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Green House Gas Emissions and Effects: A Multivariate Investigation

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ABSTRACT

Various studies reveal the rising impact of greenhouse gas emissions on economic indices. Fewer studies have critically investigated the impact of these emissions on death rate and their association. The present study aims to probe into the impact of greenhouse gas emissions on death rate and explore the association thereof considering gross domestic product, utilizing secondary data released by official government statistics. Two multiple linear regression models were estimated, the dependent variables being gross domestic product (GDP) and death rate (DR) while the emissions in liquid, solid, and gaseous forms were considered predictors. The two significant models had P values of $1.67E-12$ and $1.3E-14$. The adjusted R square values were 69.7% for the GDP model and 73.78% for the DR model, clearly describing how the emissions accounted for the variations in the dependent variables. Canonical correlation was deployed to explore the association between the group of variables considered since it is a multivariate case. The association between the group of variables was significant having $P = 0.00$ implying the relationship is worthy of note. The study revealed that the emissions significantly impact the death rate and gross domestic product of the study area. For the GDP model, the gaseous form had the highest unit of impact having a coefficient of 0.103507, and the least is the liquid form with a coefficient of -0.031180. In the death rate model, it is the solid form having a coefficient of 0.0041667 that appeared to have the highest effect, and gas was the least with -0.013379 units.

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16 *Keywords: GHG; GDP; DR; Canonical Correlation; Regression; F-Test*17
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19 1. INTRODUCTION

20 The environment in which man lives needs to be adequately catered for in order to
21 maintain balance in the ecosystem, so that the resources it offers can be optimized for the
22 benefit of the occupants. Human activities have a direct impact on this outcome, determining
23 whether it will be conducive or toxic to human life and living organisms in general (Achike &
24 Anthony, 2014; Mikhaylov et al., 2020; Tagwi, 2022). Man needs energy (especially from fossil
25 fuels) in various forms to ease transportation, manufacturing processes, agriculture, and so
26 on. To meet these demands, particularly in agriculture, the use of chemical inputs is altering
27 natural cycles and causing environmental damage. Examples include water and air pollution,
28 loss of biodiversity, and increased greenhouse gas (GHG) emissions. These problems are
29 further intensified by activities like mining, industrial production, and other commercial
30 ventures (Donou et al., 2024; Mikhaylov et al., 2020; Yue & Gao, 2018).

31 GHG emissions are simply the release of gases mainly composed of carbon dioxide (CO₂),
32 methane (CH₄), nitrous oxide (N₂O), and fluorinated gases into the Earth's atmosphere. The
33 sources of these gases are mainly from human activities, including industrial, agricultural, and
34 waste management (Chehabeddine & Tvaronavičienė, 2020; Moumen et al., 2019). These
35 gases, when trapped, further accumulate to constitute the greenhouse effect, which leads to
36 global warming (Lamb et al., 2021). As the global population is projected to reach 9 billion by
37 2050 (Achike & Anthony, 2014; Mikhaylov et al., 2020), increasing pressure is being placed
38 on sectors such as agriculture, forestry, and fisheries to ensure food security. This demand is
39 driving the search for new lands, often leading to deforestation (Yue & Gao, 2018). Foreign
40 investment in forest lands has been linked to environmental pollution and forest loss, which
41 have dangerous consequences for ecosystems and global trade. Deforestation, particularly in
42 Nigeria, is a major concern as it is a significant contributor to CO₂ emissions (Achike &
43 Anthony, 2014; Adesiji & Obaniyi, 2012). When forests are cleared and trees are burned or
44 decay, carbon is released into the atmosphere, increasing GHG concentrations and
45 exacerbating global warming (Jeffrey et al., 2021). The increasing concentration of GHGs is
46 already having a negative effect on the environment, human health, and the economy. Without
47 concerted efforts to reduce emissions, these impacts are expected to become more severe.

48 Several research studies have been carried out on the effect of energy consumption on GDP
49 and other economic indicators (Apergis et al., 2010; Menyah & Wolde-Rufael, 2010; Shakeel
50 et al., 2014; Tagwi, 2022; Zhang & Cheng, 2009), concerning geographical terrains
51 (continents) and predominant activities in such territories. Cause-and-effect analysis has been
52 conducted, and the relationship has been critically analyzed (Apergis et al., 2010; Asafu-

53 Adjaye, 2000; Coondoo & Dinda, 2002; Nayan et al., 2013; Soytaş et al., 2007; Ziramba,
54 2009).

55 (Tagwi, 2022) conducted research investigating the effects of climate change (rainfall and
56 temperature), carbon emissions, and renewable energy consumption on agricultural economic
57 growth in South Africa over the period from 1972 to 2021. Using the ARDL (Auto Regressive
58 Distributed Lag) model, the authors analyze both the short- and long-term relationships
59 between these factors. The results depict that climate change has a short-term negative effect
60 on agriculture, whereas, in the long term, agricultural growth can improve despite climate
61 challenges. Carbon emissions are positively correlated with agricultural growth, whereas
62 renewable energy usage appears to have no significant impact on economic growth in either
63 the short or long term. For the Environmental Kuznets Curve (EKC), CO₂ emissions increase
64 with economic growth up to a point, after which they decrease as economies mature and
65 implement cleaner technologies.

66 (Mikhaylov et al., 2020) revealed how human activities significantly affect global climate
67 change. This is evident in the proportion and concentration of greenhouse gases in the
68 atmosphere. The effect of climate change on human health globally is examined, with a
69 specific focus on African countries. The energy balance method was employed to simulate
70 trends in greenhouse gas emission predictions in various sectors until the year 2030. Data
71 from their research revealed greenhouse gas emissions from different sectors, including
72 industrial processes, transportation fuels, land use and biomass burning, waste disposal and
73 treatment, electric power stations, fossil fuel retrieval, processing and distribution, and
74 residential, commercial, and other sources, with the highest being from electric power stations,
75 accounting for 25.6% of the data. The data source was from the European Environmental
76 Agency. Recommendations were made that organizations should reduce carbon emissions
77 into the air over the next 10 years. This can be achieved by switching to alternative sources
78 of energy (water, solar, and wind) to meet the targets set by the Paris Agreement.

79 (Hamrani et al., 2020) deployed three categories of machine learning models and compared
80 their performance in predicting soil GHG emissions. GHG emissions data were collected from
81 an agricultural research site in Quebec over the period from 2012 to 2017. The data include
82 CO₂ and N₂O fluxes along with environmental variables such as air and soil temperature,
83 precipitation, and humidity. From their study, the LSTM model proved to be the most effective
84 in predicting both CO₂ and N₂O emissions from agricultural soils, especially for capturing

85 short-term variations and peak emissions. Additionally, the Random Forest model offered a
86 fast and effective alternative for CO₂ prediction but was less accurate for N₂O emissions.

87 (Nayan et al., 2013) deployed the GMM (Generalized Method of Moments) estimator to ensure
88 accurate results. In their study, the data used was from 23 selected countries over the period
89 2000–2011. Two models were considered, namely, the energy consumption model and the
90 GDP model. Results from the former model revealed that GDP has a significant effect on
91 energy consumption, while for the latter model, energy consumption has a less significant
92 effect on real GDP per capita. Other significant determinants of energy consumption were
93 energy price and investment.

94 (Kumar et al., 2024) investigated the GHG emissions from rice crops under various treatment
95 combinations (T₁, T₂, ..., T₇) of fertilizer management practices. The control treatment T1 had
96 no nitrogen in its composition and recorded the lowest CO₂ emissions, though it had the least
97 rice output. T2 had the highest CO₂ and N₂O emissions, with values of 1165 kg CO₂e ha⁻¹
98 and 352 kg CO₂e ha⁻¹, respectively. The study highlighted the need to balance the drive for
99 increased rice productivity with environmental sustainability.

100 In this work, the impact of greenhouse gas emissions on Gross Domestic Product (GDP) and
101 the death rate (DR), representing economic and health impacts respectively, is explored. The
102 death rate has not been considered in the literature, which is included in this research.
103 Additionally, the relationships between the dependent variables (GDP & DR) and GHG
104 emissions in Nigeria are examined on a multivariate level.

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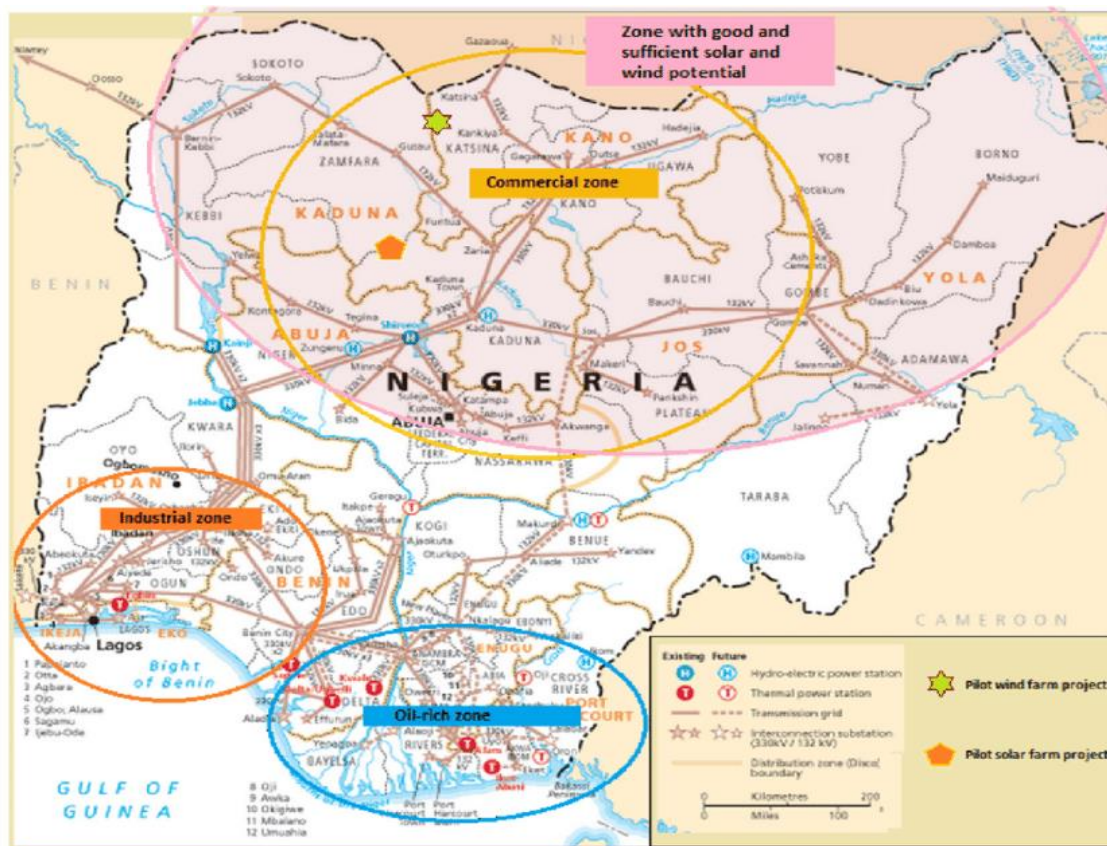
106 **2. MATERIAL AND METHODS**

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108 **2.1 Study area**

109 The study area, Nigeria, is situated in West Africa; it is located between the Sahel to
110 the north and the Gulf of Guinea to the south in the Atlantic Ocean ("Nigeria," 2024). It is
111 regarded as an oil-producing state because it is endowed with crude oil and other mineral
112 resources (Adesugba & Hoon, 2018). It is, therefore, characterized by many industrial

113 activities involving fossil fuel processing, distribution, and consumption.



114
 115 **Fig. 1. Map of Nigeria showing energy resources, distribution, and socio-economic**
 116 **zones** (Adewuyi et al., 2020)
 117

118 **2.2 Data source and framework**

119 The data sets used in this study were from secondary sources, the first collected from
 120 official government statistics on their website (<https://www.nigerianstat.gov.ng/>). The data
 121 spans a period of 51 years, from 1960 to 2011. The dataset is composed of greenhouse gas
 122 (GHG) emissions (liquid, solid, and gas), GDP, and DR, with the former constituting the
 123 independent variable and the latter the dependent variable, respectively. The second dataset
 124 used was from World Development Indicators, revealing greenhouse gas emissions of
 125 countries from 1990 to 2020 (*Greenhouse Gas (GHG) Emissions Climate Watch*, 2023).

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132 2.3 Methodology

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134 2.3.1 Multiple Regression

135 Multiple linear regression is a statistical technique that deploys two or more
 136 independent variables referred to as regressors, (X_i s) to predict the outcome of a dependent
 137 variable referred to as the regressand, (Y).

138 Two multiple linear regression models are considered here:

$$139 \text{GDP}_t = f(L_t; S_t; G_t) \Rightarrow \text{GDP}_t = \beta_0 + \beta_1 L_t + \beta_2 S_t + \beta_3 G_t + \varepsilon_i \quad (1)$$

$$140 \text{DR}_t = f(L_t; S_t; G_t) \Rightarrow \text{DR}_t = \beta_0 + \beta_1 L_t + \beta_2 S_t + \beta_3 G_t + \varepsilon_i \quad (2)$$

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142 2.3.2 Log Transformation of Variable

143 Here, regression is considered on the natural logarithms of the dependent variable,
 144 Y , i.e $\log(Y)$. The reason for this is to handle heteroscedasticity, influence of outliers, skewness
 145 of data, and linearize non-linear relationships.

146

$$147 \log \text{GDP}_t = f(L_t; S_t; G_t) \Rightarrow \log \text{GDP}_t = \beta_0 + \beta_1 L_t + \beta_2 S_t + \beta_3 G_t + \varepsilon_i \quad (3)$$

$$148 \log \text{DR}_t = f(L_t; S_t; G_t) \Rightarrow \log \text{DR}_t = \beta_0 + \beta_1 L_t + \beta_2 S_t + \beta_3 G_t + \varepsilon_i \quad (4)$$

149 where.

150 $\text{GDP}_t =$ gross domestic product during period t

151 $\text{DR}_t =$ death rate during period t

152 $L_t =$ liquid form of GHG emissions at period t

153 β_i are regression coefficients, where $i = 0, 1, 2, 3$

154 $G_t =$ gaseous form of GHG emissions at period t

155 $G_t =$ gaseous form of GHG emissions at period t

156 $\varepsilon_i =$ is the error term

157

158 2.3.3 Canonical Correlation

159 This is a multivariate statistical technique that studies the relationships between
 160 multiple dependent and independent variables. It determines the linear combinations of
 161 variables from each set that are most highly correlated with each other. It is simply an
 162 extension of simple correlation (bivariate), focusing on groups of variables. This is suitable for
 163 this study as we have multiple dependent and independent variables.

$$164 \text{Let } U = a_1 X_1 + a_2 X_2 + a_3 X_3 = a'X \quad (5)$$

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$$166 V = b_1 Y_1 + b_2 Y_2 = b'Y \quad (6)$$

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168 such that $X_1 = L$, $X_2 = S$, $X_3 = G$, $Y_1 = GDP$, and $Y_2 = DR$
 169 $a = [a_1, a_2, a_3,]$ and $b = [b_1, b_2, b_3,]$ are vectors of coefficients (canonical weights) to be
 170 determined. U and V are linear combinations of X and Y . The canonical correlations, cc are the
 171 square roots of the eigenvalues of the following matrix.

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$$173 \quad R_{YY}^{-1} R_{YX} R_{XX}^{-1} R_{XY} \quad (7)$$

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175 Where R_{XY} and R_{YX} are the Covariance matrices between X and Y ,
 176 and Y and X respectively, R_{XX} is the covariance matrix of X with itself, and R_{YY} is the
 177 covariance matrix of Y and itself.

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179 **2.3.4 Hypothesis**

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181 H_{01} : GDP has no relationship with GHG emissions

182 H_{11} : GDP has a significant relationship with GHG emissions

183 H_{02} : DR has no relationship with GHG emissions

184 H_{12} : DR has a significant relationship with GHG emissions

185 H_{03} : GDP & DR has no relationship with GHG emissions

186 H_{13} : GDP & DR has a significant relationship with GHG emissions

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188 The data is explored from the descriptive statistics, then the regression to obtain
 189 model coefficients. Analysis of Variance (ANOVA) was carried out to test the significance of
 190 the model. Analyses were conducted on RStudio version 2024.09.0 (© 2009 – 2024 Posit
 191 Software, PBC).

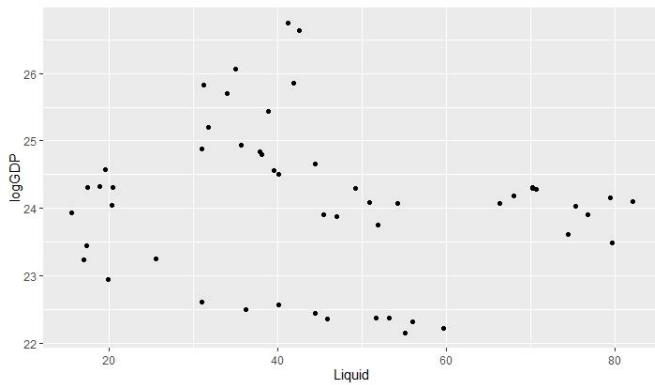
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193 **3. RESULTS AND DISCUSSION**

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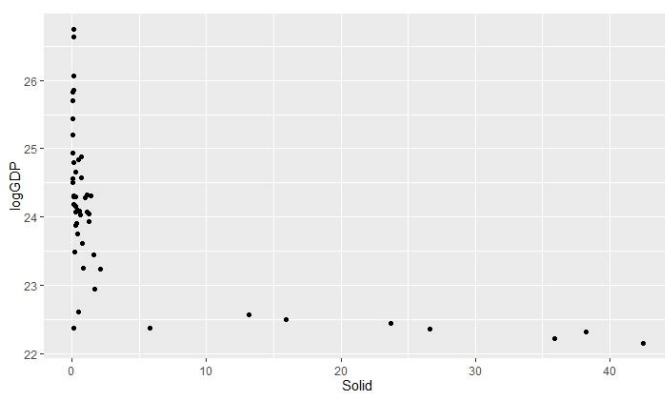
195 The scatter plots from Fig. 2 – Fig. 7 depict the pairwise trend of independent and dependent
 196 variables.

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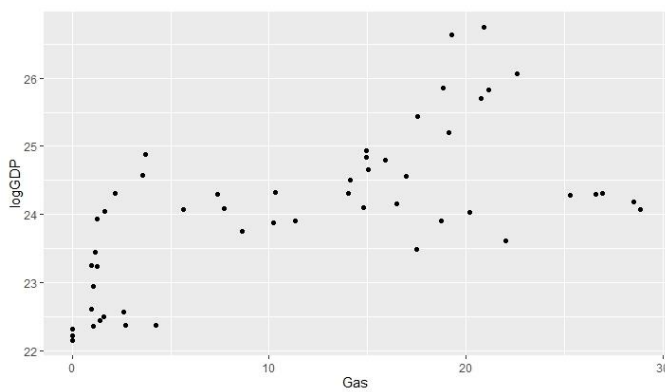
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199 **Fig. 2. Scatter plot of liquid form and logGDP**



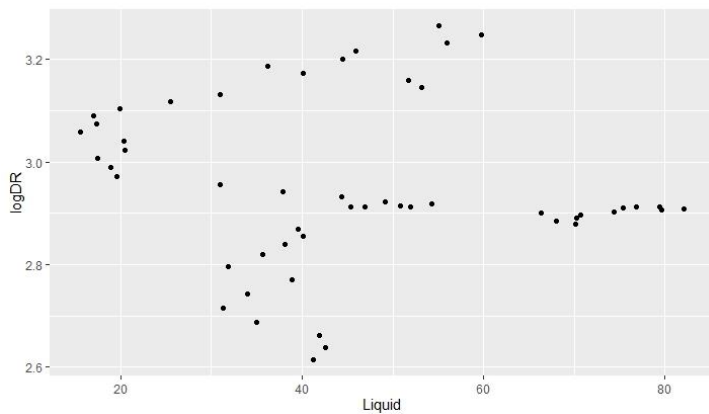
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201 **Fig. 3. Scatter plot of solid form and logGDP**



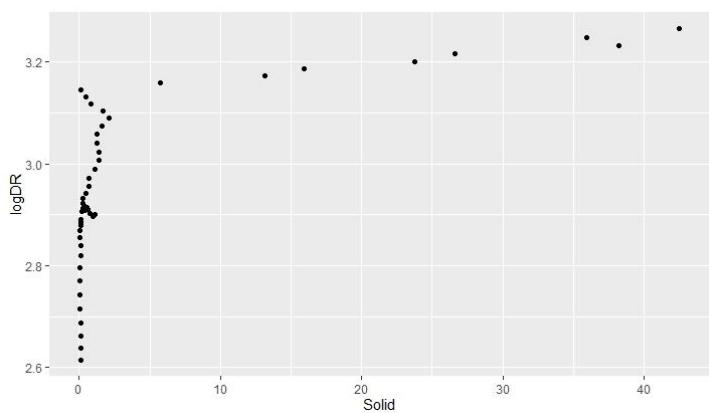
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203 **Fig. 4. Scatter plot of gaseous form and logGDP**



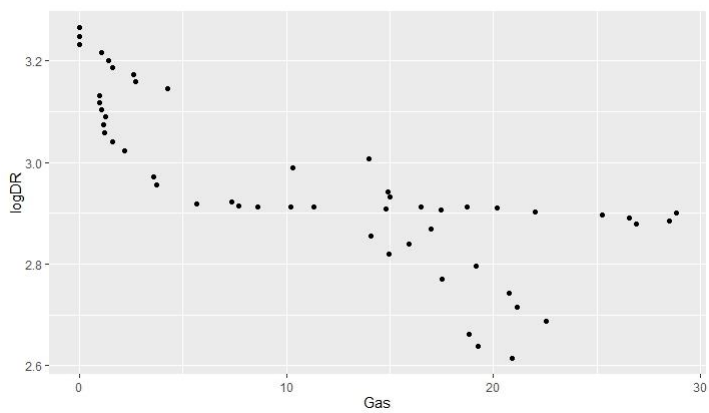
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205 **Fig. 5. Scatter plot of liquid form and logDR**

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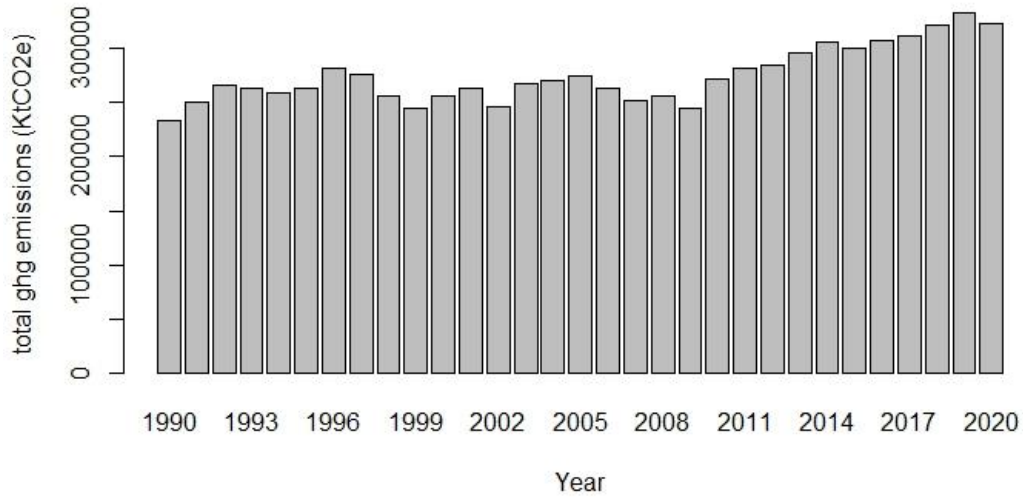
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208 **Fig. 6. Scatter plot of solid form and logDR**

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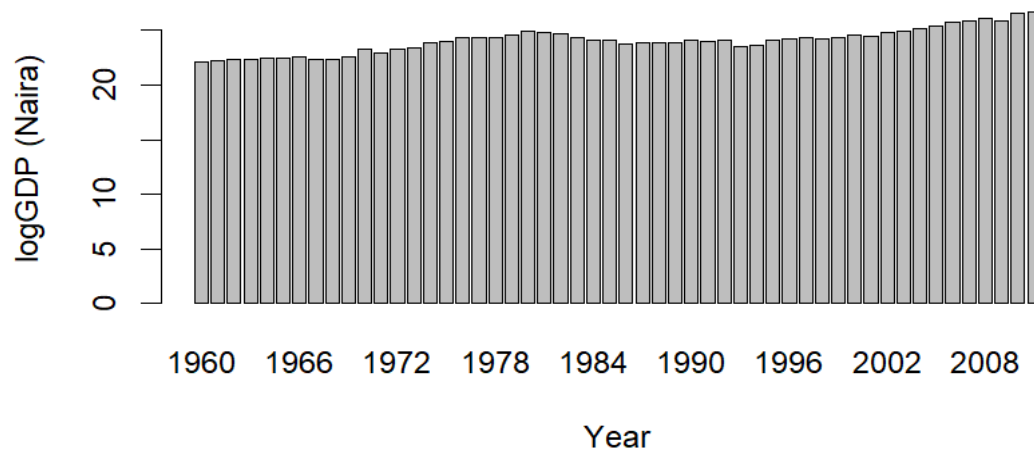


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211 **Fig. 7. Scatter plot of gaseous form and logGDP**

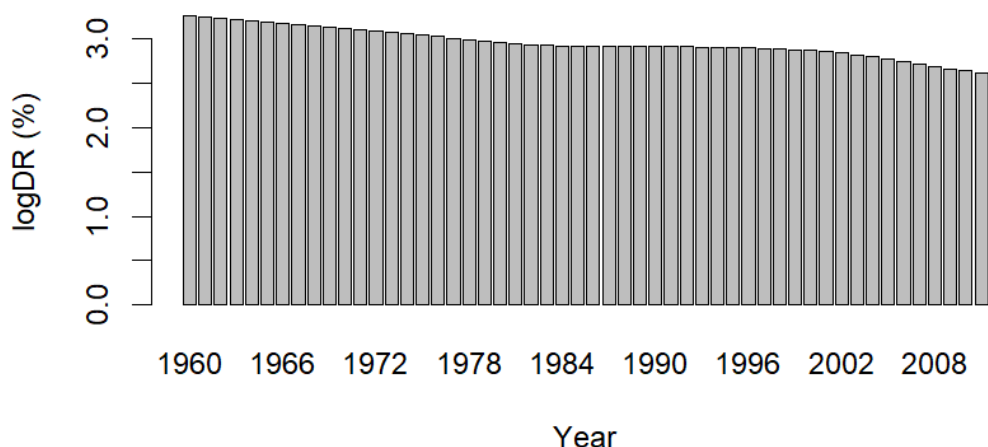
212 The bar plot in Fig. 8. Depicts the ghg emissions from Nigeria within the period 1990-
 213 2020, it can be observed that there is on average an upward trend, implying higher emissions
 214 as the year's progresses.
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 217 **Fig. 8. Total GHG emissions from Nigeria (1990-2020) (greenhouse gas (ghg) emissions**
 218 **climate watch, 2023)**
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 225 **Fig. 9. Total GDP of Nigeria from (1960-2011) (<https://www.nigerianstat.gov.ng/>)**
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Fig. 10. Total DR of Nigeria from (1960-2011) (<https://www.nigerianstat.gov.ng/>)

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Table 1 gives insight into the characteristics of the data used in this study; it describes the shape and some features of the data. The mean, median, variance, maximum, and minimum values of the variables that have been studied are displayed. All variables are skewed positively, with Solid being highly skewed and having the highest value (2.588989). Additionally, Solid alone appears to be leptokurtic, having a kurtosis (5.535710) greater than 3, while all others are platykurtic (with kurtosis less than 3). The result of the Jarque-Bera test revealed that only Solid is not normally distributed since its p-value is less than 5%; all other variables are normally distributed, having p-values greater than 5%. The simple correlation matrix in Table 2 reveals the association between variables. There exists a strong negative association between the dependent variables (logGDP & logDR), implying that as one of the variables increases, the other decreases at a high rate. That is, an increase in the death rate leads to a decrease in the gross domestic product, whereas the independent variables have a moderately positive association between them except for Solid & Gas, which have a noticeable weak negative correlation, suggesting that an increase in a certain variable suggests an increase in another, while in other instances, the reverse is the case (decrease). This nature of association leads to the formulation of regression models to provide depth and insight into their interactions. Table 3 reveals the variance-covariance matrix of the variables. Table 1. gives an insight into the characteristics of the data used in this study, it describes the shape and some features of the data. The mean, median, variance, maximum and minimum values of the variables that have been studied are displayed. All variables are skewed positively with the Solid been highly skewed having the highest value (2.588989). Also, Solid

251 alone appears to be leptokurtic having kurtosis (5.535710) > 3 while all others are platykurtic
252 (having kurtosis < 3). The result of the Jarque-Bera test revealed that only Solid is not normally
253 distributed since it's p-value is less than 5%, all other variables are normally distributed having
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255 between variables. There exists a strong negative association between the dependent
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258 domestic product, whereas the independent variables have a moderately positive association
259 between them except solid & gas having a noticeable weak negative correlation, suggesting
260 an increase in a certain variable suggests an increase in another and other instances reverse
261 is the case (decrease). This nature of association leads to the formulation of regression
262 models to give depth and insight into their interactions. Table 3. reveals the variance-
263 covariance matrix of the variables.

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286 **Table 1. Descriptive statistics**

	log GDP	log DR	Liquid	Solid	Gas
Observations (n)	52	52	52	52	52
Minimum	22.158350	2.615496	15.517750	0.015114	0.000000
Maximum	26.744289	3.264805	82.123880	42.518840	28.848980
1st Quartile	23.395670	2.883608	31.672103	0.124291	2.055874
3rd Quartile	24.600558	3.077716	55.325992	1.286846	18.890455
Mean	24.065091	2.954924	45.003468	4.327135	11.624690
Median	24.093980	2.913790	42.204780	0.418869	12.651905
Sum	1251.384745	153.656029	2340.180310	225.011045	604.483864
SE Mean	0.157660	0.022426	2.628732	1.419224	1.257094
LCL Mean	23.748576	2.909902	39.726068	1.477924	9.100968
UCL Mean	24.381606	2.999945	50.280867	7.176347	14.148411
Variance	1.292540	0.026151	359.332100	104.738261	82.174841
Std Deviation	1.136899	0.161713	18.956057	10.234171	9.065034
Skewness	0.205570	0.036157	0.295778	2.588989	0.190702
Kurtosis	-0.356546	-0.590282	-0.906248	5.535710	-1.339701
Jarque-Bera	0.54259	0.54259	2.2724	136.33	3.8505
Probability	0.7689	0.7624	0.321	2.2E-16	0.1458

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Table 2. Correlation matrix (Pearson's)

$$\rho = \begin{bmatrix}
 \text{variable} & \text{logGDP} & \text{logDR} & \text{liquid} & \text{solid} & \text{gas} \\
 \text{logGDP} & 1.000000 & -0.9397350 & -0.1387798 & -0.5989205 & 0.6478934 \\
 \text{logDR} & -0.9397350 & 1.000000 & -0.1025083 & 0.6582682 & -0.7826115 \\
 \text{liquid} & -0.1387798 & -0.1025083 & 1.000000 & 0.1012665 & 0.4802593 \\
 \text{solid} & -0.5989205 & 0.6582682 & 0.1012665 & 1.000000 & -0.4791950 \\
 \text{gas} & 0.6478934 & -0.7826115 & 0.4802593 & -0.4791950 & 1.000000
 \end{bmatrix}$$

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300 **Table 3. Variance-covariance matrix**

301 $\Sigma =$

<i>variable</i>	<i>logGDP</i>	<i>logDR</i>	<i>liquid</i>	<i>solid</i>	<i>gas</i>
<i>logGDP</i>	1.292540	-0.17277202	-2.990861	6.968574	6.677210
<i>logDR</i>	-0.17277202	0.02615122	-0.31423379	1.08943546	-1.14725947
<i>liquid</i>	-2.990861	-0.31423379	359.3320996	19.645661	82.5264542
<i>solid</i>	6.968574	1.08943546	19.645661	104.738261	-44.456413
<i>gas</i>	6.677210	-1.14725947	82.5264542	-44.456413	82.174841

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303

304 **Table 4a. Regression results in the logGDP model**

	Estimate	Std. error	t statistic	Prob	Model Significance	
Intercept	24.337531	0.234930	103.597	2E-16 ^{****}	R-square	0.6973
Liquid	-0.031180	0.006017	-5.182	4.3E-06 ^{****}	Adj. R-square	0.6782
Solid	-0.016751	0.011138	-1.504	0.139	F-statistic	36.84
Gas	0.103507	0.014262	7.257	2.97E-09 ^{****}	Prob.*	1.67E-12 ^{****}

305 *Significance levels: 0 ^{****}, 0.001 ^{***}, 0.01 ^{**}, 0.05 ^{*}, 0.1 ['], 1

306 The regression model is significant (p-value = 1.67E-12), implying there exists a
 307 significant relationship between the independent variables and GDP, further supporting the
 308 decision to reject H_{01} . The higher the value of the adjusted R-squared, the better it fits the
 309 data; the adjusted R-squared implies the independent variables can account for 67.8% of the
 310 variation in GDP. All regression coefficients are significant except for "solid." The first
 311 estimated regression model is as follows:

312 $logGDP = 24.337531 - 0.031180L - 0.016751S + 0.103507G$

313 The model suggests that for every unit increase in independent variables, GDP decreases by
 314 0.031180 and 0.016751, and increases by 0.103507 units, respectively.

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316 **Table 4b. Regression results of logDR model**

	Estimate	Std. error	t statistic	Prob	Model Significance	
Intercept	3.0042595	0.0301647	99.595	2E-16 ^{****}	R-square	0.7532
Liquid	0.0020620	0.0007726	2.669	0.01035 ^{**}	Adj. R-square	0.7378
Solid	0.0041667	0.0014301	2.914	0.00541 ^{**}	F-statistic	48.84
Gas	-0.013779	0.0018312	-7.524	1.2E-09 ^{****}	Prob.*	1.3E-14 ^{****}

317 *Significance levels: 0 ^{****}, 0.001 ^{***}, 0.01 ^{**}, 0.05 ^{*}, 0.1 ['], 1

318 The second model, the log DR model, is also statistically significant (p-value = 1.3E-
 319 14), suggesting that there exists a significant relationship between the independent variables
 320 and the death rate. This informs us of our decision not to reject H_{12} . The predictors can account

321 for 73.4% of the variation in the death rate (Adjusted R-squared = 0.7378). The regression
 322 coefficients are all significant; thus, the model is effective.

323
$$\log DR = 3.0042595 + 0.0020620L + 0.0041667S - 0.013779G$$

324 The above model implies that for every unit increase in the independent variables (liquid, solid,
 325 and gas), DR increases by 0.0020620 and 0.0041667, respectively, while it decreases by
 326 0.013779 units.

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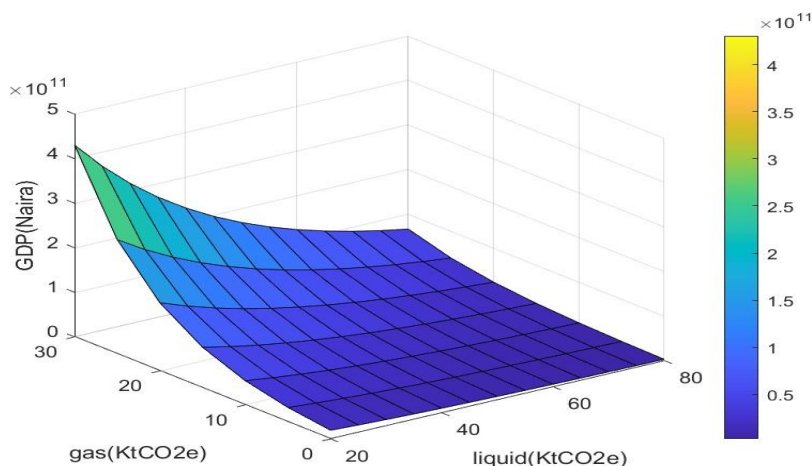
328 **Table 5. Canonical correlations**

	Stat	Approx.	df1	df2	Prob.*	
Cc1	0.8733005	0.1136586	30.80363	6	94	0.00****
Cc2	0.7218916	0.4788726	26.11772	2	48	2.11E-08****
X Coeff			Y Coeff			
Gas	-0.0123759	-0.0093683	-0.0157534	logGDP	0.0711156	-0.3531482
Liquid	0.0005746	0.0090769	0.0020830	logDR	1.3186979	-2.1621870
Solid	0.0049277	-0.0042853	-0.0159887			

329 *Significance levels: 0 ****, 0.001 ***, 0.01 **, 0.05 ', 0.1 ' ', 1

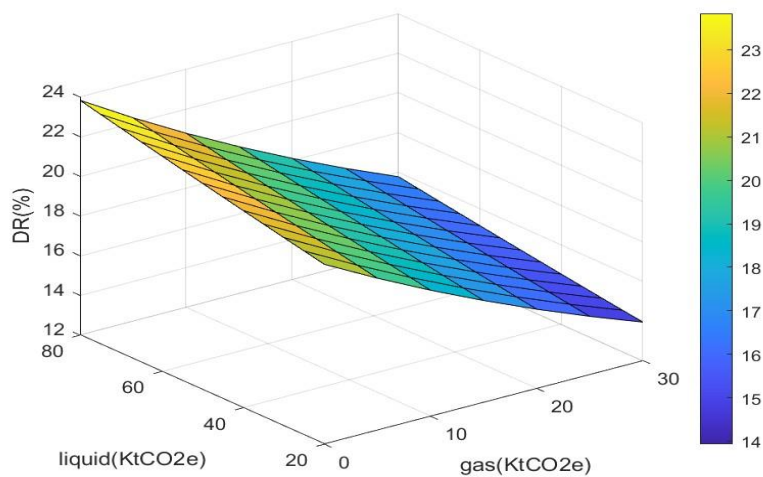
330 The canonical correlations are significant, both having very small p-values (0.00 and 2.11E-
 331 08), implying that the two groups of variables have meaningful associations between them,
 332 leading to the non-rejection of the hypothesis H_{13} . The first canonical correlation (0.8733005)
 333 suggests a strong correlation between the sets of variables. Therefore, the GHG emissions
 334 can explain the variability in GDP and DR. The second canonical correlation (0.7218916) also
 335 supports this claim. The canonical coefficients (X coeff, Y coeff) depict how each variable
 336 contributes to the canonical variates.

337



338

339 **Fig. 11. 3D plot of GDP model with solid as constant**
 340
 341



342 **Fig. 12. 3D plot of DR model with solid as constant**
 343

344 From the models obtained, we observed that the liquid and solid forms of emissions reduce
 345 GDP, while the gaseous form increases GDP. This is illustrated by Fig. 11. Regarding the
 346 death rate, the situation is reversed. The liquid and solid forms of emissions increase the
 347 death rate, while the gaseous form decreases it. This is illustrated by Fig. 12. This observation might
 348 be explained by the following facts: Firstly, the gas form of emission in the area under study
 349 corresponds to the lowest maximum source of emission at 28.848980 KtCO₂e, while the
 350 maximum for the liquid and solid forms was 82.123880 KtCO₂e and 42.518840 KtCO₂e,
 351 respectively. It may be argued that gaseous emissions are mainly from heavy industries
 352 usually located on the outskirts of cities where they are situated. The more a country produces,
 353 the higher its GDP over time. The location of these industries minimizes their effect on the
 354 health of the inhabitants. Meanwhile, the increase in the death rate from the liquid and solid
 355 forms can be linked to everyday activities within the populace, such as transportation, cooking,
 356 road construction, and so on, which involve the combustion of fuels. The proximity of these
 357 activities to human settlements implies a high risk of air pollution, which can be toxic to
 358 humans.
 359

360 **4. CONCLUSION** 361 362

363 The study results reveal that GHG emissions have a significant effect on gross
 364 domestic product and death rates. From the death rate model, it was revealed that an increase
 365 in GHG emissions can have adverse effects on human health, thereby leading to an increase
 366 in the death rate, which, by extension, can affect life expectancy. Since these emissions

367 release substances into the atmosphere, they have adverse effects on the balance of the
368 ecosystem. Humans inhale the polluted air into their systems, which can have toxic effects in
369 the body. It is necessary to note that most of the research reviewed in the literature studies
370 has not specifically considered the impact of these emissions on the death rate. For the second
371 model, GHG emissions also have a significant effect on GDP, further aligning with previous
372 studies (Achike & Anthony, 2014; Apergis et al., 2010; Menyah & Wolde-Rufael, 2010). In our
373 GDP model, it was revealed that the liquid and solid forms of greenhouse gas emissions led
374 to a decrease in GDP, whereas the gaseous form led to an increase in GDP. This suggests
375 that attention should be given to the two forms to increase gross domestic product. Meanwhile,
376 on the multivariate level, the groups of variables were seen to be strongly correlated, indicating
377 that the quantum of emissions will affect the dependent variables. This approach was
378 necessary because restricting the association to a univariate scope may not fully capture the
379 dynamics of the relationship.

380 GHG emissions are a major concern in many countries characterized by activities that
381 support these emissions. The populace needs to be healthy before they can build the
382 economy. The first form of wealth must be the individual's health because this is the foundation
383 of every other activity that can be embarked upon. This study has revealed the significance of
384 these emissions to the environment, making it unsafe for the inhabitants. The present
385 investigation may be expanded to other countries' available data.

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478 **DEFINITIONS, ACRONYMS, ABBREVIATIONS**479 **DR** – Death rate480 **GDP** – Gross Domestic Product481 **Cc** – Canonical correlation482 H_{0i} – i^{th} null hypothesis483 H_{1j} – j^{th} alternative hypothesis484 **KtCO₂e** – Kilotonnes of Carbon dioxide equivalent. Which is a unit measurement for
485 greenhouse gas emissions.

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