climate change is a long-term change in the average weather conditions like its usual temperature, rainfall, and windiness. The climate changes, naturally, due to natural processes connecting the atmosphere, ocean and land and variations in heat output from the sun. Climate change can occur from human activities. According to Peter & Odjugo (2010), climate change is different from temporal climatic variation and secular changes in climate for about 100 to 150 years without clear and permanent effects on the environment. Climate change is an alteration in the imperial of the climate due to the irregularity of its properties for decades or more. This is caused by natural developments (bio-geographical) and human activities (anthropogenic). The natural processes are the astronomical and the extraterrestrial processes (Peter & Odjugo, 2010). The astronomical aspects are changes in the eccentricity of the earth's orbit, changes in the obliquity of the plane of the ecliptic and changes in orbital procession while the extra-terrestrial factors are the quantity and quality of solar radiation. The anthropogenic elements are the human activities (e.g. industrialization, burning of fossil fuel, gas flaring, urbanization and agriculture) that either produce a tremendous quantity of greenhouse gases into the atmosphere that depletes the ozone layer or actions that lessen the number of carbons absorbed from the atmosphere. IPCC, (2007) attributed the current global warming to human factors (IPCC, 2007).

Climate change is a global public health problem that disproportionately threatens vulnerable populations (e.g. coastline inhabitants, indigenous peoples and economically disadvantaged communities) with important consequences on human health including mental health, children and women's health. Ozor (2009) demonstrated the processes that lead to climate change using secondary data from 1990 - 2006 to enable a better understanding of the concept. The study described the impacts of climate change on various issues of national development such as agricultural productivity, food insecurity, resourceconflicts, unemployment, environmentally induced migration, livelihood problems and health issues. It was noted that the impacts include devastating effects of flooding, drought, erosion, desertification, sea level rise, heat stress, pests and diseases, and erratic rainfall patterns. Haines, Kovats, Campbell-Lendrum and Corvalan, (2006) concluded that empirical observation of the health consequences of recent climate change, followed by formulation, testing and then modification of hypotheses would require a long time series (probably several decades) of careful monitoring. While this process may accord with the principles of empirical science, it would not provide the timely information needed to inform current policy decisions on GHG (greenhouse gas) emission abatement, so as to offset possible health consequences in the future. Therefore, estimation of the future health effects of climate change will come from risk assessment based on the current understanding of the effects of climate variation on health from observations made in the present and recent past, acknowledging the influence of modulating factors. Observations of short-term variations in climate show that even small temperature increases and precipitation changes can result in measurable impacts on malaria, diarrhoeal episodes, injuries related to floods, and malnutrition. This allows estimates of the health effects of past and future climate change to be made.

Though the impacts of climate change are global, the most vulnerable are the poor and marginalized people from developing countries who depend directly on their ecosystems for survival. These are the same people who have the least capacity to adapt to the rapid changes that are affecting their environment (WHO, 2016), who do not have access to adequate safe water, or adequate sanitation and lack access to land, credit or knowledge. Climate change-related impacts on the ecosystems are likely to affect the population by creating favourable conditions fordisease pathogens and placing the communities at high risk of malnutrition, diarrhoeal diseases and other environmental health effects attributable to climate change (Ebi and Mcgregor 2008). There is important evidence to show that climate change affects the occurrence and distribution of human diseases and malnutrition. Changes in the frequency and spread of infectious diseases are some of the widely documented potential effects of climate change and could have consequences for human health as well as economic and societal impacts. The 44 indicators in the reports of the *Lancet* Countdown uncover a persistent rise in the health impacts of climate change and the current health consequences of the delayed countries response— providing a clear imperative for faster action that prioritised planet and peoples' health above all other (Romanello, McGushin, Di Napoli, et.al, 2021). Extreme weather such as heat waves, cyclones, and floods, is an expression of climate variability. These events are influenced by climate change, such as wildfires, which continue to cause high human morbidity and mortality and adversely affect mental health and well-being. Long-term changes to Earth's energy balance are increasing the frequency and intensity of many extreme events and the probability of compound events, with trends projected to accelerate under certain greenhouse gas emissions scenarios (Ebi, Vanos, Baldwin et. al, 2021).

Evidence from the Lancet Countdown discovers declining trends in the yield potential of major crops, rising heat wave exposures, and increasing climate suitability for the transmission of infectious diseases, hence, endangering the health of children around the globe (Romanello, McGushin, MacGuire et.al, 2021). The prevalence of tropical diseases and other threats to human health depends on the local climate. According to the Intergovernmental Panel on Climate Change

(IPCC, 2007), extreme temperatures can lead to loss of life, while climate-related disturbances in ecological systems can indirectly impact the incidence of infectious diseases. Extreme weather can destroy shelter, contaminate water supplies, cripple crop and livestock production, and tear apart existing health and other service infrastructures. This will increase the existing burden of disease and other non-health needs of vulnerable human populations. The magnitude and nature of climate change impacts on human health vary by region, by the relative vulnerability of population groups, by the extent and duration of exposure to climate change itself and by society's ability to adapt to or cope with the change (IPCC, 2007). Nigeria's economy is mainly dependent on natural resources that are vulnerable to climate impacts and people's health will be affected when resources are damaged. This prompted Ubi-Abai and Mbobo (2020) to conclude that excessive emissions of greenhouse gases from sectors of the economy have had debilitating effects on the health of Nigerians. More so, Oguntoke and Adeoye, (2017) noted that a high concentration of nitrogen dioxide (NO2) causes lung damage which results in shortness of breath and chest pain. Matthew et. al. (2018) in the examination of the long-run effects of emissions of greenhouse gas on health outcomes in Nigeria using the Autoregressive Distributed Lag Model (ARDL)shows that a 1% increase in greenhouse gas emissions reduces life expectancy by 4.2% and increases mortality rate by 146.6%.

Climate change can also affect the human standard of living through its effects on productive activities. Omojolaibi (2010) tested annual data of carbon emissions and GDP per capita from 1980-2010 on the study of environmental quality and economic growth in some selected West African countries using pooled OLS. The results agreed with the Environmental Kuznets Curve (EKC) while the fixed effects results were at variance with the relevance of the environmental Kuznets curve in West Africa. Furthermore, Yang (2007) studied the causal relationship between different types of energy consumption and GDP in Taiwan for the period 1980–2005 in panel data estimation. The author found a bi-directional causality between energy and GDP. However, this result deviates from Cheng & Lai (1997) who found a uni-directional causal relationship between GDP to energy use in Taiwan. Nwafor & Onuoha (2008) study of the impacts of climate change on agricultural products observed that developmental progress achieved in sub-Saharan Africa may be obliterated unless climate change effects are addressed. Odjugo (2010) also argued that the process of poverty eradication may be difficult due to the negative effects of climate change on economic growth. Agwu and Okhimamhe (2009) on gender dimensions of climate change in North-Central and South-Eastern Nigeria show that the impacts of climate change in South-Eastern Nigeria include the destruction of shelter, arable farmlands, access roads and economic trees by landslides and tornadoes and responsible for excessive heat, heightened insect activity and the drying up of streams. Alwis & Limaye (2021) argued that the health costs of air pollution and climate change already exceed $US800b per year — a yearly bill that is expected to increase without a stronger societal response to address this crisis. This price tag perhaps underestimates the total costs of these problems, as a result of the limits in available health data. The substantial growing health and financial costs of both fossil fuel-triggered air pollution and climate change are often ignored. A clear inference from the reviews is that studies on climate change focused more on the impacts of climate change on economic outputs and emphasis is small on the effect on human health.

3. Research Methodology

The theoretical framework for the study is Ramsey–Cass–Koopmans (Ramsey 1928, Koopmans 1965, Cass 1965) infinitely-lived agent framework. The theory assumes that an increase in the consumption of fossil fuels can be attributed to the increasing level of economic growth. Since the 1900s, the activities of human beings have been causing greenhouse gas Emissions (GHGE) in a dangerous state and causing climate change. This was assumed to have adversely affected individuals' health in the society. The combustion of fossil fuels is essential in producing goods and services. The combustion of fossil fuel releases carbon dioxide which contaminates the environment and has an adverse effect on individuals' health. Sharma (2011) observed that higher economic growth has an impact on the emissions of CO2 at least in the short-run and can adversely affect individuals' health. Given that higher economic growth impacted the emissions of CO2 in the short-run and the increase in the consumption of fossil fuel can be attributed to the increasing level of economic growth from the structural models of climate–economy interactions of Ramsey–Cass–Koopmans (1965) infinitely-lived agent theory, the interactions between climate change and human health can be specified as:

$$LIFE/IMR = f(FDL, MEEM, NIEM, C02, GHGE, FOF)\ldots\ldots\ldots(1)$$

Equation (1)states that life expectancy *(LIFE) or* Infant mortality rate *(IMR)*depends on forest depletion *(FDL)*, methane emission *(MEEM)*, nitrous oxide emission *(NIEM)*, C02 emissions *(CO2)*, greenhouse gas emissions *(GHGE)* and fossil fuel energy *(FOF)*. Explicitly, equation (1) can be written as:

$$LIFE_t/IMR_t = \beta_0 + \beta_1 FDL_t + \beta_2 MEEM_t + \beta_3 NIEM_t + \beta_4 CO2_t + \beta_5 GHGE_t + \beta_6 FOF_t + \epsilon_t \ldots\ldots\ldots(2)$$

A priori, forest depletion *(FDL)*, methane emission *(MEEM)*, nitrous oxide emission *(NIEM)*, C02 emission *(CO2)*, greenhouse gas emission *(GHGE)* and fossil fuel energy *(FOF)* are expected to beinversely related to life expectancy and infant mortality.

3.1 Estimation Technique

The study employed time series data covering a period of 42 years (1981 to 2022). Augmented Dickey-Fuller (ADF) and Philipps Perron unit root tests are used to determine the stationarity level of the variables. The result of the unit root tests guides the choice of estimation methods. Co-integration test is used to check for the long-run relationship between climate change and human health. The data for the study was obtained from the World Development Indicator

Table 1: Data and their Measurement

Variables	Description	Measurement	Source
LIFE	Life expectancy rate	Life expectancy at birth, total (years)	WDI 2024
IMR	Infant mortality rate	Mortality rate, infant (per 1,000 live births)	
MEEM	Methane Emission	Kt of C02	
FOF	Fossil fuel energy	Fossil fuel energy consumption (% of total)	
NIEM	Nitrous oxide Emission	Thousand metric tons of C02 equivalent	
C02	C02 Emission	CO2 emissions (kt)	
GHGE	Greenhouse Gas Emission	GHG net emissions/removals by LUCF (Mt of CO2 equivalent)	
FDL	Forest Depletion	Express as %	Climate Watch, 2024

Descriptive Statistics of the Variables Used

Table 2 shows the descriptive statistics of the variables used in the study. The table shows the total number of observations, mean, standard deviation maximum, and minimum values. The average life expectancy was 48.6 years with a standard deviation of about 2.7. The infant mortality rate was an average of 102.2 per thousand life births with a standard deviation of about 20.1 per thousand life births. The average methane emission was 143,674.5Kt with a standard deviation of 7515.1Kt while the average fossil fuel energy was about 19.6% with a standard deviation of 1.5. The average nitrous oxide emission was 29,703.6 metric tons with a standard deviation of 5545.1 metric tons. The C02 emission and Greenhouse Gas emission averaged around 95,836.9 and 323.3 with standard deviations of 10358.1 and 21.1%. Finally, forest depletion averaged 4.4% with a standard deviation of 1.3.

Table 2: Descriptive Statistics of the Variables Used

Variables	*Obs*	*Mean*	*Std. Dev.*	*Max*	*Min*
LIFE	42	48.6	2.7	52.9	45.5
IMR	42	102.2	20.1	124.3	70.6
MEEM	42	143674.5	7515.1	157860.8	124198.2
FOF	42	19.6	1.5	22.8	15.9
NIEM	42	29703.6	5545.1	20146.9	41196.3
C02	42	95836.9	10358.1	119544.1	72768.8
GHGE	42	323.3	21.2	378.6	282.1
FDL	42	4.4	1.3	6.4	2.1

Source: Author Computation, 2024

4. Results and Discussion

4.1 Stationarity Test

The time series properties of the data were examined using a unit root test. The unit root test was based on the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The results of ADF and PP tests in Table 3 indicate that life expectancy *(LIFE)*, fossil fuel energy *(FOF)*, and forest depletion *(FDL)*, are I(0) while other variables are I(1). This implies that life expectancy *(LIFE)*, fossil fuel energy *(FOF)*, and forest depletion *(FDL)*, are integrated of order zero while other variables are integrated of order one. Given this situation, the Autoregressive Distributed Lag Model (ARDL) is the appropriate estimation technique. The Akaike Information Criterion gives the optimum lag length as 4. The Schwarz information criterion was used to decide the optimum lag length and their probabilities were found to be significant at $p < 0.05$.

Table 3: Unit Root Test Results

ADF			Phillips-Perron		
Variables	**Levels**	**First Difference**	**Levels**	**First Differen ce**	**Decision**
LIFE	-3.23***	-1.90	-2.38	-4.83*	I(0)
IMR	-2.98	-0.91	-2.38	-4.83*	I(1)
MEEM	-2.28	-3.51***	-2.36	-5.52*	I(1)
FOF	-3.40***	-3.17***	-3.22***	-7.02*	I(0)
NIEM	-2.37	-1.94	-2.03	-6.08*	I(1)
C02	-2.68	-2.07	-3.09	-6.98*	I(1)
GHGE	-2.19	-2.38	-2.77	-7.08*	I(1)
FDL	-1.94	-0.26	-2.79**	-1.91	I(0)

, ** and *** denote significance at 1%, 5% and 10% levels respectively.

Source: Author computation, 2023

4.2 Bound Test for Co-integration

The bounds test results in Table 4 established the existence of a long-run relationship between climate change, infant mortality, and life expectancy. The *F-Statistic* is greater than the *Pesaran Critical Value* at a 5% level. Hence, we conclude that a long-run relationship exists between climate change, infant mortality, and life expectancy.

Table 4: Bounds Test for Climate Change, Infant Mortality Rate and Life Expectancy

Bounds Test for Climate Change andInfant Mortality			**Bounds Test for Climate Change and Life Expectancy**		
Panel A			**Panel A**		
Test Statistic	**Values**	**K**	**Test Statistic**	**Values**	**K**
F-Statistic	9.5720	6	F-Statistic	4.3116	6
Panel B	**Pesaran *et al.* (2001) critical values**		**Panel B**	**Pesaran *et al.* (2001) critical values**	
Critical Value Bound	I(0)	I(1)	Critical Value Bound	I(0)	I(1)
(at 5% Significane Level)	2.27	3.28	(at 5% Significane Level)	2.27	3.28

4.3 ARDL Results of the Effects of Climate Change on Human Health in Nigeria

Table 5 shows the ARDL results of the short-run and long-run effects of climate change on life expectancy in Nigeria. The results show that Forest Depletion *(FDL)* adversely impacts life expectancy in the short-run and long-run. Only the long-run result is significant at 5% level. Nitrous Oxide Emission *(NIEM)* has negative significant effects on life expectancy in the short-run and the long-run. C02 emission and Fossil fuel energy *(FOF) also have* negative effects on life expectancy in the short-run and the long-run. However, only the C02 emission was significant at a 5% level in the short-run. The greenhouse gas emission *(GHGE)* shows an adverse effect on life expectancy only in the long-run. The ECM result of the dynamic of adjustment is correctly signed and significant at the 1% level. It should noted that climate change interacts with health and environmental variables to have an impact on life expectancy (see Ubi-Abai and Mbobo 2020; Omojolaibi, 2010). These results corroborate the findings of Ubi-Abai and Mbobo (2020), Oguntoke and Adeoye, (2017), and Omojolaibi (2010) among others.

The R^2 and the adjusted-R^2 are 0.87 and 0.81 in the short-run model. This is a very good explanatory power. The Durbin-Watson statistics of 2.11 show the absence of auto-correlation. The Breusch-Godfrey Serial

Correlation LM tests also affirmed the absence of auto-correlation.

Table 5: Short-run and Long-run ARDL Estimate of the Effects of Climate Change on Life Expectancy

Short-Run		Long-Run	
Variables	Dependent Variable: D(INLIFE) Coefficients	Variables	Dependent Variable: D(INLIFE) Coefficients
D(INLIFE(-1))	-0.2985 (0.16236)***	INLIFE(-1)	0.1226 (0.0365)*
D(INFDL)	-0.0151 (0.0041)	INFDL(-1)	-0.0275 (0.0117)**
D(INNIEM(-1))	-0.0394(0.0086)*	INMEEM	-0.0763 (0.0437)***
D(INC02) D(INFOF)	-0.0389 (0.0095)* -0.0296 (0.0079)*	INC02(-1) INGIIGE INFOF(-1)	-0.0244 (0.0311) -0.1168 (0.0741 -0.0055 (0.0164)
CointEq(-1)	-0.1226 (0.0179)*	C	0.0452 (0.2135)
R-squared	0.8661		
Adjusted R-squared	0.8115		
S.E. of regression	0.0009		
Sum squared resid	2.63E-05		
Log likelihood	221.7158		
Durbin-Watson stat	2.1105		
Mean dependent var	0.0014		
S.D. dependent var	0.0023		
Akaike info criterion	-10.7547		
Schwarz criterion	-10.2428		
Hannan-Quinn criter.	-10.5710		

Figure 1 and Figure 2 show the CUSUM and CUSUM of squares of the recursive test for stability of results. The Figures indicate that the model is stable and well- behaved

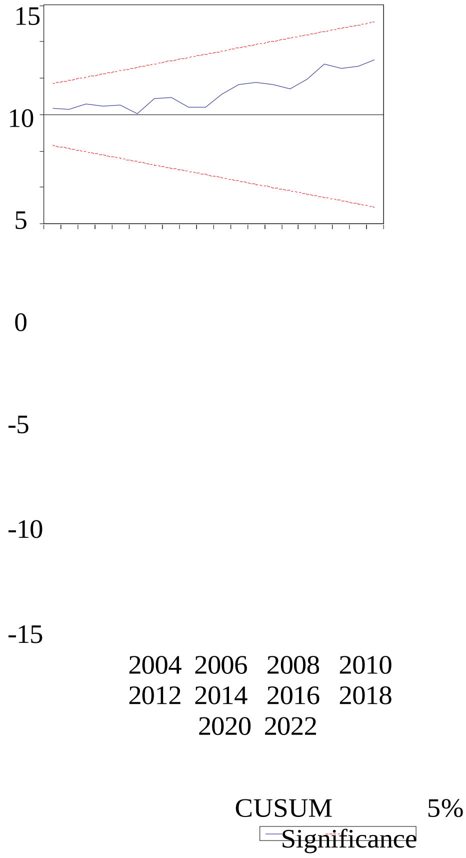
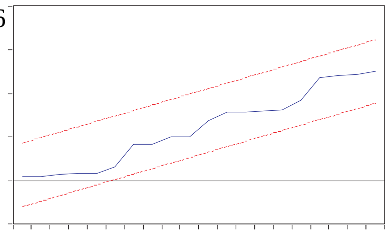


Figure 1: Plot of the Cumulative Sum of Recursive Residual of the Model



0.4

0.0

-0.4

2004 2006 2008 2010
2012 2014 2016 2018
2020 2020

Standard Errors are in Parenthesis

The diagnostic tests in Table 6 for the robustness checks indicate that the model is w i t h o u t s e r i a l c o r r e l a t i o n a n d heteroscedasticity problems. The model is correctly specified, with a normally distributed error.

Table 6: Short-Run Diagnostics Tests of ARDL Model of Effects of Effects of Climate Change on Life Expectancy

Test Statistics	LM Version	F Version
A: Serial Correlation	CHSQ(1) = 5.013993 (0.0815)	F(2,18) = 1.327780 (0.2898)
B: Functional Form	CHSQ(19) = 0.301065 (0.7666)	F(1, 19) = 0.090640 (0.7666)
C: Normality	CHSQ(1) = 3.1164(0.5259)	NA
D: Heteroscedasticity	CHSQ(18) = 11.40234 (0.8765)	F(18, 20) = 0.459071 (0.9488)

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

202
0 CUSUM of Squares 5
202 % Significance
2

Figure 2: Plot of the Cumulative Sum of Recursive Residual of the Model

Table 7 shows the ARDL results of the short-run and long-run effects of climate change on infant mortality in Nigeria. The results show that Forest Depletion *(FDL) and* Nitrous Oxide Emission *(NIEM)* significantly impact infant mortality negatively in the short-run and long-run at a 1% level. C02 emission *has* negative effects on infant mortality in the short-run and the long-run. However, only the short-run result is significant at the 1% level. Furthermore, greenhouse gas emission *(GHGE)* and Fossil fuel energy *(FOF)* have significant adverse effects on infant mortality in the short-run and long-run. The speed of adjustment result is likewise correctly signed and significant at the 1% level.

The R^2 and the adjusted-R^2 are 0.99. This is also a good explanatory power for the results. The Durbin- Watson statistics of 2.3 show no auto-correlation problem in the model. The Breusch-Godfrey Serial Correlation LM test affirmed no auto-correlation.

Table 7: Short-run and Long-run ARDL Estimate of the Effects of Climate Change on Infant Mortality

Short-Run		**Long-Run**	
ariables	**Dependent Variable:** D(INIMR)	**Variables**	**Dependent Variable:** D(INIMR)
	Coefficients		**Coefficients**
(INIMR(-1))	0.9307 (0.015)*	INIMR(-1)	0.0025 (0.0104)
(INFDL(-1))	-0.0337 (0.0049)*	INFDL(-1))	-0.0337 (0.0101)*
(INNIEM(-1))	-0.0239 (0.0048)*	INNIEM(-1))	-0.0239 (0.0089)*
(INC02)	-0.0329 (0.0072)*	INC02(-1)	-0.0085 (0.0154)
(INGHGE)	-0.1297 (0.0164)*	INGHGE(-1))	-0.0714(0.0291)**
(INFOF(-1))	-0.0272(0.0046)*	D(INFOF(-1))	-0.0272(0.0079)*
ointEq(-1)	-0.0025 (0.0002)*	C	-0.1934(0.1336)
-squared	0.9936		
djusted R-squared	0.9897		
.E. of regression	0.0005		
um squared resid	5.55E-06		
og likelihood	252.0900		
urbin-Watson stat	2.3249		
ean dependent var	-0.0062		
.D. dependent var	0.0048		
kaike info riterion	-12.1585		
chwarz criterion	-11.5186		
annan-Quinn riter.	-11.9289		

** Significant at 1%, 5% and 10% level Standard Errors are in Parenthesis*

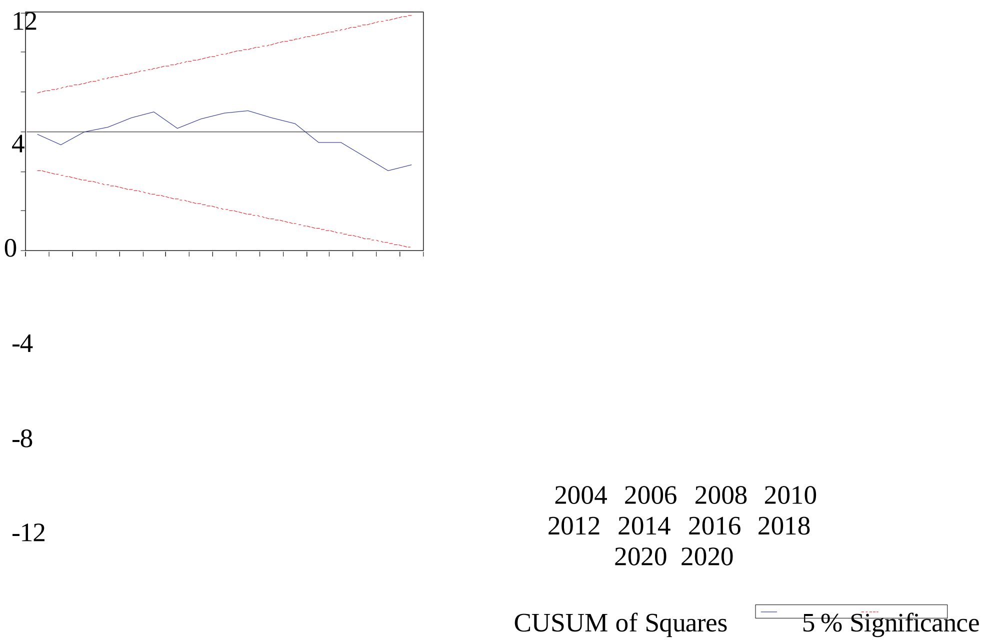
The diagnostic tests on the nexus between climate change and infant mortality in Table 8 for the robustness checks indicate that the model is without the problem of serial correlation and heteroscedasticity. Also, the model is correctly specified, and the errors are normally distributed.

Table 8: Short-Run Diagnostics Tests of ARDL Model of Effects of Climate Change on Infant Mortality

Test Statistics	LM Version	F Version
A: Serial Correlation	CHSQ(2) = 9.650663 (0.0008)	F(2,15) = 2.466154 (0.1186)
B: Functional Form	CHSQ(16) = 1.942811 (0.0698)	F(1, 16) = 3.774514 (0.0698)
C: Normality	CHSQ(1) = 2.8111(0.4010)	NA
D: Heteroscedasticity	CHSQ(1) = 28.29806 (0.6545)	F(21, 17) = 1.105441 (0.4216)
A:Lagrange multiplier test of residual serial correlation B:Ramsey's RESET test using the square of the fitted values C:Based on a test of skewness and kurtosis of residuals D:Based on the regression of squared residuals on squared fitted values		

Figure 3 and Figure 4 show the CUSUM and CUSUM of squares of the recursive test for stability of results of the nexus between climate change and infant mortality. The Figures indicate a well-estimated, stable and well-behaved model.

Figure 4: Plot of the Cumulative Sum of Squares of Recursive Residual of the Model



5. Conclusion

This study examines the effects of climate change on life expectancy and infant mortality in Nigeria from 1981 - 2022. The results show that CO2 emission, forest depletion, fossil fuel energy, greenhouse gas emission, and nitrous oxide emission have adverse effects on infant mortality and life expectancy in Nigeria. The effects were found to permeate infant mortality and life expectancy through socio-economic and environmental variables. Thus, climate change appears to have strong adverse effects on human health in Nigeria. It is therefore important for the policymakers to evolve and implement policies to curb climate destruction to mitigate the adverse effects of climate change on human health in Nigeria.

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