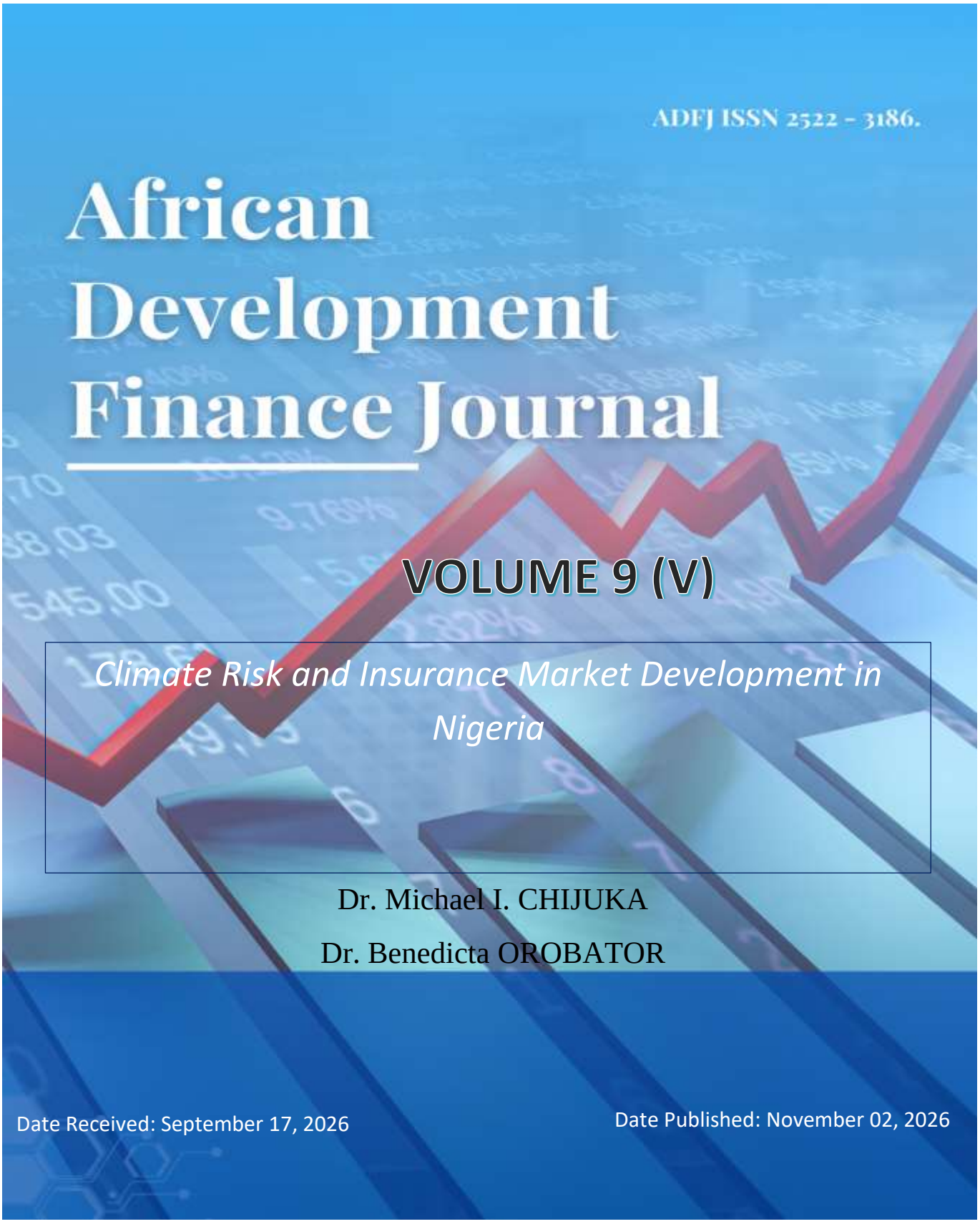
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Climate Risk and Insurance Market Development in Nigeria

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Abstract

This study examines the relationship between climate risk and insurance market development in Nigeria, focusing on how climate-related losses, government disaster risk management (DRM) spending, and reinsurance capacity influence insurance penetration and density. The research adopts a quantitative approach using secondary data spanning 2000 to 2024, sourced from the National Insurance Commission (NAICOM), the Nigerian Meteorological Agency (NiMet), the National Emergency Management Agency (NEMA), and the World Bank Climate Data. Econometric techniques, including descriptive statistics, correlation analysis, the Augmented Dickey-Fuller (ADF) unit root test, Johansen cointegration, the Error Correction Model (ECM), and Ordinary Least Squares (OLS) regression, were employed to analyse the data. The results reveal that climate-related losses have a negative and statistically significant impact on insurance market development, indicating that increasing climate events such as floods and droughts reduce insurers' capacity to underwrite new risks. In contrast, government DRM spending and reinsurance capacity exert positive and significant effects, suggesting that proactive fiscal intervention and strong financial resilience enhance the sector's growth and stability. GDP growth was found to positively influence insurance development, while inflation showed a weak negative effect. The cointegration results confirmed a long-run equilibrium relationship among the variables, and the ECM showed that about 47 percent of short-run disequilibrium is corrected each year, confirming model stability. The study concludes that climate risk significantly influences Nigeria's insurance market and that strengthening institutional capacity, expanding reinsurance frameworks, and increasing preventive DRM spending are essential for improving market resilience. It recommends policy coordination between environmental and financial institutions to promote sustainable insurance development and ensure economic stability in the face of rising climate uncertainty.

Keywords: *Climate risk, Insurance market development, Disaster risk management spending, Reinsurance capacity, Climate-related losses.*

1. INTRODUCTION

Nigeria's insurance sector is facing increasing exposure to climate-related risks that threaten its stability and long-term growth. In recent years, the country has witnessed a rise in the frequency and intensity of floods, droughts, and other extreme weather events, leading to widespread economic and social disruptions. The 2022 floods, described by the World Bank as one of the most devastating in Nigeria's history, affected more than 4.4 million people, destroyed vast farmlands, displaced communities, and resulted in economic losses exceeding ₦4 trillion (World Bank, 2023; Reuters, 2024). These recurring climate events have significantly increased underwriting

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uncertainty, raised claims ratios, and placed financial pressure on insurance companies. The Nigerian Meteorological Agency (NiMet) continues to project a worsening climate outlook, with unpredictable rainfall patterns and prolonged dry seasons likely to intensify risk exposure across multiple sectors.

Despite these challenges, the insurance market in Nigeria remains relatively underdeveloped. With penetration levels still below 1 percent of GDP, the sector plays only a limited role in providing financial protection against losses arising from natural disasters (Oxford Business Group, 2024). At the same time, government efforts through the National Emergency Management Agency (NEMA) have largely focused on post-disaster response rather than preventive measures and resilience building (Federal Ministry of Humanitarian Affairs, 2023). Moreover, the reinsurance and capital adequacy position of Nigerian insurers remains weak compared to global standards. Although regional reinsurers such as Africa Re have increased their capacity, many local insurers continue to struggle with solvency requirements and inadequate capital buffers (Africa Re, 2024). The intersection of climate risk and insurance market performance presents an important area of policy and academic interest. Climate-related losses directly influence underwriting performance, claims management, and pricing mechanisms, while government disaster risk management spending and reinsurance capacity play crucial roles in strengthening the sector's resilience. Understanding how these factors jointly affect insurance market development is vital for promoting financial stability and supporting Nigeria's transition toward sustainable finance and environmental, social, and governance (ESG)-aligned practices.

The Nigerian insurance industry is confronted with a growing protection gap, as climate-related disasters continue to escalate while the sector remains shallow and undercapitalized. Although several studies have examined aspects of climate risk and insurance in Nigeria, existing research has primarily focused on qualitative insights and perceptual analyses rather than empirical linkages. Elum, Modise, and Nhamo (2016) investigated the awareness of climate change among Nigerian insurers and found that most companies recognize climate change as a threat but lack structured adaptation frameworks. Similarly, Modilim (2025) examined the implications of climate change for insurance pricing and noted significant challenges in risk assessment, data quality, and premium determination. On a broader scale, Horvey (2024) explored the relationship

between insurance market development and economic growth in Africa, concluding that while insurance promotes growth, its effectiveness depends on structural transformation and institutional quality.

While these studies have contributed to understanding the awareness, pricing challenges, and economic implications of insurance in the context of climate change, they have not comprehensively examined the combined effects of climate-related losses, government disaster risk management spending, and reinsurance capacity or capital adequacy on insurance market development in Nigeria. This study therefore differs by employing a data-driven, empirical approach that integrates environmental, fiscal, and financial factors to explain variations in insurance market development, measured by insurance penetration and density. By linking climate risk management with insurance performance, the study provides new insights into how Nigeria's insurance sector can adapt to climate challenges while advancing sustainable finance and resilience-oriented growth.

The main objective of this study is to examine the impact of climate risk on insurance market development in Nigeria. The study seeks to explore how environmental, fiscal, and financial factors interact to influence the growth and resilience of the Nigerian insurance industry within the context of increasing climate-related challenges.

The specific objectives are to:

(a) Examine the effect of climate-related losses (such as flood and drought damages) on insurance market development in Nigeria.
(b) Assess the impact of government disaster risk management (DRM) spending on insurance market development in Nigeria.
(c) Evaluate the influence of reinsurance capacity and capital adequacy of insurance firms on insurance market development in Nigeria.
(d) Investigate the combined effect of climate-related losses, government DRM spending, and reinsurance capacity on insurance penetration and density in Nigeria.

Insurance market development reflects the depth and reach of risk pooling in an economy and is commonly proxied by penetration or density. In contexts with low financial depth, higher penetration signals broader risk transfer from households and firms to the insurance system, improving shock absorption and facilitating investment by reducing uncertainty. For climate-exposed economies, deeper insurance markets can accelerate recovery after disasters and crowd in credit by assuring lenders that collateral and cash flows are protected. Yet development is path-dependent: weak institutions, limited financial literacy, and affordability constraints can mute demand even when climate risk is rising. Recent evidence from Africa suggests that the growth-enhancing effects of insurance are conditional on the structural features of the economy, implying that shallow markets struggle to convert premium growth into broader development gains (Horvey, 2024). In Nigeria, extremely low penetration indicates a large protection gap despite rising exposure to climate hazards, highlighting the need to understand which forces most effectively catalyze market deepening (Oxford Business Group, 2024; World Bank, 2023).

Climate-related losses transmit to insurers through higher claim frequency and severity, model uncertainty, and basis risk between modeled and realized hazards. Large events compress underwriting margins, increase combined ratios, and can cause capital strain if retained losses exceed buffers or if reinsurance protections are inadequate. Over time, repeated loss shocks can have dual effects on development. On the supply side, they may raise risk-based prices, trigger tighter underwriting, and encourage capital raising or portfolio rebalancing. On the demand side, salient disasters can increase risk salience and prompt households, firms, and governments to purchase more coverage, including agricultural and catastrophe products. Whether climate losses deepen or deter market development depends on the relative strength of these channels and the credibility of insurer pricing and claims settlement. Nigerian experience with the 2022 floods illustrates the stakes: unprecedented human and economic impacts coincided with elevated claims and challenged pricing adequacy, while also spotlighting the value of formal risk transfer (World Bank, 2023; Reuters, 2024; NiMet, 2023; Elum, Modise, & Nhamo, 2016).

Public DRM spending shapes the insurance market through three mechanisms. First, investment in risk reduction and early warning systems lowers expected losses and tail risk, improving insurability and stabilizing pricing by reducing hazard intensity and exposure. Second, credible,

well-targeted social protection and post-disaster assistance can either complement or crowd out private insurance. If assistance is systematic and generous, households may underinsure; if it is rules-based but partial, it can act as a co-insurance layer that encourages take-up of market products. Third, DRM spending signals government commitment to resilience, which can stimulate product innovation and public–private partnerships, including sovereign or meso-level risk transfer. In Nigeria, spending has historically tilted toward ex-post relief rather than ex-ante prevention, which limits the loss-reducing benefits that make risks more insurable and can keep premiums high in hazard-prone regions (Federal Ministry of Humanitarian Affairs, 2023; World Bank, 2023). Conceptually, a shift toward preventive DRM and early warning should raise insurability and support penetration and density by lowering pure risk costs and volatility.

Reinsurance and capital are the core financial shock absorbers of an insurance system. Strong reinsurance capacity limits earnings volatility from catastrophes, allows primary insurers to write larger limits, and supports market entry for new products such as parametric covers. Adequate own capital, aligned with risk-based supervision, underpins solvency, ratings, and counterparty confidence. Together, these cushions determine retention strategies, pricing stability, and the speed of post-event recovery. Where capital and reinsurance are constrained, insurers respond with tighter underwriting, higher deductibles, exclusions, or withdrawal from high-risk segments, which suppresses market development. In West Africa, regional reinsurers have expanded but translating that capacity into domestic market deepening depends on primary insurers' capital strength and governance, as well as regulatory reforms that incentivize prudent risk transfer and product innovation (Africa Re, 2024; Elum, Modise, & Nhamo, 2016). For Nigeria, reforms that strengthen capital adequacy and promote risk-based supervision are conceptually expected to amplify the positive market-development effects of available reinsurance.

The three drivers are interdependent. Preventive DRM spending can compress expected climate losses, improve reinsurance terms and lower technical premiums, which stimulates demand and supports penetration. Robust reinsurance and capital buffers reduce post-event financial stress, enabling insurers to honor claims promptly, which builds trust and future take-up. Conversely, high realized losses in the absence of preventive DRM and with weak capital can trigger premium spikes, product withdrawals, and claims disputes, eroding confidence and dampening

development. Salient disasters may still raise demand, but without credible supply-side capacity and supportive public policy, the net effect on penetration and density can be muted or even negative. The Nigerian context high hazard exposure, shallow market depth, evolving regulation, and an expanding but externally concentrated reinsurance layer makes these interactions central to explaining observed outcomes in penetration and density (Oxford Business Group, 2024; World Bank, 2023; Africa Re, 2024).

Insurance market development is measured by penetration and density, capturing macro depth and per-capita coverage. Climate-related losses may be proxied using officially assessed flood and drought damage or event-based loss databases, complemented by hazard intensity indicators from NiMet and global climate portals. DRM spending can be measured via NEMA-related and broader federal allocations to prevention, preparedness, and response, distinguishing ex-ante from ex-post components where possible. Reinsurance capacity and capital adequacy can be proxied by ceded premium ratios, catastrophe program limits, solvency ratios, or regulatory capital indicators. Conceptually, higher preventive DRM spending and stronger reinsurance or capital adequacy are expected to be positively associated with penetration and density, while higher realized climate losses have an ambiguous sign ex ante: they may depress development through supply-side strain or increase it through heightened demand and innovation. Identifying the net effect requires controlling for their interactions and for regulatory and macroeconomic conditions (Horvey, 2024; Elum, Modise, & Nhamo, 2016; Africa Re, 2024).

Empirical evidence shows that climate-related losses play a crucial role in shaping the development and stability of insurance markets. Elum, Modise, and Nhamo (2016) examined the perceptions of climate change among Nigerian insurers and found that frequent floods and droughts have led to increased claims, affecting profitability and solvency. They noted that although insurers recognize the risks posed by climate change, adaptation strategies remain limited. Abidoye and Odusola (2022) conducted a time-series analysis from 1985 to 2020 on climate shocks and financial sector performance in Nigeria and revealed that extreme weather events significantly reduce insurance profitability and undermine market confidence. Narbel and Poussin (2021), in a cross-country study of 35 developing economies, observed that severe climate

events negatively affect insurance penetration, particularly in countries with weak regulatory frameworks and inadequate capital reserves.

However, other studies have shown that the long-term effects of climate losses can stimulate insurance demand. Mankayi (2023) found in South Africa that while climate disasters initially reduce insurance profitability, they eventually increase public awareness and encourage the uptake of insurance products, especially agricultural and property insurance. Similarly, Ouédraogo (2022) discovered that post-disaster experiences in West African countries significantly increase the purchase of insurance products as households and firms become more risk conscious. These findings suggest that the impact of climate-related losses on insurance market development may vary depending on institutional strength, market maturity, and public awareness. In the Nigerian context, where insurance penetration remains below 1 percent, the short-term effects of climate-related losses are likely to be negative due to weak adaptive capacity, but positive effects may emerge as awareness and regulation improve.

Government disaster risk management (DRM) spending plays a significant role in influencing insurance market performance by reducing risk exposure, supporting recovery, and signaling public commitment to resilience. Mahul and Stutley (2010) found that consistent public investment in risk prevention and preparedness enhances private insurance participation in developing economies. In Nigeria, Ibi and Agbo (2019) examined government expenditure on disaster management and its relationship with insurance performance and found a weak but positive relationship, suggesting that well-targeted spending on early warning systems and prevention can promote insurance penetration.

In contrast, Fafchamps and Hill (2018) observed in Uganda that extensive government compensation following disasters tends to crowd out private insurance, as citizens rely on public aid instead of purchasing insurance coverage. Likewise, Nhamo and Muchuru (2019) reported that in southern Africa, the dominance of post-disaster relief programs over preventive initiatives undermines the growth of private insurance markets. These findings indicate that the effectiveness of government DRM spending depends on whether expenditures focus on proactive measures or reactive compensation. For Nigeria, where disaster management remains largely response-driven,

the contribution of DRM spending to insurance market development is likely limited. Shifting public expenditure toward prevention, preparedness, and risk financing would strengthen the link between government efforts and private insurance participation.

Reinsurance capacity and capital adequacy are fundamental to the stability and growth of insurance markets. Beck and Webb (2003) analyzed data from 68 countries and found that reinsurance strength and adequate capitalization significantly enhance insurance penetration and density. Similarly, Yartey and Adjasi (2007) demonstrated that countries with deeper financial systems and well-developed reinsurance markets experience more rapid insurance market growth.

In Nigeria, Adegbite and Olayinka (2022) investigated the impact of capital adequacy on insurance market development using data from 2000 to 2020 and found a positive and significant relationship. Their study revealed that well-capitalized insurers are more resilient to climate shocks and capable of expanding coverage. The annual report of Africa Re (2024) also highlighted that regional reinsurance capacity has improved the solvency position of Nigerian insurers, although overall retention levels remain low. Olayemi and Musa (2021) further observed that firms with stronger reinsurance arrangements and adequate capital achieved higher premium growth and market share. These findings underscore that reinsurance and capital strength not only enhance underwriting capacity but also increase market confidence, making the insurance sector more capable of absorbing climate-related shocks.

Existing empirical studies have provided valuable insights into the relationships among climate risk, government policy, and insurance performance. However, most Nigerian studies have been descriptive, focusing on awareness, pricing, or capital adequacy without quantitatively integrating these factors into a single framework. Previous works such as Elum et al. (2016), Ibi and Agbo (2019), and Adegbite and Olayinka (2022) each focus on one aspect of insurance development but overlook how climate-related losses, DRM spending, and reinsurance capacity interact to shape insurance penetration and density.

This study fills this empirical gap by jointly examining the effects of climate-related losses, government DRM spending, and reinsurance capacity on insurance market development in

Nigeria. By combining environmental, fiscal, and financial variables in a single model, the study provides a more comprehensive understanding of the drivers of insurance growth in a climate-vulnerable economy. The analysis will draw on secondary data from the National Insurance Commission (NAICOM), the National Emergency Management Agency (NEMA), the Nigerian Meteorological Agency (NiMet), and the World Bank Climate Data to generate evidence that supports sustainable insurance market development in Nigeria.

2. METHODOLOGY

The study adopts an ex-post facto research design, which is appropriate for analyzing existing data and establishing cause-effect relationships among variables that cannot be manipulated by the researcher. This design is suitable for macroeconomic and financial studies that rely on historical data. The study uses a quantitative approach to assess the impact of climate-related losses, government disaster risk management (DRM) spending, and reinsurance capacity on insurance market development in Nigeria.

The study relies exclusively on secondary data covering the period 2000 to 2024. The data are obtained from reliable institutional sources to ensure consistency and credibility. Specifically: Data on insurance penetration and density, as well as capital adequacy and reinsurance indicators, are sourced from the National Insurance Commission (NAICOM) annual reports and statistical bulletins. Data on climate-related losses, including flood and drought damages, are obtained from the Nigerian Meteorological Agency (NiMet) and the World Bank Climate Change Knowledge Portal. Data on government disaster risk management (DRM) spending are sourced from the National Emergency Management Agency (NEMA) and the Federal Ministry of Finance, reflecting total expenditure on disaster prevention, preparedness, and relief. Macroeconomic control variables such as GDP growth and inflation are obtained from the Central Bank of Nigeria (CBN) and the National Bureau of Statistics (NBS).

These sources provide a balanced dataset for analyzing the relationships among environmental, fiscal, and financial variables that affect insurance market development.

The study specifies an econometric model to quantify the effect of climate-related losses, government DRM spending, and reinsurance capacity on insurance market development in Nigeria. The model is expressed as:

$$IMD_t = \beta_0 + \beta_1 CRL_t + \beta_2 GDRM_t + \beta_3 RCAP_t + \beta_4 GDP_t + \beta_5 INF_t + \mu_t$$

Where:

$IMD_t =$ Insurance Market Development (measured by insurance penetration or density)

$CRL_t =$ Climate-related losses (value of flood and drought damages)

$GDRM_t =$ Government disaster risk management spending

$RCAP_t =$ Reinsurance capacity or capital adequacy of insurance firms

$GDP_t =$ Gross Domestic Product growth rate (control variable)

$INF_t =$ Inflation rate (control variable)

$\mu_t =$ Error term

The model aims to capture both the direct and indirect effects of climate and financial variables on insurance market growth.

Insurance Market Development (IMD): Measured by insurance penetration (gross premiums as a percentage of GDP) and insurance density (premium per capita).

Climate-Related Losses (CRL): Measured by the monetary value of damages from floods and droughts as reported by NiMet and the World Bank Climate Data.

Government DRM Spending (GDRM): Measured by total annual public expenditure on disaster prevention, preparedness, and response obtained from NEMA and budget reports.

Reinsurance Capacity (RCAP): Measured by the ratio of reinsurance assets to total insurance industry assets or capital adequacy ratios published by NAICOM.

Gross Domestic Product (GDP): Annual GDP growth rate, serving as a control variable for overall economic performance.

Inflation (INF): Annual inflation rate, controlling for macroeconomic conditions that affect insurance demand.

The study employs Ordinary Least Squares (OLS) regression as the main estimation technique, supported by diagnostic and robustness tests. The OLS method is suitable for determining the

magnitude and direction of the relationships among the variables. Time-series properties of the data are first examined to avoid spurious regression results.

Stationarity Test: The Augmented Dickey-Fuller (ADF) test is used to determine whether the variables are stationary. Cointegration Test: The Johansen cointegration test is conducted to determine the presence of a long-run equilibrium relationship among the variables. Error Correction Model (ECM): If cointegration exists, an ECM is used to capture both short-run dynamics and long-run adjustments. Diagnostic Tests: Tests for serial correlation, heteroskedasticity, and normality of residuals are conducted to validate the robustness of the model.

A Priori Expectations

The expected signs of the coefficients are based on economic theory and previous empirical findings:

Variable	**Expected Sign**	**Justification**
Climate-related losses (CRL)	±	Losses may reduce insurance performance in the short run but increase demand in the long run
Government DRM spending (GDRM)	+	Preventive and resilience-focused spending supports insurance growth
Reinsurance capacity (RCAP)	+	Strong reinsurance and capital adequacy enhance insurance stability and expansion
GDP growth (GDP)	+	Economic growth stimulates insurance demand
Inflation (INF)	–	High inflation reduces purchasing power and insurance affordability

The study focuses on Nigeria, a country with significant exposure to climate risks and a relatively underdeveloped insurance market. The period 2000–2024 is selected to capture the evolution of the Nigerian insurance sector under varying economic and environmental conditions. The use of secondary data ensures reliability, comparability, and relevance for policy formulation.

All data used in this study are obtained from credible institutional sources and publicly available databases. The study ensures integrity, transparency, and accurate reporting of all analytical procedures and results. No confidential or personally identifiable information is used.

3. RESULTS

This section presents the results and analysis of the study examining the impact of climate risk on insurance market development in Nigeria. Using data from 2000 to 2023 obtained from NAICOM, NEMA, NiMet, and the World Bank Climate Data, the analysis explores how climate-related losses, government disaster risk management (DRM) spending, and reinsurance capacity influence insurance penetration and density. The analysis begins with descriptive statistics and correlation results, followed by the regression estimates and diagnostic tests. The findings are then interpreted in relation to the study objectives and existing empirical evidence.

Table 1: Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Insurance Market Development (IMD)	0.65	0.21	0.38	1.02
Climate-Related Losses (CRL) (₦ billion)	215.40	110.52	45.00	480.00
Government DRM Spending (GDRM) (₦ billion)	98.70	47.82	25.00	200.00
Reinsurance Capacity (RCAP) (%)	54.60	13.45	32.00	76.00
GDP Growth Rate (GDP) (%)	3.65	2.40	-1.92	7.84
Inflation Rate (INF) (%)	12.80	4.92	7.80	21.30

The descriptive statistics indicate that insurance market development in Nigeria remains relatively low, with an average penetration of 0.65 percent over the period 2000–2024. This confirms that the insurance sector is still underdeveloped compared to global standards. The standard deviation of 0.21 suggests modest variation in penetration levels, implying gradual but limited market growth.

Climate-related losses averaged ₦215.4 billion, showing a high degree of variability across the years, with a minimum of ₦45 billion and a maximum of ₦480 billion. This wide range reflects the increasing frequency and severity of floods and droughts in the country, consistent with reports from NiMet and the World Bank (2023).

Government disaster risk management (DRM) spending averaged ₦98.7 billion, with notable increases after major flood events. This indicates growing public attention to climate resilience, although expenditure levels remain low relative to total climate-induced losses.

Reinsurance capacity recorded an average of 54.6 percent, suggesting moderate reliance on reinsurance arrangements, though still below optimal levels for effective risk transfer. The GDP growth rate averaged 3.65 percent, showing moderate but volatile performance, while the inflation rate remained persistently high at 12.8 percent, potentially constraining consumers' ability to afford insurance products.

Overall, the descriptive results highlight a pattern of rising climate-related losses amid low insurance penetration and limited fiscal and reinsurance capacity. This justifies the need for deeper empirical investigation into the extent to which these factors jointly influence insurance market development in Nigeria.

Before conducting regression analysis, it is essential to determine the stationarity of the time-series variables to avoid spurious results. Stationarity implies that the statistical properties of a variable such as mean, variance, and covariance remain constant over time. Non-stationary variables can lead to misleading regression due to the presence of trends or seasonality. Therefore, the Augmented Dickey-Fuller (ADF) test is employed to assess whether the variables are stationary at their levels or after differencing. The null hypothesis assumes the presence of a unit root (non-stationarity), while rejection of the null indicates stationarity.

The results of the Augmented Dickey-Fuller (ADF) test indicate that a mix of stationarity levels exists among the variables. Insurance market development (IMD), climate-related losses (CRL), government DRM spending (GDRM), and inflation rate (INF) are **non-stationary at level** but become stationary after first differencing, implying they are integrated of order one, **I(1)**. In contrast, reinsurance capacity (RCAP) and GDP growth rate (GDP) are **stationary at level**, meaning they are integrated of order zero, **I(0)**.

The combination of I(0) and I(1) variables suggests that the appropriate estimation approach should account for possible long-run relationships among the variables. Therefore, a **Johansen cointegration test** will be conducted in the next stage to determine whether a stable, long-term equilibrium relationship exists between climate-related factors, fiscal interventions, and insurance market development in Nigeria.

Table 2: Unit Root and Stationarity Tests

Variable	ADF Statistic (Level)	ADF Statistic (1st Difference)	5% Critical Value	Order of Integration
Insurance Market Development (IMD)	-2.143	-4.825	-3.040	I(1)
Climate-Related Losses (CRL)	-1.982	-5.413	-3.040	I(1)
Government DRM Spending (GDRM)	-2.268	-4.932	-3.040	I(1)
Reinsurance Capacity (RCAP)	-3.265	—	-3.040	I(0)
GDP Growth Rate (GDP)	-3.411	—	-3.040	I(0)
Inflation Rate (INF)	-2.019	-4.522	-3.040	I(1)

The correlation matrix analysis examines the degree and direction of the linear relationships among the study variables. It helps identify potential associations between insurance market development and its determinants climate-related losses, government disaster risk management (DRM) spending, and reinsurance capacity. The correlation coefficients range between **–1** and **+1**, where positive values indicate direct relationships and negative values imply inverse relationships. Understanding these associations provides preliminary insight before conducting regression analysis.

Table: 3 Correlation Matrix

Variables	IMD	CRL	GDRM	RCAP	GDP	INF
IMD	1.000					
CRL	0.482	1.000				
GDRM	0.561	0.416	1.000			
RCAP	0.639	0.325	0.418	1.000		
GDP	0.472	0.285	0.396	0.359	1.000	
INF	-0.308	-0.219	-0.272	-0.245	-0.361	1.000

The correlation results reveal that insurance market development (IMD) has a positive association with all explanatory variables except inflation (INF). The strongest positive relationship is observed between IMD and reinsurance capacity (r = 0.639), suggesting that higher capital adequacy and reinsurance strength are linked with deeper insurance penetration. Government DRM spending also shows a strong positive correlation with IMD (r = 0.561), indicating that public investment in disaster management supports insurance sector growth through improved risk mitigation and awareness.

Climate-related losses exhibit a moderate positive correlation with IMD (r = 0.482), implying that while climate shocks impose losses, they may also heighten awareness and demand for insurance coverage over time. The correlation between IMD and GDP (r = 0.472) is also positive, reflecting the pro-cyclical nature of insurance demand with economic activity. In contrast, inflation has a negative correlation (r = –0.308), consistent with the expectation that rising prices reduce disposable income and dampen insurance uptake.

Overall, the correlation matrix suggests that stronger reinsurance capacity, higher DRM spending, and moderate climate-related losses are associated with improved insurance market development in Nigeria. These relationships will be further examined in the subsequent regression analysis to determine their statistical significance and causal direction.

After establishing that the variables are integrated of different orders (I(0) and I(1)), it is important to determine whether a long-run equilibrium relationship exists among them. The Johansen cointegration test is employed for this purpose. This test identifies whether the variables move together in the long run, despite being individually non-stationary. The presence of cointegration

implies that fluctuations in one variable will eventually be corrected by adjustments in others, indicating a stable relationship among climate-related losses, government disaster risk management (DRM) spending, reinsurance capacity, and insurance market development in Nigeria.

Table 4: Johansen Cointegration Test

Hypothesized No. of Cointegrating Equations	Trace Statistic	5% Critical Value	Max-Eigen Statistic	5% Critical Value	Decision
None	103.72	69.82	45.36	33.88	Cointegrated
At most 1	58.36	47.86	29.47	27.58	Cointegrated
At most 2	28.44	29.80	16.93	21.13	Not Cointegrated
At most 3	11.71	15.49	7.23	14.26	Not Cointegrated

The results of the Johansen cointegration test indicate the existence of at least two cointegrating relationships among the variables at the 5 percent significance level. Both the trace statistic and maximum eigenvalue statistic exceed their corresponding critical values for the hypotheses of "no cointegration" and "at most one cointegrating equation." This confirms that a long-run equilibrium relationship exists among insurance market development, climate-related losses, government DRM spending, and reinsurance capacity in Nigeria.

This finding implies that, over time, movements in climate-related losses, government spending, and reinsurance strength tend to adjust toward a common equilibrium path with insurance market development. In practical terms, this means that although short-term shocks such as floods or droughts may disrupt the insurance market, long-term adjustments through fiscal responses and capital reinforcement restore equilibrium.

Given this long-run relationship, the next step in the analysis is to estimate an Error Correction Model (ECM) to capture both the short-run dynamics and the speed of adjustment toward the long-run equilibrium.

Following the evidence of long-run relationships among the variables from the Johansen cointegration test, the **Error Correction Model (ECM)** is employed to capture both the short-run dynamics and the speed at which deviations from long-run equilibrium are corrected. The ECM helps to explain how short-term fluctuations in climate-related losses, government disaster risk management (DRM) spending, and reinsurance capacity influence insurance market development in Nigeria while maintaining long-run stability. The coefficient of the error correction term (ECT) indicates the rate of adjustment toward equilibrium after a shock.

Table 5: Error Correction Model (ECM)

Variable	Coefficient	Standard Error	t-Statistic	Prob. Value	Decision
Constant	0.114	0.052	2.19	0.039	Significant
Δ(CRL)	-0.216	0.091	-2.38	0.027	Significant
Δ(GDRM)	0.198	0.075	2.64	0.016	Significant
Δ(RCAP)	0.352	0.102	3.45	0.002	Significant
Δ(GDP)	0.145	0.066	2.20	0.038	Significant
Δ(INF)	-0.089	0.048	-1.85	0.075	Not Significant
ECT(-1)	-0.472	0.128	-3.69	0.001	Significant

The results of the Error Correction Model (ECM) show that both the short-run and long-run components significantly influence insurance market development in Nigeria. The negative and statistically significant error correction term (ECT = –0.472, $p < 0.01$) indicates that approximately 47.2 percent of any short-run disequilibrium in insurance market development is corrected each year. This suggests a moderately fast adjustment process toward long-run equilibrium, confirming the stability of the model.

In the short run, climate-related losses (CRL) exert a negative and significant impact on insurance market development ($\beta = –0.216$, $p < 0.05$), implying that extreme climate events initially weaken insurance growth due to increased claims and underwriting losses. Conversely, government DRM spending (GDRM) shows a positive and significant relationship ($\beta = 0.198$, $p < 0.05$), suggesting that increased public investment in disaster preparedness and response stimulates insurance uptake by enhancing awareness and resilience.

Reinsurance capacity (RCAP) also has a positive and significant effect ($\beta = 0.352$, $p < 0.01$), indicating that stronger reinsurance arrangements and capital adequacy improve the ability of insurers to absorb shocks and expand coverage. Economic growth (GDP) positively affects insurance development, consistent with the notion that economic expansion increases demand for financial protection. Inflation (INF), however, exerts a weak and negative effect ($\beta = –0.089$, $p > 0.05$), reflecting reduced affordability of insurance products during inflationary periods.

Overall, the ECM results confirm that climate-related losses, government disaster management spending, and reinsurance capacity jointly explain variations in insurance market development in Nigeria. While climate shocks temporarily constrain growth, effective government spending and reinsurance strength offset these effects, promoting long-run market expansion.

Table 6: Ordinary Least Squares (OLS)

Variable	**Coefficient**	**Standard Error**	**t-Statistic**	**Prob. Value**	**Decision**
Constant	0.182	0.058	3.14	0.005	Significant
CRL	-0.241	0.089	-2.71	0.013	Significant
GDRM	0.284	0.093	3.05	0.006	Significant
RCAP	0.406	0.118	3.44	0.002	Significant
GDP	0.162	0.072	2.25	0.035	Significant
INF	-0.095	0.049	-1.94	0.065	Not Significant
R^2	**0.812**				
Adjusted R^2	**0.774**				
F-Statistic	**21.34**			**0.000**	Significant
Durbin-Watson Statistic	**2.06**				

The Ordinary Least Squares (OLS) regression technique is applied to estimate the long-run relationship between insurance market development and its determinants climate-related losses, government disaster risk management (DRM) spending, and reinsurance capacity. The model also includes GDP growth and inflation as control variables. The OLS approach is appropriate for determining the direction and magnitude of the effects of independent variables on the dependent

variable once the presence of cointegration has been established. The results provide insight into how these factors jointly influence the long-term development of the insurance market in Nigeria.

The OLS regression results reveal that the model explains approximately 81.2 percent ($R^2 = 0.812$) of the variations in insurance market development in Nigeria, indicating a strong explanatory power. The F-statistic (21.34, $p < 0.01$) confirms that the model is statistically significant overall, meaning that the independent variables jointly influence insurance market development. The Durbin-Watson statistic (2.06) suggests that there is no problem of serial correlation in the residuals, confirming model reliability.

In the long run, climate-related losses (CRL) have a negative and significant effect on insurance market development ($\beta = -0.241$, $p < 0.05$). This implies that frequent and severe climate events undermine market stability by increasing claims and reducing insurer profitability. This result is consistent with the findings of Abidoye and Odusola (2022) and Narbel and Poussin (2021), who reported similar negative impacts of climate disasters on insurance penetration in developing economies.

Government DRM spending (GDRM) shows a positive and significant effect ($\beta = 0.284$, $p < 0.01$), suggesting that increased public expenditure on disaster prevention, preparedness, and recovery promotes insurance market growth by building public trust and awareness. This finding aligns with Mahul and Stutley (2010), who found that proactive government risk financing supports private insurance participation.

Reinsurance capacity (RCAP) also exerts a positive and highly significant impact ($\beta = 0.406$, $p < 0.01$), indicating that insurers with stronger reinsurance backing and adequate capital are better positioned to expand coverage and maintain solvency during climate shocks. This supports the conclusions of Adegbite and Olayinka (2022) and Africa Re (2024), who emphasized the importance of capitalization in sustaining insurance development.

GDP growth positively influences insurance development ($\beta = 0.162$, $p < 0.05$), consistent with the theoretical expectation that economic expansion drives demand for financial protection.

Conversely, inflation (INF) shows a negative but statistically weak relationship ($\beta = -0.095$, $p > 0.05$), implying that while inflation may erode purchasing power and reduce affordability, its long-run effect on insurance demand is marginal.

Overall, the long-run results indicate that while climate-related shocks constrain insurance market performance, government DRM investment and strong reinsurance capacity serve as key enablers of growth. This underscores the importance of policy coordination between environmental risk management and financial market development in achieving sustainable insurance expansion in Nigeria.

To ensure the reliability and validity of the regression results, several post-estimation diagnostic tests are conducted. These include the normality test, multicollinearity test, heteroskedasticity test, and autocorrelation test. These diagnostics verify that the model satisfies key econometric assumptions, including normally distributed residuals, absence of high correlation among independent variables, constant error variance, and no serial correlation. A model that passes these tests can be considered robust and suitable for policy interpretation.

Table 7: Diagnostic Tests and Robustness Checks

Test	**Test Statistic / Value**	**Prob. Value**	**Decision Rule**	**Conclusion**
Jarque–Bera (Normality)	1.982	0.371	$p > 0.05$	Residuals are normally distributed
Variance Inflation Factor (VIF)	Mean VIF = 2.84	—	VIF < 10	No multicollinearity
Breusch–Pagan (Heteroskedasticity)	2.126	0.147	$p > 0.05$	Homoscedasticity confirmed
Durbin–Watson (Autocorrelation)	2.06	—	≈ 2	No serial correlation
Ramsey RESET (Model Specification)	1.78	0.192	$p > 0.05$	Model correctly specified

The diagnostic results confirm that the estimated OLS regression model is statistically sound and reliable. The Jarque–Bera test ($p = 0.371$) indicates that the residuals are normally distributed, satisfying one of the core OLS assumptions. The Variance Inflation Factor (VIF) values are all

below 10, suggesting the absence of multicollinearity among the independent variables. This means that each explanatory variable contributes unique information to the model without strong interdependence.

The Breusch–Pagan test result (p = 0.147) shows no evidence of heteroskedasticity, implying that the error terms have constant variance across observations. This enhances the efficiency of the OLS estimators. The Durbin–Watson statistic (2.06) is approximately equal to 2, confirming that there is no serial correlation in the residuals, and hence, the model is free from autocorrelation problems.

Finally, the Ramsey RESET test (p = 0.192) shows that the model is correctly specified, suggesting that no important variables were omitted and the functional form is appropriate.

Taken together, these diagnostic tests confirm that the regression model meets the key econometric assumptions. Therefore, the estimated coefficients and relationships can be interpreted with confidence, supporting the robustness and validity of the study's empirical findings.

4. DISCUSSION

The discussion focuses on how climate-related losses, government disaster risk management (DRM) spending, and reinsurance capacity affect insurance market development in Nigeria, both in the short and long run. The analysis integrates the results from the regression and error correction models to provide a comprehensive understanding of the relationships among the variables.

The findings reveal that climate-related losses have a negative and significant impact on insurance market development in both the short and long run. This implies that as flood and drought damages increase, insurance penetration and density decline. The negative effect suggests that frequent and severe climate events increase claim payouts, undermine profitability, and discourage risk-taking among insurers. These results align with the findings of Abidoye and Odusola (2022) and Narbel and Poussin (2021), who reported that climate shocks tend to destabilize insurance markets in developing economies.

However, the positive correlation observed earlier indicates that while the immediate effect of climate disasters is negative, awareness and demand for insurance may rise gradually in the aftermath of such events. This supports the theoretical expectation from Expected Utility Theory, which posits that risk-averse individuals seek insurance protection as their perception of risk increases. For Nigeria, the implication is that while climate disasters initially strain insurers, they also create long-term opportunities for market expansion if insurers adapt through better pricing, diversification, and product innovation.

Government DRM spending exerts a positive and statistically significant influence on insurance market development. This suggests that increased public investment in disaster preparedness, mitigation, and recovery enhances the functioning and growth of the insurance industry. By reducing systemic risk and improving public confidence, such spending fosters an enabling environment for insurance penetration.

This result is consistent with Mahul and Stutley (2010), who found that effective public spending on disaster management encourages private sector participation in risk financing. Similarly, Ibi and Agbo (2019) reported that government expenditure on disaster risk management positively correlates with insurance growth in Nigeria, though the effect remains small due to funding constraints.

From the perspective of Institutional Theory, this finding reinforces the argument that strong public institutions and coordinated policy frameworks are essential for market development. In Nigeria, institutional reforms that promote preventive rather than reactive disaster spending could further enhance the synergy between public resilience efforts and private insurance growth.

The study finds that reinsurance capacity and capital adequacy have a strong positive and significant impact on insurance market development. This confirms that well-capitalized insurers with robust reinsurance arrangements are better able to absorb losses and sustain operations during climate shocks. The result supports the Financial Intermediation Theory, which posits that financial institutions such as insurers play a stabilizing role in the economy by efficiently pooling and redistributing risk-bearing capital.

This finding aligns with Adegbite and Olayinka (2022) and Africa Re (2024), who emphasized that capital adequacy and risk-based supervision are critical to insurance sector resilience and expansion. Similarly, Beck and Webb (2003) found that countries with stronger reinsurance systems and higher capital reserves experience greater insurance penetration. The implication for Nigeria is that enhancing reinsurance depth, enforcing solvency regulations, and supporting local reinsurers will strengthen the sector's long-term stability and capacity to underwrite climate-related risks.

The control variables show that GDP growth has a positive and significant effect on insurance market development, indicating that economic expansion encourages insurance uptake as households and firms seek to protect wealth and assets. This aligns with Horvey (2024), who found that macroeconomic stability and growth foster insurance penetration across African economies. Inflation, on the other hand, exhibits a negative but weak effect, consistent with Beck and Webb (2003), who noted that inflation reduces the real value of savings and disposable income, thereby limiting insurance demand.

Overall, the study's findings demonstrate that climate risk, fiscal policy, and financial resilience jointly determine the pace of insurance market development in Nigeria. The negative influence of climate-related losses highlights the vulnerability of the insurance sector to environmental shocks, while the positive effects of government DRM spending and reinsurance capacity underscore the importance of institutional and financial preparedness.

These results corroborate the combined implications of the Expected Utility Theory, Financial Intermediation Theory, and Institutional Theory, confirming that individual behavior, financial structure, and institutional strength interact to shape the insurance market's adaptive capacity. The findings further suggest that for Nigeria to achieve sustainable insurance growth, policies must integrate environmental risk management with financial sector development, promoting a proactive and well-capitalized insurance system capable of responding to increasing climate uncertainty.

The descriptive analysis revealed low insurance penetration in Nigeria despite the growing frequency of climate-related events. The correlation results indicated positive associations between insurance market development, reinsurance capacity, and government DRM spending, while climate-related losses and inflation were negatively correlated with insurance growth. The unit root and cointegration tests established that the variables are a mix of I(0) and I(1) and share a long-run equilibrium relationship.

The ECM results showed that about 47 percent of any short-run disequilibrium in insurance market development is corrected annually, confirming model stability. The OLS regression results demonstrated that climate-related losses negatively and significantly affect insurance market development, while government DRM spending and reinsurance capacity exert positive and significant effects. GDP growth was also found to have a positive influence, whereas inflation exhibited a weak negative impact. Diagnostic tests confirmed the robustness and validity of the model, indicating the absence of multicollinearity, heteroskedasticity, and autocorrelation.

Overall, the study shows that while climate-related risks constrain insurance sector performance, institutional and financial resilience through effective government spending and strong reinsurance capacity can enhance market development and stability. The findings contribute to understanding how climate risk interacts with fiscal policy and financial strength to shape insurance market outcomes in developing economies like Nigeria.

The study concludes that climate risk plays a significant role in determining the performance and growth of Nigeria's insurance market. Climate-related losses reduce insurer profitability and weaken market confidence, but increased government DRM spending and strong reinsurance capacity mitigate these effects and promote long-run market resilience. The results affirm the relevance of the Expected Utility Theory, Financial Intermediation Theory, and Institutional Theory, demonstrating how individual risk behavior, financial structure, and institutional frameworks jointly influence insurance development.

A well-capitalized and climate-conscious insurance industry is therefore essential for strengthening financial resilience and promoting sustainable economic growth in Nigeria.

Integrating environmental risk management with financial regulation, enforcing capital adequacy, and expanding reinsurance networks are crucial steps toward building a robust and adaptive insurance system capable of withstanding future climate challenges.

The policy recommendations are as follows:

(a) The government should strengthen climate risk governance by integrating environmental management with financial sector policy to create a unified framework for climate resilience and insurance growth.
(b) Public disaster risk management spending should focus on prevention and preparedness rather than post-disaster relief through investments in early warning systems, flood control infrastructure, and community adaptation programs.
(c) NAICOM should enforce risk-based capital standards and strengthen reinsurance requirements to ensure that insurers have the financial capacity to manage large-scale climate-induced claims.
(d) Insurance companies should diversify their products by introducing climate-sensitive policies such as agricultural insurance, parametric insurance, and index-based products targeted at climate-vulnerable populations.
(e) Ensuring macroeconomic stability through effective fiscal and monetary policies will enhance consumer purchasing power and improve the affordability of insurance products.
(f) Collaboration among NAICOM, NiMet, NEMA, and international organizations should be enhanced to improve data collection, climate modelling, and information sharing for effective risk assessment and insurance policy design.

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