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RESEARCH ARTICLE

SECURITY EXPENDITURE, ECONOMIC GROWTH AND ENVIRONMENTAL SUSTAINABILITY IN NIGERIA: A PANEL DATA ANALYSIS (2000-2024)

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ABSTRACT

The paper focuses on discussing the relationship between security spending and economic growth and environmental sustainability in Nigeria during 2000 - 2024 and also compares Nigeria to a West African (ECOWAS) panel standard. Annual data are obtained with references to the World Bank database, World Development Indicators (WDI) through the following: military expenditure as a share of GDP (MS.MIL.XPND.GD.ZS), GDP per capita growth (NY.GDP.PCAP.KD.ZG), and the emission of greenhouse-gases (GHG) per capita excluding land-use change and forestry (EN.GHG.ALL.PC.CE.AR5). Environmental sustainability is quantified (i) directly in the form of (GHG emissions per capita) and (ii) in the form of a composite index, which augments with renewable energy utilization and forest coverage and declines with emissions. A case study of pooled and fixed-effects (country and year) panel models with cluster-robust standard errors is estimated using time-series data on Nigeria only. In terms of the average military spending during the period, Nigeria spends an average of 0.56 percent of GDP on military expenditure, which is lower compared to the average 2.12 percent in ECOWAS, whereas average GHG emissions per capita are approximately 1.98 tCO2, which is higher than the ECOWAS average. Empirical studies have shown that, in a pooled estimation, high military expenditure correlates with a greater emission, although correlation in within-country (fixed-effects) estimation is less, an indication that the correlation may largely be cross country. The growth of military expenditure and the growth of GDP per capita are both negatively related to sustainability when the environmental sustainability is gauged using the composite index (2000 - 2021). The findings emphasize that security policies are required to reduce the environmental externalities and the growth policies need to be such that welfare gains are not coupled to emissions as a result of energy transition and land protection.

Keywords: Military expenditure, economic growth, greenhouse gas emissions, renewable energy, forest cover, ECOWAS panel.

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1.0. INTRODUCTION

The Nigerian policy environment is in a triadic state: (1) heightened security demands which drive up internal security budgets and defense expenditures, (2) development demands which keep the economy on a broad-based growth path, and (3) environmental protection promises in the face of rising climate risks. Security expenditure is capable of having both direct and indirect impacts on environment by fuel-intensive operations, procurement and infrastructure as well as by deflecting fiscal resources towards climate-hardy infrastructure and clean energy. Meanwhile, scale effects can increase emissions caused by economic growth as opined by Stockholm internal peace research institute, military expenditure data base retrieved (February, 24, 2026).

The paper makes contributions to the evidence of security-growth-environment nexus, paying specific attention to Nigeria. Since Nigeria has a short and shock-prone macro-environmental time series, we complement a Nigeria-specific narrative with a comparative ECOWAS panel (15 countries) from 2000 to 2024. The panel design enables us to distinguish between-country differences and within-country (over-time) variation, which employs the fixed effects. The pattern is drawn from Efayena and Olele (2024) perspectives on environmental sustainability, terrorism, and military expenditure.

1.1. Research Questions

This paper tried to answer three questions:

(i) How do military expenditure, economic growth, and emissions in Nigeria altered since 2000?

(ii) Does more military spending related to more emissions in an ECOWAS panel when growth and structural controls are added?

(iii) Are the findings different between a multi-indicator sustainability index and emissions only as the measure of environmental performance?

2.0. CONCEPTUALIZATION AND RESEARCH FRAMEWORK

The study employed a panel data analysis as surrogate for data extraction from Nigeria and selected ECOWAS countries from 2000 to 2024. The study employed four (4) theories to enable it conduct the study. Firstly, the trade mill of destructive perspective that argues that militarization and defence activity can intensify environmental harm through fuel use, logistics, weapons systems, training and infrastructure as stated by Bradford and Stoner (2017).

Secondly, the environmental kuznet curve (Ekc) suggests that environmental degradation may first rise and later fall with income growth, although in many developing economics the early scale effect still dominate as the economy grows, the energy consumption and industrial production increases, as well as transport activities. In the case of Nigeria, the oil sector is directly associated with growth determinates in terms physical capacity emissions.

Thirdly, the scale composition technique view explains that growth effect the environment through-scale of production, the composition of the economy, and technology used.

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Fourthly, supporting view, the fiscal allocation or opportunity cost theory which argues that higher security spending may crowd out spending on environmental protection, clean energy, and climate adaption.

In all these theories, the study anchored on the third theory of the scale composition techniques that state that growth effect the environment through scale of production, the composition of the economy, and technology used. Recent evidence of Sub-Saharan Africa Asongu, SA and Ndour, CT (2023) indicates that the effect of military expenditure on emissions and sustainability performance might be greater, with the quality of governance and environmental regulation helping soothe these impacts. Nevertheless, the evidence on Nigeria-specific is still mixed and is prone to the selection of the environmental indicator and estimation method. Food and agriculture organization of the United Nations retrieved February 24, 2026.

3.0. METHODOLOGY

3.1. Data Sources and Sample

The annual data is based on World Bank World Development Indicators (WDI) that is generated through World Bank API (Excel bulk downloads). The ECOWAS panel includes 15 member states (Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo) on 2000-2024. This leaves the panel out of balance as not every country year reports all indicators.

3.2. Variable Construction

Security expenditure is proxied by military expenditure, as expressed in the percentage of gross domestic product European Commission, Joint Research Centre (2024) global greenhouse gas emission (WDI: MS.MIL.XPND.GD.ZS). GDP per capita growth (annual percentage; WDI: NY.GDP.PCAP.KD.ZG) retrieved February 24, 2024 is economic growth. Environmental sustainability is calculated in two forms (i) the primary measure is in (GHG emissions per capita excluding land-use change and forestry), which is the emissions expressed in tCO2e per capita (WDI: EN.GHG.ALL.PC.CE.AR5); (ii) a robustness measure is an Environmental Sustainability Index (0-1) in which renewable energy consumption is expressed as a percentage of total final energy (WDI: EG.FEC.RNEW.ZS), and forest area is expressed as a percentage of land.

Index construction (2000-2021): The index is constructed by computing a min-max scaled value using the ECOWAS panel over 2000-2021; s_k = (x_k -min(x_k)/(max(x_k)-min(x_k). There is inversion of emissions: s_em_inv =1 -s_em. EnvIndex = (s_renew + s_forest + s_em inv)/ 3 then. EnvIndex is only calculated on those country-years that do not have missing values of all three components.

International Energy Agency (IEA) energy statistics date browser (March 25, 2025).

The controls of structural change and scale include urban population percentage of total population (WDI: SP.URB.TOTL.IN.ZS is measured in percentage points) and population size in total population (WDI: SP.POP.TOTL). Year fixed effects pick up regular shocks (e.g. cyclical commodity prices around the world). United Nations Population Division on World Organization Prospects, retrieved February 24, 2026.

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3.3. Econometric Specification

We estimate pooled OLS with year fixed effects and a two-way fixed-effects (TWFE) model: y_it = beta1*Mil_it + beta2*Growth_it + beta3*Urban_it + beta4*ln(Pop)_it + mu_i + lambda_t + e_it, where mu i is the time-invariant country factors and lambda t is the common shocks of a year. Standard errors are country clustered. Another complementary case study is an estimation of a Nigeria-only time-series model (linear time trend) and Newey-West/HAC standard errors.

All computations, tables, and figures in this paper are produced from the downloaded WDI datasets.

Table 1: Variables and data sources (WDI indicators)

Variable	Code	Role	Source
Military expenditure (% of GDP)	MS.MIL.XPND.GD.ZS	Security expenditure proxy	World Bank WDI (source: SIPRI)
GDP per capita growth (annual %)	NY.GDP.PCAP.KD.ZG	Economic growth	World Bank WDI
GHG emissions per capita excl. LULUCF (tCO2e/capita)	EN.GHG.ALL.PC.CE.AR5	Environmental pressure (higher=worse)	World Bank WDI (AR5 CO2e)
Renewable energy consumption (% of total final)	EG.FEC.RNEW.ZS	Sustainability component (higher=better)	World Bank WDI
Forest area (% of land area)	AG.LND.FRST.ZS	Sustainability component (higher=better)	World Bank WDI
Urban population (% of total)	SP.URB.TOTL.IN.ZS	Control (structural change)	World Bank WDI
Population, total	SP.POP.TOTL	Scale control (log)	World Bank WDI

Note. EnvIndex is the mean of min-max scaled renewable energy, forest area, and inverse emissions.

4.0. PRESENTATION OF RESULT AND DISCUSSION

4.1. Descriptive Patterns

Summary statistic of ECOWAS panel (analysis sample) and Nigeria indicate that the average military spending in ECOWAS is 1.12 percent of GDP, whereas Nigeria is on average 0.56 percent in 2000-2024. The mean GHGs emissions in Nigeria (1.98 tCO2e/capita) are higher than the sample mean in ECOWAS (1.34 tCO2e/capita). The urbanization of Nigeria is also fast (43.3% in 2000 to 63.0% in 2024), which can have influence on energy demand and transport emissions.

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Table 2: Descriptive statistics (2000-2024)

Variable	Panel Mean	Panel SD	Panel Min	Panel Max	Nigeria Mean	Nigeria SD	Nigeria Min	Nigeria Max
Military expenditure (%GDP)	1.125	0.754	0.193	4.680	0.556	0.173	0.348	1.013
GDPpc growth (%)	2.048	3.643	-20.894	19.431	2.145	3.781	-8.342	12.210
GHG per capita (tCO2e)	1.338	0.418	0.674	3.006	1.982	0.450	1.482	3.006
Urban population (%)	42.545	13.553	16.131	76.772	53.247	6.020	43.279	62.976

The above illustrate Nigeria's trends and panel associations.

All computation, tables and figures in this study are produced from the downloaded WDI datasets.

Panel Ecowas Mean: The average value across all country-year observations in the Ecowas panel

Panel SD: The standard deviation across all country-year observation. It shows overall dispersion in the panel.

Panel Min: The smallest observed value in the full Ecowas panel sample**.**

Panel Max: The largest observed value in the full Ecowas sample.

Nigeria Mean: The average value for Nigeria alone across the study period.

Nigeria DS: The standard deviation for Nigeria across time. The shows how much Nigeria varies year to year.

Nigeria Min: The lowest value recorded for in the sample period.

Nigeria Max: The highest value recorded for Nigeria in the sample period.

Summarily, the Descriptive patterns show how military expenditure, GDP per capita growth, emissions, and sustainability indicators evolve over time in Nigeria and in the ECOWAS sample. The descriptive statistics summarize the central tendency, dispersion, and range of each variable. Panel statistics describe the full ECOWAS country-year sample, while Nigeria statistics isolate the Nigeria time-series profile. Together, they show whether Nigeria differs from the regional average and whether Nigeria's own values are relatively stable or volatile over time**.**

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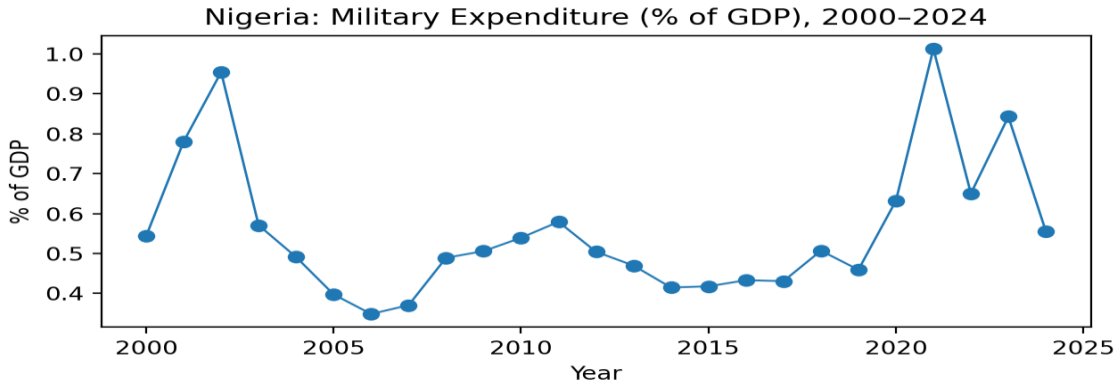

Figure 1: Nigeria's military expenditure as a share of GDP (WDI: MS.MIL.XPND.GD.ZS).

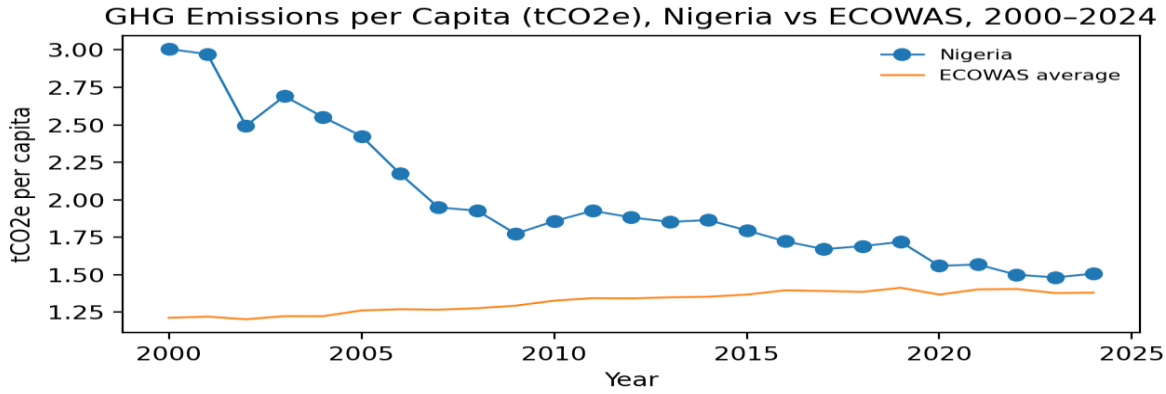

Figure 2: GHG emissions per capita (tCO2e/capita) for Nigeria and the ECOWAS average (WDI: EN.GHG.ALL.PC.CE.AR5).

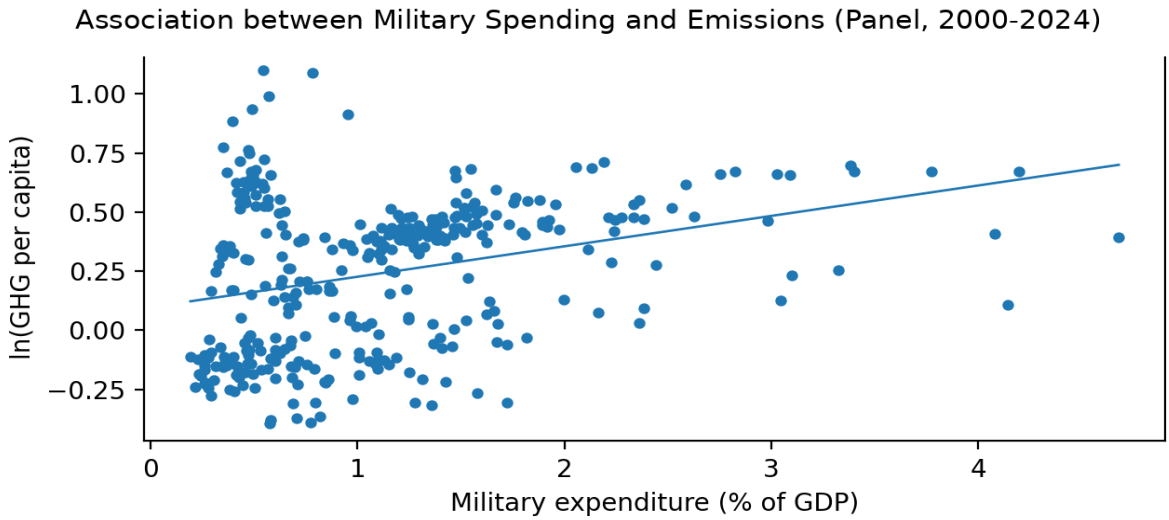

Figure 3: Scatter association between military expenditure and ln(GHG per capita) across the ECOWAS panel (2000-2024).

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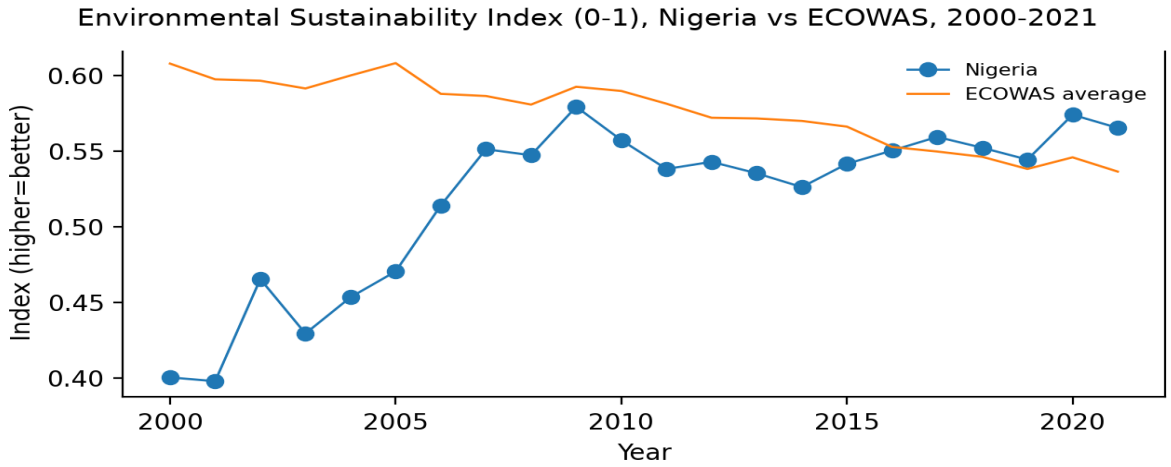

Figure 4: Composite Environmental Sustainability Index (0-1) for Nigeria and the ECOWAS average (2000-2021).

Table 3: Correlation Matrix (panel sample)

Indicators	MilExp	GDPpcGr	GHGpc	Urban	lnPop
MilExp	1.000	-0.048	0.269	-0.502	0.072
GDPpcGr	-0.048	1.000	0.094	0.072	-0.027
GHGpc	0.269	0.094	1.000	-0.100	0.216
Urban	-0.502	0.072	-0.100	1.000	-0.259
LnPop	0.072	-0.027	0.216	-0.259	1.000

Note. Correlations are unconditional and do not account for fixed effects or time trends.

Regression Findings

The four specifications described in Table 4. The positive and statistically significant relationship between military expenditure and emissions can be seen in Model 1 (fixed year effects, pooled OLS): a 1 percentage point rise in military spending (as percentage of GDP) is linked to an average of 13.8 percentage point rise in GHG emissions per capita (dependent variable in logs), other things remaining constant. Comparatively, Model 2 (two-way fixed effects), has a smaller and statistically non-significant coefficient, and this indicates that the common relationship is only contributed by the between-country differences but not by within-country time changes.

Model 3 relies on the EnvIndex (2000-2021) which shows that rise in military expenditures and increase in the growth of GDP per capita are linked to a lower score on sustainability, which is in line with a trade-off between militarization, rise in energy demand, and sustainability. In the model 4 (Nigeria-only time series), the relationship between military spending and emissions is negative following the control of linear time trend. One such way is that the instances of insecurity both increase the expenditure on security and smother economic activity (and consequently emissions) in a short-run. The magnitude of the Nigeria time-series coefficients (in particular, the urbanization one) is big, and it must be interpreted with care due to the small sample size, the possibility of multicollinearity between the time trend and the coefficient, and limitation of measurement.

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Strengths and weaknesses: The estimates are associative as opposed to causal. Conflict intensity, governance and macroeconomic shocks that influence growth and emissions plausibly endogenously predict military spending. The future research could investigate the robustness by (i) lagged military expenditure, (ii) introduce conflict and governance indicators, (iii) enabling the use of non-linear time trends in the Nigeria case study, and (iv) estimating dynamic panel models where reasonable.

Table 4: Regression Results (coefficients with robust standard errors)

Variable	Pooled OLS (Year FE)	Country-Year FE ln(GHGpc)	Country-Year FE EnvIndex	Nigeria TS (HAC)
Military exp. (%GDP)	0.138***	0.026	-0.009	-0.127**
	(0.025)	(0.043)	(0.016)	(0.063)
GDPpc growth (%)	0.010	0.003	-0.002**	-0.003
	(0.006)	(0.003)	(0.001)	(0.003)
Urban pop. (%)	0.001	-0.028	0.007	-1.036***
	(0.002)	(0.025)	(0.009)	(0.179)
ln(Population)	0.047***	-0.985	0.217	
	(0.017)	(0.635)	(0.213)	
Time trend				0.820***
				(0.147)
Observations	340	340	296	25
R-squared	0.162	0.881	0.956	0.961

Note. *, **, *** denote 10%, 5%, and 1% significance. Model 2 clusters SEs by country. Model 3 uses 2000-2021 due to renewable-energy data availability. Model 4 uses HAC(1) standard errors.

Discussion and Policy Implications

Three implications In the light of the evidence, we can draw three practical implications on Nigeria and other such economies:

1) **Security-environment co-benefits:** in an environment where defense expenditure is inevitable, reduction of emissions can take place by using energy efficient bases, clean fuels, low-carbon logistics and environmental risk assessment during security planning.

2) **Decoupling growth and emissions:** The correlation between GDP per capita growth and the EnvIndex is negative, which indicates that growth in the region is frequently accompanied by the increase of the environmental pressure. The intensity of emissions can be decreased with policies to increase renewables and grid efficiency, decrease gas flaring, and decrease the use of diesel.

3) **Save land and ecosystems:** The forest-cover processes contribute to the EnvIndex and are able to counter increasing emissions. Enforcement of deforestation, agroforestry scaling, and climate-smart agriculture would enhance the growth-environment trade-off.

The finding of a comparison between pooled and fixed-effects estimates makes the most obvious point: pooled relations indicate the combination of between-country and within-country variation, whereas the two-way fixed-effects model can be used to extract the within-country changes across time. The dominance of the pooled association in this application indicates that the cross country

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differences are the key to most of the correlation between military expenditure and emissions, and the within country changes are more responsive to shocks, regime changes and measurement factors. Governance indicators, conflict intensities measures, and energy prices might be used in future work to make mechanisms more understandable and easier to identify.

5.0. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Based on WDI data, 2000-2024, the paper has analyzed security expenditure relations, economic development and environmental performance, Nigeria as the case study and ECOWAS as a control group. There is positive correlation between military spending and per-capita emissions, but the correlation becomes weaker and statistically non-significant after accounting country and year fixed effects, which means that this correlation is explained by the cross-country variations.

Once the sustainability is measured by both military expenditures and GDP per capita growth in the context of the environmental performance measured by EnvIndex (2000-2021), sustainability is negatively correlated with both indicators. Although the analysis is observational, and thus cannot be used to prove causality, the findings can be used to justify policy measures that (i) minimize the environmental footprint of security operations and (ii) speed up energy transition and land protection in a way that the improvement of welfare is less emissions-intensive.

5.2. Recommendations

Government is supposed to make security expenditure more efficient and accountable: The increased security spending should not be done only where it is required, but also the money allocated to defense and internal security needs to be adequately reviewed so that the money spent in this area is not wasted. This will assist in minimizing wastage and enhancing security performance and preventing the channeling of the public resources out of sectors that lead to economic growth and environmental conservation.

Nigeria must ensure that security spending is in line with sustainable development goals: The policymakers are advised to make sure that the environmental consideration is incorporated in the security policies and defense related activities. This involves encouraging cleaner technologies, improved energy consumption, and environmentally friendly ways of operation in the military and security activities in order to ensure that national security activities do not enhance environmental degradation.

Government ought to invest more in green development and low carbon development: As economic growth may increase the pressure on the environment when being promoted by carbon-intensive activities, Nigeria ought to encourage renewable energy, cleaner transport, sustainable industrial processes, and climate-intelligent infrastructure. This will assist the nation to realize economic growth and at the same time avoid a high level of greenhouse gas emission.

There should be increased regional cooperation in ECOWAS: Due to the frequent occurrence of security and environmental issues spanning national borders, Nigeria and other countries in the ECOWAS needs to intensify cooperation in security management, intelligence sharing, environmental

governance and sustainable development planning. The integrated regional strategy will enhance the stability and environmental performance.

Conflict of Interest

The authors declare that no conflict of interest exist in this manuscript.

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