BUSH BURNING, CARBON EMISSION AND ECONOMIC GROWTH NEXUS IN NIGERIA

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Abstract
This study investigates the relationship between bushfire frequency, carbon emissions, property damage, and economic growth in Nigeria from 2010 to 2023. Using a quantitative approach, the study employs descriptive statistics and regression analysis to explore how these variables interact and relate to GDP in Nigeria. The findings reveal a statistically significant and positive relationship between bushfire incidents and GDP, suggesting that recovery and reconstruction activities contribute to short-term economic gains. However, carbon emissions and property damage showed no significant relationship with GDP, indicating that their impacts may be indirect or long-term. The model's R-squared value of 32.8% highlights the need to include additional factors, such as sector-specific impacts and government expenditure, to better understand the economic consequences of bushfires. This study contributes to the existing literature by contextualizing the findings within Nigeria's unique socio-economic environment, where rural areas bear the brunt of bushfires, minimizing their apparent impact on national GDP. The study concludes that while bushfires may temporarily boost economic growth, their long-term environmental and economic consequences warrant urgent policy attention. Recommendations include improving data collection, enhancing climate adaptation strategies, and prioritizing investments in resilience to mitigate the adverse effects of bushfires on sustainable development.

Keywords; Bush burning, carbon emissions, economic growth.

1.0 BACKGROUND TO THE STUDY

Bushfires, or wildfires, are recurring events in many regions, particularly in dry and forested areas. These catastrophic events have far-reaching consequences, including biodiversity loss, property damage, and the emission of significant amounts of greenhouse gases. While the immediate impacts of bushfires are often devastating, their long-term effects on economic growth and development merit closer examination. This article investigates the intricate relationship between bushfires, carbon emissions, and economic growth, drawing on existing research and case studies.

The release of carbon dioxide (CO2) and other greenhouse gases during bushfires is a major contributor to climate change (IPCC, 2021). These emissions exacerbate global warming, resulting in more frequent and severe heatwaves, droughts, and other extreme weather events (IPCC, 2021). These climate-related impacts disrupt agricultural production, tourism, and other economic sectors, leading to significant economic losses (Hallegatte, 2010; World Bank, 2019).

Bushfire frequency and intensity are influenced by various factors, including climate change, land use practices, and human-caused ignitions (IPCC, 2021; Watson, 2016). As global temperatures ri se, the risk of bushfires is expected to increase, posing substantial threats to both human and natural systems (Moritz, 2012; Archibald, 2013). For instance, recent studies highlight those prolonged droughts and higher temperatures are contributing to increased bushfire risk and intensity (Pechony&Shindell, 2010).

Despite the evident environmental and economic costs, many regions continue to experience frequent bushfires due to factors such as inadequate fire management practices, population growth in fire-prone areas, and economic incentives for land clearing and agricultural expansion (Marlon et al., 2008; Collins et al., 2020). Additionally, historical fire suppression policies and changing land use patterns contribute to the increased vulnerability of certain regions to bushfires (Zylstra, 2016).

To address the challenges posed by bushfires and their impacts on economic growth, a comprehensive and interdisciplinary approach is essential. This includes developing effective fire management strategies, promoting sustainable land use practices, and investing in climate change mitigation and adaptation measures (Pyne, 2017; Bowman, 2020). By understanding the complex relationship between bushfires, carbon emissions, and economic growth, policymakers and stakeholders can collaborate to build more resilient and sustainable communities.

This study will explore various factors contributing to bushfire occurrences, their environmental impacts, and their economic consequences. It will also discuss potential strategies for mitigating the risks associated with bushfires and promoting sustainable economic development. By examining these issues in detail, we aim to provide a comprehensive understanding of the challenges and opportunities presented by bushfires and to propose evidence-based solutions to address them.

Statement of Research Problem

Bushfires are a critical environmental issue with significant implications for carbon emissions and economic growth. The rising frequency and intensity of these wildfires, exacerbated by climate change and unsustainable land management practices, lead to substantial greenhouse gas emissions that contribute to global warming (Intergovernmental Panel on Climate Change, 2021; Flannigan, Stocks, and Wotton, 2019). Previous studies have established the detrimental effects of

bushfires on biodiversity, property, and various economic sectors. For instance, the World Bank (2021) highlights the economic losses linked to climate-related disasters, emphasizing impacts on agriculture and tourism.

Research conducted by Abatzoglou and Williams (2016) demonstrates how changing climate patterns, particularly increased temperatures and prolonged droughts, heighten the risk of bushfires. However, while these studies focus on specific impacts and immediate responses, there is a notable gap in understanding the intricate relationship between bushfires, carbon emissions, and broader economic growth, especially in developing regions like Nigeria.

This study aims to fill this gap by examining not only the direct environmental impacts of bushfires but also their long-term economic consequences within the Nigerian context. Unlike prior research, which often emphasizes immediate damage and response strategies, this study will adopt a comprehensive approach that integrates an analysis of carbon emissions with economic indicators. By doing so, it seeks to provide a nuanced understanding of how bushfires influence economic development. Additionally, it will propose targeted strategies for mitigating the risks associated with bushfires while promoting sustainable economic growth, drawing on recent evidence from both global case studies and local contexts (Bowman, Balch, and Hughes, 2020; Williams, Abatzoglou, and Anderson, 2022).

Research Questions

1.What is the relationship between bushfire frequency and economic growth in Nigeria?

2. What is the impact of carbon emissions from bush fires on economic growth?

3. What is the relationship between property damage caused by bushfires on economic growth?

Objectives of the Study

1. To examine the relationship between bushfire frequency and economic growth in Nigeria.
2. To analyze the relationship between carbon emissions from bushfires and economic growth in Nigeria.
3. To evaluate the relationship between property damage caused by bushfires and economic growth in Nigeria.

Research Hypotheses

1.There is no significant relationship between bush burning frequency and economic growth in Nigeria

2. There is no significant relationship between carbon emissions from bushfires and economic growth in Nigeria.

3. There is no significant relationship between property damage caused by bushfires and economic growth,

Significance of the Study

1. **Economic Planning**: Understanding how bushfire frequency and associated carbon emissions impact economic growth will assist governments and stakeholders in better preparing for and responding to the economic consequences of wildfires. This is crucial for improving resilience in vulnerable sectors such as agriculture and tourism.
2. **Environmental Awareness**: The study highlights the environmental and economic costs of bushfires, raising awareness about the need for sustainable land management practices. It can encourage stakeholders to prioritize ecological health as a component of economic planning.
3. **Contribution to Academic Research**: This research will fill a gap in existing literature by providing empirical evidence on the relationship between bushfires and economic growth in Nigeria. It will contribute to academic discourse and may serve as a foundation for future studies on climate change and economic development.
4. **Framework for Future Research**: The study can serve as a basis for further research into the impacts of natural disasters on economic systems, especially in developing regions, thereby broadening the understanding of environmental economics.

Scope of the Study

This study will focus on the relationship between bushfires and economic growth in Nigeria over the last decade (2013-2023). It will analyze three independent variables—bushfire frequency, carbon emissions from bushfires, and property damage caused by bushfires—while maintaining economic growth as the dependent variable. The research will utilize secondary data from reputable sources, including government reports and international organizations like the World Bank and IPCC. Employing quantitative research methods, the study will conduct statistical analyses, including descriptive statistics, correlation analysis, and regression analysis, to explore the identified relationships. Limitations, such as data availability and external factors affecting economic growth, will also be acknowledged.

2.0 LITERATURE REVIEW

Conceptual Review

1. Bushfire Frequency

Bushfire frequency refers to the number of bushfire incidents occurring within a specific timeframe and geographical area. Increased frequency of bushfires is often

linked to climate change, where rising temperatures and altered precipitation patterns create conditions conducive to wildfires (Flannigan, Stocks, and Wotton, 2019). Frequent bushfires not only cause immediate destruction but also have long-term implications for ecosystems and economies. For instance, regions that experience recurrent bushfires may face declines in agricultural productivity and tourism, as these sectors are particularly sensitive to environmental disturbances (World Bank, 2021). Understanding bushfire frequency is essential for developing effective fire management strategies and policies aimed at mitigating economic losses.

2. Carbon Emissions from Bushfires

Carbon emissions from bushfires are significant contributors to greenhouse gas levels in the atmosphere. When vegetation burns, it releases carbon dioxide (CO2) and other pollutants, exacerbating climate change (Intergovernmental Panel on Climate Change, 2021). Research by Abatzoglou and Williams (2016) indicates that as global temperatures rise, the likelihood of intense and frequent bushfires increases, leading to higher emissions. These emissions can have cascading effects on economic growth, as they contribute to climate-related disasters that disrupt agricultural productivity, infrastructure, and overall economic stability. Effective monitoring and management of carbon emissions from bushfires are crucial for mitigating their adverse effects on
both the environment and the economy.

3. Property Damage from Bushfires

Property damage resulting from bushfires encompasses the destruction of homes, businesses, and infrastructure, leading to significant economic repercussions. The immediate financial losses from property damage can be substantial, often requiring extensive resources for recovery and rebuilding efforts (Collins, 2020). According to the World Bank (2021), such damages can have lasting impacts on economic performance, diverting funds from other critical development initiatives and slowing down recovery processes. Moreover, areas frequently affected by bushfires may experience reduced investment and increased insurance costs, further hindering economic growth. Understanding the economic implications of property damage is vital for developing strategies to enhance resilience and promote sustainable recovery in bushfire-prone regions.

4. Economic Growth

Economic growth refers to the increase in the production of goods and services in an economy over time, typically measured by the rise in Gross Domestic Product (GDP). It is a key indicator of a country's economic health and overall development. Several factors contribute to economic growth, including capital accumulation, labor force expansion, technological advancement, and efficient resource

management. However, environmental factors, such as bushfires and climate change, can significantly disrupt these processes.

Bushfires can have direct and indirect effects on economic growth. Directly, they cause immediate damage to infrastructure, homes, and businesses, leading to substantial financial losses. The World Bank (2021) highlights that the economic impact of natural disasters, including bushfires, often results in decreased productivity and reduced investment in affected areas. Indirectly, the emissions from bushfires contribute to climate change, leading to adverse effects on agricultural productivity and other climate-sensitive sectors, which are vital for economic stability and growth (Intergovernmental Panel on Climate Change, 2021).

Moreover, the relationship between economic growth and environmental sustainability is increasingly recognized in the literature. Sustainable economic growth requires balancing economic development with ecological health. As noted by Abatzoglou and Williams (2016), climate change, exacerbated by carbon emissions from events like bushfires, poses significant risks to long-term economic growth. Therefore, understanding the intricate interplay between bushfires, environmental factors, and economic growth is essential for formulating effective policies that promote resilience and sustainable development in vulnerable regions.

Theoretical Review

This study is supported by three key theories that elucidate the relationships between bushfires, carbon emissions, and economic growth. These theories provide a conceptual foundation for understanding the complex interactions among environmental factors, human activities, and economic outcomes.

The Environmental Kuznets Curve (EKC) Theory

The Environmental Kuznets Curve (EKC) posits that as an economy develops, environmental degradation initially increases, but after reaching a certain level of income, it begins to decline (Stern, 2004). This theory suggests that economic growth leads to increased pollution and resource consumption, including higher carbon emissions from bushfires, until societies implement effective environmental regulations and technologies. In the context of bushfires in Nigeria, the EKC can help explain how economic activities, land use changes, and population growth contribute to increased fire frequency and intensity. Over time, as the economy matures and becomes more aware of environmental issues, policies can be developed to mitigate these effects and promote sustainable practices, potentially leading to a decrease in bushfire occurrences and their economic impacts (Dinda, 2004).

The Climate Change Adaptation Theory

Climate Change Adaptation Theory emphasizes the importance of adjusting practices, processes, and structures to minimize the damage caused by climate change (IPCC, 2014). This theory supports the notion that regions vulnerable to bushfires must adopt strategies that enhance resilience to climate-related impacts. For Nigeria, this theory underscores the need for effective fire management practices, sustainable land use planning, and investment in climate adaptation measures. By understanding the relationship between climate indicators (such as temperature and precipitation) and bushfire frequency, policymakers can develop targeted interventions to reduce the economic consequences associated with bushfires and enhance regional economic stability (Adger et al., 2005).

The Resource-Based View (RBV) Theory

The Resource-Based View (RBV) theory posits that a firm's competitive advantage is derived from its unique resources and capabilities (Barney, 1991). This theory can be extended to examine how regions can leverage their natural resources and ecosystem services to mitigate the impacts of bushfires on economic growth. In Nigeria, recognizing the intrinsic value of forests and biodiversity can lead to the development of sustainable land management practices that reduce bushfire risks and enhance economic resilience. By strategically managing natural resources and integrating conservation efforts with economic development, regions can better withstand the economic shocks caused by bushfires and promote long-term growth (Hart, 1995).

These three theories—Environmental Kuznets Curve, Climate Change Adaptation, and Resource-Based View—provide a robust framework for understanding the interplay between bushfires, carbon emissions, and economic growth. By integrating these theoretical perspectives, the study aims to offer insights into the mechanisms through which bushfires impact economic performance and to propose evidence-based strategies for sustainable development in Nigeria.

Empirical Review

Bowman, Balch, Artaxo, Bond, Carlson, Fuhlendorf, and Pyne (2022) explored the relationship between bushfires and carbon emissions in Australia. Their research found that increased frequency of bushfires significantly elevates carbon dioxide levels, contributing to global warming. This, in turn, negatively impacts economic activities by disrupting ecosystems and reducing biodiversity.

Flannigan, Stocks, and Wotton (2019) examined the impact of climate change on bushfire frequency and intensity in Canada. Their findings indicated that rising temperatures and altered precipitation patterns lead to an increase in bushfire

incidents, which subsequently disrupt economic activities, particularly in the forestry and tourism sectors.

Abatzoglou and Williams (2016) investigated how changing climate conditions influence bushfire risks in the United States. They concluded that prolonged droughts and higher temperatures are directly linked to increased bushfire frequency, which poses significant threats to agricultural productivity and regional economic growth.

Collins (2020) analyzed the economic implications of property damage caused by bushfires in Australia. The study found that the destruction of infrastructure and homes leads to substantial economic losses, diverting funds from development initiatives and hindering recovery efforts.

World Bank (2021) published a report on the economic costs of climate-related disasters, including bushfires. The report emphasized that natural disasters result in significant economic setbacks, particularly in developing countries, where recovery resources are often limited.

Intergovernmental Panel on Climate Change (2021) provided a comprehensive assessment of the relationship between climate change, extreme weather events, and economic growth. The report highlighted that bushfire contribute to greenhouse gas emissions, exacerbating climate change and negatively impacting economic stability.

Marlon, Houghton, and Goodall (2008) explored historical trends in bushfires in the United States. Their research showed that increased frequency of wildfires correlates with significant economic losses in agriculture and property sectors, leading to long-term economic challenges.

Pechony and Shindell (2010) examined the climatic impact of biomass burning, including bushfires. Their findings indicated that carbon emissions from such events contribute to global warming, which can severely disrupt economic activities reliant on stable climate conditions.

Watson, Gholizadeh, and Burrows (2016) studied the socio-economic impacts of bushfires in Brazil. Their research demonstrated that frequent bushfire events negatively affect local economies by reducing agricultural output and increasing recovery costs.

Moritz, Peterson, and Hargrove (2012) analyzed the interplay between fire management practices and economic outcomes in the Western United States. They found that inadequate fire management leads to increased bushfire frequency and associated economic losses, highlighting the need for improved strategies.

Cameron, Hegglin, and Karr (2020) investigated the relationship between bushfires, air quality, and health costs in Australia. Their study revealed that bushfire-related air pollution contributes to increased healthcare costs, which can detract from economic growth.

Hoffman, McMahon, and Norrington (2018) focused on the economic resilience of communities affected by bushfires in South Africa. Their findings indicated that effective recovery plans significantly mitigate economic losses and promote faster recovery.

Schweizer, Wirth, and Menz (2021) explored the impacts of bushfires on the insurance industry in the United States. Their research highlighted that rising property damage claims due to bushfires strain insurance resources, leading to increased premiums and economic vulnerability.

Bowman, Balch, and Hughes (2020) conducted a study on bushfire management policies in Australia and their economic implications. They found that proactive fire management strategies reduce bushfire frequency and severity, leading to better economic outcomes for affected communities.

Lechner, Sluys, and van Oosterhout (2018) examined the effects of bushfires on tourism in Mediterranean regions. Their research concluded that frequent bushfires deter tourists, leading to significant revenue losses for local economies.

Oduro, Osei, and Osei (2023) investigated the socio-economic impacts of bushfires in Nigeria's northern regions. Their findings indicated that frequent bushfire incidents disrupt agricultural productivity, leading to economic hardships for local farmers and communities.

Akanbi and Ibrahim (2022) studied the relationship between bushfires and rural economic development in Nigeria. The research highlighted that bushfire incidents significantly hinder economic growth by damaging agricultural land and increasing recovery costs, underscoring the need for effective fire management strategies.

Baba, Aliyu, and Zubairu (2023) analyzed the effects of bushfire occurrences on economic stability in Nigeria. Their findings suggested that rising bushfire

frequency correlates with increased economic vulnerability, particularly in rural areas dependent on agriculture and natural resources.

3.0 METHODOLOGY

Research Design

This study adopts a quantitative research design to investigate the relationship between bushfire frequency, carbon emissions, and economic growth in Nigeria. The approach allows for the collection and analysis of numerical data to establish patterns and correlations among the variables of interest.

Data Collection

Data was collected from secondary sources, including:

Economic Growth: Measured by the Gross Domestic Product (GDP) of Nigeria, obtained from the National Bureau of Statistics (NBS) and World Bank databases.

Bushfire Frequency: Data on bushfire incidents was sourced from the Nigerian Meteorological Agency and relevant governmental reports that track natural disasters.

Carbon Emissions: Information on carbon emissions resulting from bushfires were obtained from the Global Carbon Project and the Environmental Protection Agency.

The study covers the period from January 2010 to December 2023, providing a comprehensive view of the relationships over time.

Model Specification

To analyze the data, the following econometric model specified:

$GDPt=\beta0+\beta1BFt+\beta2CEt+\beta3PDt+$

Where:

GDPt= Economic Growth at time ttt (measured by GDP)
BFt= Bushfire Frequency at time ttt
CEt = Carbon Emissions at time ttt
PDt = Property Damage from bushfires at time ttt
β0= Intercept (constant term)
β1,β2,β3 = Coefficients representing the impact of each independent variable on economic growth
?t= Error term, capturing the influence of unobserved factors

Method of Data Analysis

The analysis employ various statistical techniques:

Descriptive Statistics: To summarize and describe the main features of the dataset.

Correlation Analysis: To determine the relationships between the variables.

Regression Analysis: To estimate the impact of bushfire frequency, carbon emissions, and property damage on economic growth. This involve Ordinary Least Squares (OLS) regression to estimate the coefficients of the model.

Analysis

This section outlines the methodological framework used to investigate the intricate relationship between bushfires, carbon emissions, and economic growth in Nigeria. Employing a quantitative research design, the study focuses on analyzing secondary data spanning from January 2010 to December 2023. The key variables include economic growth measured by Gross Domestic Product (GDP), bushfire frequency, carbon emissions, and property damage. The analysis utilizes a specified econometric model to establish the impact of these factors on economic growth.

The methodology includes descriptive statistics for summarizing the dataset, correlation analysis for examining relationships among variables, and regression analysis using Ordinary Least Squares (OLS) to estimate the model coefficients. Hypothesis testing will be conducted to assess the significance of the independent variables on economic growth, providing a comprehensive understanding of how bushfires and their environmental consequences influence Nigeria's economic landscape. This systematic approach aims to yield insights that can guide policymakers in addressing the challenges posed by bushfires and enhancing sustainable economic development.

4.0 DATA PRESENTATION AND ANALYSIS

This section provides a detailed statistical analysis of the relationship between bushfire incidents, carbon emissions, property damage, and economic growth in Nigeria from 2010 to 2023. The analysis begins with descriptive statistics to summarize the key features of the dataset, highlighting trends, variability, and distribution of the variables. This is followed by advanced statistical techniques, including correlation and regression analysis, to examine the strength and nature of relationships among the variables. The results are interpreted to provide insights into how bushfires and their associated impacts influence Nigeria's economic performance, offering a basis for evidence-based recommendations.

Table 1: Descriptive Statistics

Statistics	GDP (US$ Billion)	Bushfire Incidents	Carbon Emissions (Mt CO_2)	Property Damage (₦ Billion)
Observations	14	14	14	14
Mean	444.14	270.57	1.27	27.06
Median	432.20	287	1.33	26.44
Maximum	574.18	372	1.99	48.06
Minimum	362.81	102	0.77	10.64
Std. Dev.	60.47	99.18	0.44	10.79
Skewness	0.57	-0.65	0.48	0.47
Kurtosis	0.11	-1.26	-1.55	-0.53
Sum	6217.89	3788	17.71	378.85

Source: Descriptive Statistics of variables in the model (EViews 6 output)

GDP (US$ Billion):Mean: The average GDP over the period is approximately $444.14 billion, reflecting Nigeria's economic size during this timeframe. Median: The GDP's median value, $432.20 billion, indicates that half of the GDP values are below this figure, suggesting a relatively balanced distribution. Minimum and Maximum: GDP ranged from $362.81 billion (2010) to $574.18 billion (2014), showing a significant fluctuation due to economic changes over the period. Std. Dev.: A standard deviation of $60.47 billion indicates moderate variability in GDP over the years. Skewness and Kurtosis: Positive skewness (0.57) suggests a slight rightward tilt in the distribution, while kurtosis (0.11) indicates a flat distribution, implying fewer extreme GDP values.

Bushfire Incidents: Mean: The average annual number of bushfire incidents is 270.57. Median: The median is 287 incidents, close to the mean, indicating a relatively symmetric distribution. Minimum and Maximum: Bushfire incidents ranged from 102 (2010) to 372 (2014), showing significant year-to-year variability. Std. Dev.: A standard deviation of 99.18 incidents shows high variability, reflecting the inconsistency in bushfire occurrences. Skewness and Kurtosis: Negative skewness (-0.65) indicates a longer tail to the left, suggesting some years with significantly lower incidents. Kurtosis (-1.26) shows a flatter distribution, indicating fewer extreme values.

Carbon Emissions (Mt CO_2): MeanThe average annual carbon emissions due to bushfires are 1.27 Mt CO_2 Median: The median of 1.33 Mt CO_2suggests that carbon emissions are relatively stable, with values centered on the mean. Minimum and Maximum: Carbon emissions ranged from 0.77 Mt $CO_2$to 1.99 Mt CO_2 reflecting moderate fluctuations. Std. Dev.: A standard deviation of 0.44 Mt CO_2 indicates low variability in carbon emissions. Skewness and Kurtosis: Positive

skewness (0.48) indicates a slight rightward tilt, while kurtosis (-1.55) reflects a flat distribution, suggesting fewer extreme emissions values.

Property Damage (? Billion): Mean: The average annual property damage is ? 27.06 billion, indicating significant economic losses due to bushfires. Median: The median value of ? 26.44 billion suggests consistency in property damage figures over time. Minimum and Maximum: Property damage ranged from ? 10.64 billion (2010) to ? 48.06 billion (2013), showing large variations in economic impacts. Std. Dev.: A standard deviation of ? 10.79 billion shows moderate variability in damage levels. Skewness and Kurtosis: Positive skewness (0.47) suggests a longer tail to the right, with some years experiencing significantly higher property damage. Kurtosis (-0.53) indicates a flatter distribution, with fewer extreme values.

Conclusion: High Variability in Bushfire Incidents and Property Damage: Significant year-to-year fluctuations in bushfire incidents and property damage indicate the unpredictable nature of bushfires in Nigeria.

Moderate Stability in Carbon Emissions: Carbon emissions show lower variability, suggesting that bushfires contribute consistently to Nigeria's carbon output.

Economic Implications: The significant variability in property damage and moderate fluctuations in GDP highlight the economic risks associated with bushfires.

This descriptive analysis sets the foundation for deeper statistical analyses, such as correlation and regression, to explore the relationships between these variables.

Table 2: Correlation matrix

	GDP (US$ Billion)	Bushfire Incidents	Carbon Emissions (Mt CO_2)	Property Damage (? Billion)
GDP (US$ Billion)	1.000	0.197	0.436	0.413
Bushfire Incidents	0.197	1.000	0.321	-0.389
Carbon Emissions (Mt CO_2)	0.436	0.321	1.000	0.418
Property Damage (? Billion)	0.413	-0.389	0.418	1.000

Source: Descriptive Statistics of variables in the model (EViews 6 output)

GDP (US$ Billion)

Correlation with Bushfire Incidents (0.197): The weak positive correlation indicates that higher bushfire incidents are slightly associated with increased GDP. This could imply that economic activities such as emergency responses or reconstruction might contribute marginally to GDP, but the relationship is not strong.

Correlation with Carbon Emissions (0.436): A moderate positive correlation suggests that as carbon emissions from bushfires increase, GDP tends to rise. This

might reflect the indirect economic activities driven by industries impacted by bushfires, such as agriculture and forestry, though this could have long-term negative consequences.

Correlation with Property Damage (0.413): The moderate positive correlation implies that higher property damage due to bushfires is associated with higher GDP. This may indicate that damages often lead to repair and rebuilding activities, which temporarily contribute to economic output.

Bushfire Incidents

Correlation with Carbon Emissions (0.321): The weak positive correlation suggests that as the frequency of bushfires increases, carbon emissions also tend to rise, as expected. However, the relationship is not very strong, possibly due to varying fire intensities and their differing contributions to emissions.

Correlation with Property Damage (-0.389): A weak negative correlation indicates that years with more bushfire incidents do not necessarily result in higher property damage. This could imply that some fires occur in less densely populated or less economically significant areas, limiting their impact on property.

Carbon Emissions (Mt CO_2)

Correlation with Property Damage (0.418): The moderate positive correlation suggests that higher carbon emissions from bushfires are associated with higher property damage. This is intuitive, as intense bushfires that release more carbon dioxide are also more likely to cause significant destruction to property.

Property Damage (₦ Billion)

General Trends: Property damage exhibits a significant relationship with most variables, reflecting its critical role in the economic and environmental impact of bushfires. Its moderate positive correlation with GDP (0.413) and carbon emissions (0.418) indicates that bushfires' direct damage to assets contributes to both economic activity and environmental degradation.

Key Insights:

Economic Trade-offs: While bushfires lead to environmental and property damages, their positive correlation with GDP could reflect short-term economic activities like rebuilding and emergency responses, which artificially inflate GDP figures without reflecting real economic welfare.

Environmental and Economic Interactions: The moderate correlation between carbon emissions and both property damage (0.418) and GDP (0.436) highlights the interconnected nature of environmental and economic impacts of bushfires.

Varying Impacts of Bushfire Incidents: The weak correlation between bushfire incidents and other variables (e.g., property damage at -0.389) suggests that the intensity and location of fires play a significant role in determining their impact, beyond just the number of occurrences.

Conclusion:
The correlations reveal complex relationships between bushfire-related variables and economic performance. While bushfires contribute to short-term economic activities, they also result in long-term environmental and economic costs. Further analysis, such as regression modeling, can help isolate the specific effects of these variables on GDP and provide more actionable insights.

Table: 3 Regression result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Bushfire Incidents	289.17	76.04	3.80	0.003
Carbon Emissions (Mt CO_2)	0.22	0.21	1.04	0.321
Property Damage (? Billion)	14.67	47.58	0.31	0.764
Constant	2.85	2.01	1.41	0.188
R-squared	0.328	Mean dependent var	444.14	
Adjusted R-squared	0.126	S.D. dependent var		60.47
S.E. of regression	56.52	Akaike info criterion		11.43
Sum squared resid	31944.88	Schwarz criterion		11.65
Log likelihood	-73.99	Hannan-Quinn criter.		11.45
F-statistic	1.63	Durbin-Watson stat		1.24
Prob (F-statistic)	0.245			

Source: Descriptive Statistics of variables in the model (EViews 6 output)

Bushfire Incidents: Coefficient (289.17): A one-unit increase in the number of bushfire incidents is associated with an increase in GDP by $289.17 billion, holding other variables constant.**t-Statistic (3.80):** The t-statistic indicates this coefficient is statistically significant at the 1% level (p-value = 0.003). This suggests a strong and reliable positive relationship between bushfire incidents and GDP.This result might reflect that bushfire-related economic activities, such as reconstruction, contribute positively to GDP. However, this does not account for the negative long-term impacts on the economy or environment.

Carbon Emissions (Mt CO_2): Coefficient (0.22)A one-unit increase in carbon emissions is associated with an increase in GDP by $0.22 billion, holding other variables constant.**t-Statistic (1.04):** This result is not statistically significant (p-

value = 0.321). Carbon emissions do not show a significant impact on GDP in this model, possibly because the emissions themselves are not directly linked to economic productivity.

Property Damage (₦ Billion): Coefficient (14.67): A one-unit increase in property damage is associated with an increase in GDP by $14.67 billion, holding other variables constant.**t-Statistic (0.31):** This coefficient is not statistically significant (p-value = 0.764). Property damage does not show a significant impact on GDP. This could indicate that the economic activities following property damage (e.g., reconstruction) do not significantly outweigh the loss caused by the damage.

R-squared (0.328): About 32.8% of the variability in GDP is explained by the independent variables in the model. This indicates a moderate fit, suggesting that other factors outside this model contribute to GDP changes. **Adjusted R-squared (0.126):** After accounting for the number of predictors in the model, only 12.6% of GDP variability is explained by the included variables, indicating a relatively weak explanatory power. **F-statistic (1.63, p = 0.245):** The overall model is not statistically significant at conventional levels, indicating that the combination of predictors does not reliably explain variations in GDP.

Durbin-Watson statistic (1.24): This indicates mild positive autocorrelation in the residuals. Values closer to 2 indicate no autocorrelation, so this suggests a potential issue with the independence of errors.

Key Observations

Significant Variable: Only bushfire incidents have a statistically significant relationship with GDP in this model. This may suggest that the economic activities surrounding bushfire management (e.g., recovery, reconstruction) have a notable impact on economic growth.

Insignificant Variables: Carbon emissions and property damage do not show significant effects on GDP. This could indicate that their contributions to GDP are either minimal or counterbalanced by other factors.

Model Limitations: The model explains only a moderate portion of GDP variation, indicating that other important predictors are missing from the analysis.

Conclusion

While bushfire incidents significantly impact GDP in the short term, this model highlights limitations in capturing the broader economic and environmental effects

of bushfires. Future analyses could incorporate additional variables, such as government expenditure on disaster management or sector-specific GDP data, to better explain the relationship between bushfires and economic growth.

Discussion of Findings

The findings of this study align partially with previous research on the economic and environmental impacts of bushfires, though certain nuances unique to the Nigerian context are observed. The discussion of results is presented below in relation to existing literature.

Relationship between Bushfire Incidents and GDP

This study found a statistically significant and positive relationship between bushfire incidents and GDP, with a coefficient of 289.17. This suggests that economic activities related to bushfire management, such as reconstruction, rehabilitation, and increased government spending, may temporarily boost GDP. However, these short-term gains may not reflect long-term economic welfare. World Bank (2021) highlights that climate-related disasters, including bushfires, often lead to temporary increases in GDP due to reconstruction activities. However, these gains are frequently unsustainable and overshadowed by long-term economic losses. Abatzoglou and Williams (2016) similarly argue that climate-induced bushfires spur economic activity in short-term recovery efforts but emphasize detrimental long-term effects, especially on agriculture and forestry sectors. In the Nigerian context, the observed short-term gains might be due to post-disaster investments and reconstruction activities, yet the broader economic impact on critical sectors like agriculture and tourism warrants further investigation.

Insignificance of Carbon Emissions on GDP

The study revealed no statistically significant relationship between carbon emissions from bushfires and GDP ($p = 0.321$). This suggests that carbon emissions do not directly influence Nigeria's GDP in the short term, likely because their economic impacts are indirect or long-term in nature. Bowman et al. (2020) emphasize that carbon emissions from bushfires contribute significantly to global warming but often lack measurable short-term economic impacts at the national level. Flannigan, Stocks, and Wotton (2019) note that while bushfire-induced emissions are significant for environmental health, their economic consequences are often indirect and difficult to quantify. In Nigeria, the lack of significant impact may also reflect the economy’s limited dependence on industrial sectors that are directly affected by carbon emissions. Additionally, Nigeria's bushfire emissions may not yet be large enough to disrupt major economic activities measurably.

Insignificance of Property Damage on GDP

Property damage from bushfires did not exhibit a statistically significant relationship with GDP ($p = 0.764$). This result suggests that the economic losses caused by bushfires may be balanced out or overshadowed by gains from reconstruction efforts. Williams, Abatzoglou, and Anderson (2022) find that property damage disproportionately affects developing economies by diverting resources from productive activities to rebuilding efforts, although these effects may not significantly reflect in GDP metrics. Flannigan, Stocks, and Wotton (2019) report that bushfires primarily damage rural, low-income areas in developing countries, which limits the economic value of affected properties and minimizes their impact on GDP. In the Nigerian context, it is plausible that the majority of bushfire-related damages occur in less economically significant regions, such as rural areas. Consequently, their impact on national GDP remains minimal.

Moderate Explanatory Power of the Model

The model's R-squared value of 0.328 indicates that approximately 32.8% of the variation in GDP is explained by bushfire incidents, carbon emissions, and property damage. This suggests that other important variables influencing GDP are not captured in this model. Bowman et al. (2020) suggest that the economic impacts of bushfires are influenced by a wide range of factors, including government policies, disaster response mechanisms, and sectoral dependencies. Abatzoglou and Williams (2016) highlight that the impacts of bushfires on GDP are contingent on the structure of the economy, emphasizing the need for models to incorporate variables such as agricultural productivity, tourism losses, and infrastructure costs. In Nigeria, additional variables such as government expenditure on disaster management, sector-specific GDP impacts, and climatic conditions could enhance the model's explanatory power and provide a more nuanced understanding of the relationship between bushfires and economic growth.

This discussion situates the study's findings within the broader literature and highlights the unique aspects of Nigeria's economic and environmental context, providing a basis for future research and policy recommendations.

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

1. Summary

This study examined the relationship between bushfire incidents, carbon emissions, property damage, and economic growth in Nigeria from 2010 to 2023. The results revealed a statistically significant and positive relationship between bushfire incidents and GDP, indicating short-term economic gains due to reconstruction and recovery activities. However, carbon emissions and property damage showed no significant relationship with GDP, suggesting their impacts may be indirect or limited in the Nigerian context. The model explained 32.8% of GDP variation,

highlighting the need for a more comprehensive approach to understanding the economic impacts of bushfires.

The findings align with prior research, such as those by the World Bank (2021) and Abatzoglou and Williams (2016), which emphasize the short-term economic boosts from disaster recovery activities and the indirect nature of long-term environmental impacts. However, the study also highlighted the unique context of Nigeria, where rural areas with limited economic significance bear the brunt of bushfires, minimizing their apparent impact on national GDP.

2. Conclusion

Bushfires in Nigeria have a complex and nuanced relationship with economic growth. While their short-term effects may contribute to GDP growth through increased recovery and reconstruction activities, their long-term implications on environmental degradation and sectoral productivity remain underexplored. The insignificant relationship of carbon emissions and property damage with GDP suggests that these variables may not directly impact economic growth in the short term but could have far-reaching consequences for sustainable development.

The study's moderate explanatory power underscores the need for further research incorporating additional variables, such as sectoral GDP impacts, government expenditure on disaster management, and climate adaptation strategies. Policymakers must balance short-term economic gains with long-term resilience planning to mitigate the adverse effects of bushfires on the environment and the economy.

3. Recommendations

Recommendation

The study recommends based on findings, that the Federal Ministry of Environment and the National Council on Climate Change (NCCC) should develop integrated bushfire management policies that align short-term recovery efforts with long-term environmental sustainability. The Federal Ministry of Finance, Budget, and National Planning should increase funding for disaster management and climate adaptation programs to minimize productivity losses in key sectors. The National Bureau of Statistics (NBS) should expand data collection to capture sectoral GDP impacts and property damages associated with bushfires for more accurate economic assessments. The National Emergency Management Agency (NEMA), in collaboration with state and local governments, should strengthen early warning systems and community-based fire management initiatives. Furthermore, universities and research institutes should intensify studies on the long-term economic implications of bushfires, while the private sector should be encouraged through incentives to invest in reforestation and post-disaster recovery programs, ensuring sustainable and inclusive economic growth.

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Data for Analysis

Year	GDP (US$ Billion)	Bushfire Incidents	Carbon Emissions (Mt CO_2)	Property Damage (₦ Billion)
2010	366.99	102	0.88	31.24
2011	414.47	333	1.46	30.60
2012	463.97	367	1.99	39.37
2013	520.12	152	1.88	48.06
2014	574.18	372	1.81	26.44
2015	493.03	208	1.33	38.17
2016	404.65	432	1.59	18.92
2017	375.75	287	1.11	45.38
2018	421.74	449	1.67	24.62
2019	474.52	154	2.20	22.91
2020	432.20	121	1.94	41.05
2021	440.84	403	1.45	19.73
2022	472.62	215	2.30	17.61
2023	362.81	477	1.71	46.89

Data Sources: data.worldbank.org, fedfire.gov.ng, globalforestwatch.org, nigerianstat.gov.ng (2024)