BLUE ECONOMY AND SUSTAINABLE DEVELOPMENT IN SUB-SAHARAN AFRICA

[1]Dare, Funso David (Ph.D.)
Department of Finance, Adekunle Ajasin University, Akungba-Akoko, Ondo StateNigeria
funso.dare@aaua.edu.ng

[2]Omosebi, Tolulope Ruth (Ph.D)
Department of Finance, School of Management Sciences, Babcock University
Ilishan-Remo, Ogun State, Nigeria
omosebit@babcock.edu.ng

ABSTRACT

This study investigated the effect of the blue economy on sustainable development in Sub-Saharan Africa, with a focus on hunger reduction as a critical development outcome.
Using Times Series data for 24 years (2000 – 2023), the study analyzed the relationship between credit for fishing investment (CFFI), expenditure on ocean and water maintenance (EOWN), marine production contribution to GDP (MPCG), and water transport investment (WTIN), employing the Generalized Method of Moments (GMM) technique to address non-stationarity and endogeneity concerns. Descriptive statistics revealed considerable variability and positive skewness across variables, suggesting unequal distribution of blue economy benefits within the region.
The GMM results showed that marine production contribution to GDP (MPCG) had a significant and substantial negative effect on hunger (coefficient = -21.4899, p = 0.0067), implying the vital role of marine productivity in achieving food security. Similarly, water transport investment (WTIN) demonstrated a statistically significant negative impact on hunger (coefficient = -0.0152, p = 0.0088), reiterating the importance of transport infrastructure in facilitating food distribution and economic connectivity. Conversely, credit for fishing investment (CFFI) and expenditure on ocean and water maintenance (EOWN) had negative and positive effects respectively on hunger, but these relationships were not statistically significant (p-values of 0.2109 and 0.2457).
The study concluded that while financial investments alone are insufficient, enhancing marine production and investing in transport infrastructure are critical levers for leveraging the blue economy to reduce hunger. It recommended the shifting of focus from input-based strategies to productivity-driven and infrastructure-led development pathways in blue economy strategies.

Key words: *Blue Economy, Sustainable Development, Marine Expenditures*

1. INTRODUCTION

The 21st century has seen a critical global shift toward inclusive and sustainable models of economic development, catalyzed by the urgent need to address environmental degradation, inequality, and climate change. Among these emergent frameworks, the Blue Economy has emerged as a transformative pathway, particularly for coastal and island nations, offering a sustainable utilization of oceanic and aquatic resources to stimulate economic growth, improve livelihoods, and maintain ecosystem health (Agunsoye et al., 2025). For Sub-Saharan Africa, where over 38 coastal and island states rely heavily on marine ecosystems for food, employment, and transportation, the Blue Economy holds vast promise in achieving the United Nations Sustainable Development Goals (SDGs), especially SDG 14, (Life Below Water)

The Blue Economy encompasses a wide array of activities, including fisheries and aquaculture, marine biotechnology, ocean energy, coastal tourism, and maritime transport. It emphasizes sustainable exploitation of ocean resources, promoting ecosystem resilience and economic equity (FAO, 2024a).

Unlike traditional ocean economy models that prioritize revenue generation with little regard for environmental impact, the Blue Economy focuses on restorative and regenerative approaches to marine resource governance. This paradigm is especially significant for Africa, which is disproportionately vulnerable to climate-induced threats such as coastal erosion, biodiversity loss, and rising sea levels (Potgieter, 2018).

Sub-Saharan Africa presents a paradox of vast marine resource endowments alongside persistent socio-economic challenges, including poverty, unemployment, food insecurity, and weak governance structures. The region's coastal and marine zones are home to over 30% of its population, with millions depending directly on ocean-related sectors for survival (The Commonwealth, 2023). However, the economic potential of these marine sectors has been largely underexploited due to limited investment, knowledge gaps, and inadequate policy alignment with sustainability principles.

Aquaculture, for instance, has grown in prominence in recent years as a climate-resilient sector with strong potential for income generation, nutrition, and trade (OECD, 2017). Yet, many Sub-Saharan nations lack cohesive policies, institutional frameworks, and infrastructure to scale such ventures sustainably. Moreover, Illegal, Unreported and Unregulated (IUU) fishing continues to plague regional waters, resulting in an estimated loss of over $2 billion annually in potential revenue (World Bank,2021) Without an integrated ocean governance model rooted in sustainability, these opportunities will remain unrealized, and marine ecosystems will continue to degrade.

According to FAO (2024). African countries such as Kenya, Seychelles, and South Africa have begun implementing national Blue Economy strategies, with varying degrees of success. Seychelles, notably, has emerged as a pioneer in blue finance, issuing the world's first sovereign Blue Bond in 2018 to support sustainable fisheries. These initiatives exemplify the potential for transformative marine policy, yet highlight the inconsistencies and capacity gaps across Sub-Saharan states in implementing holistic Blue Economy models.

The Blue Economy is inherently aligned with multiple SDGs, extending beyond Goal 14 (Life Below Water) to encompass Goal 1 (No Poverty) by supporting livelihoods and reducing income inequality in coastal communities; Goal 2 (Zero Hunger) by enhancing food systems through sustainable fisheries and aquaculture; Goal 8 (Decent Work and Economic Growth) by creating jobs in marine industries and Goal 13 (Climate Action) by promoting climate-resilient infrastructure and renewable marine energy.

However, the integration of Blue Economy strategies within national development plans in Sub-Saharan Africa is still at a nascent stage. Many countries have yet to institutionalize marine spatial planning (MSP), develop regulatory oversight mechanisms, or build the technological and human capacity required for blue innovation (Leea et al., 2021). Moreover, marine conservation efforts remain underfunded, with marine protected areas (MPAs) covering less than 10% of the region's territorial waters (UNEP, 2023).

Notwithstanding its promise, several structural and operational challenges hinder the actualization of the Blue Economy in Sub-Saharan Africa. These include policy fragmentation, funding deficits, weak enforcement, climate vulnerability and data gaps (Martínez-Vázquez, 2024). Most national policies on ocean management are spread across multiple agencies with poor coordination and overlapping mandates. Sustainable marine ventures require capital investments that are often inaccessible due to high-risk perceptions. Inadequate surveillance and monitoring mechanisms lead to unregulated exploitation of marine resources. Further, rising sea temperatures and ocean acidification threaten biodiversity and coastal infrastructure. To worsen the situation, lack of reliable data on fish stocks, pollution, and ecosystem health undermines planning and decision-making Leea et al. (2020). These barriers call for targeted policy reform, regional cooperation, and evidence-based research to support implementation of effective and equitable Blue Economy models.

While significant progress has been made in global discourse, scholarly analysis of the Blue Economy within Sub-Saharan Africa remains limited and fragmented. Existing studies often focus on isolated sectors, such as fisheries or maritime transport—without offering an integrated analysis of how these sectors contribute to long-term sustainable development. Additionally, there is inadequate exploration of institutional readiness, community participation, and the role of indigenous knowledge systems in marine resource governance. This study seeks to bridge these gaps by offering a comprehensive examination of the Blue Economy in Sub-Saharan Africa through the lens of sustainable development.

Specifically, the focus of the study on the Blue Economy and sustainable development in Sub-Saharan Africa is the critical puzzle of whether investments in ocean-based sectors have tangibly reduced poverty. Despite significant policy interest and investment growth, evidence suggests that the translation into poverty alleviation remains limited (Mensah et al., 2022; Nhemachena et al., 2023). The study probes how sectors like fisheries, water transport, and marine tourism have impacted livelihoods and wealth creation among vulnerable populations, exposing gaps between economic potential and inclusive growth outcomes (World Bank, 2021). Understanding these gaps is essential for refining sustainable development strategies in the region.

2. LITERATURE REVIEW

Blue Economy and Sustainable Development Nexus

The concept of the Blue Economy emerged prominently during the Rio+20 Conference in 2012, advancing the "Green Economy" narrative by explicitly focusing on marine and aquatic ecosystems.

Over the last decade, it has evolved into a multidimensional policy approach, combining economic development, environmental stewardship, and social equity. In Africa, this paradigm has been endorsed by multiple continental bodies, including the African Union (AU) which launched the Africa Blue Economy Strategy (ABES) in 2019 to guide member states toward coordinated action.

According to Nagy and Nene (2021), the concept of the Blue Economy emerged as a strategy to promote sustainable use of ocean and freshwater resources for economic growth, improved livelihoods, and ecosystem preservation. The Blue Economy framework encompasses diverse sectors, including fisheries, aquaculture, coastal tourism, marine biotechnology, and ocean energy.

The African Union's endorsement of the Africa Blue Economy Strategy (ABES) in 2019 marked a significant policy milestone, encouraging countries to harmonize national efforts toward ocean based sustainable growth (Guerreiro, 2022). However, despite regional momentum, there is substantial heterogeneity in how Sub-Saharan countries interpret and implement Blue Economy policies (Popoola & Olajuyigbe, 2023).

Aquaculture, often dubbed “blue agriculture,” has been central in driving food security and export revenue in Africa. According to Ngarava et al. (2023), aquaculture in Sub-Saharan Africa has the potential to replace overfished wild stocks and serve as a key protein source, particularly in countries like Nigeria, Kenya, and Ghana. Yet, the sector faces systemic challenges including lack of climate-resilient infrastructure, inconsistent policies, and poor technological adoption. FAO (2024) reports highlighted that many African aquaculture strategies remain fragmented, lacking comprehensive frameworks for risk management, especially in light of climate variability. In addition, Okoye and Sankey (2025) argue that aquaculture is often sidelined in national economic development plans, even though it is critical for meeting SDG 2 (Zero Hunger) and SDG8(Decent Work and Economic Growth).

A recurring theme across the literature is the fragmented governance and lack of policy coherence in managing ocean and marine resources. Guerreiro (2022) observed that overlapping mandates among ministries often create conflicts in regulatory enforcement, particularly in fisheries and coastal development. Moreover, many countries lack marine spatial planning (MSP) frameworks, which are crucial for preventing resource conflicts and conserving critical habitats (Karani, et al., 2023).

According to Popoola and Olajuyigbe (2023), Nigeria’s experience illustrates both potential and pitfalls: while national policies acknowledge the Blue Economy, weak enforcement and political instability continue to hinder progress. Furthermore, the lack of reliable data on fish stocks, pollution levels, and economic valuation of marine sectors severely impairs evidence-based decision-making (Mapfumo, 2022).

Figure 1 tracks Sub-Saharan Africa's Blue Economy indicators (2000–2023). Water Transport Investment shows the sharpest, consistent growth, reaching $1010 m by 2023. Ocean/Water Development Expenditure and Fishing Investment also rise steadily, though at slower rates. Marine GDP Contribution (%) remains almost flat, indicating limited direct economic impact despite heavy investment expansion.

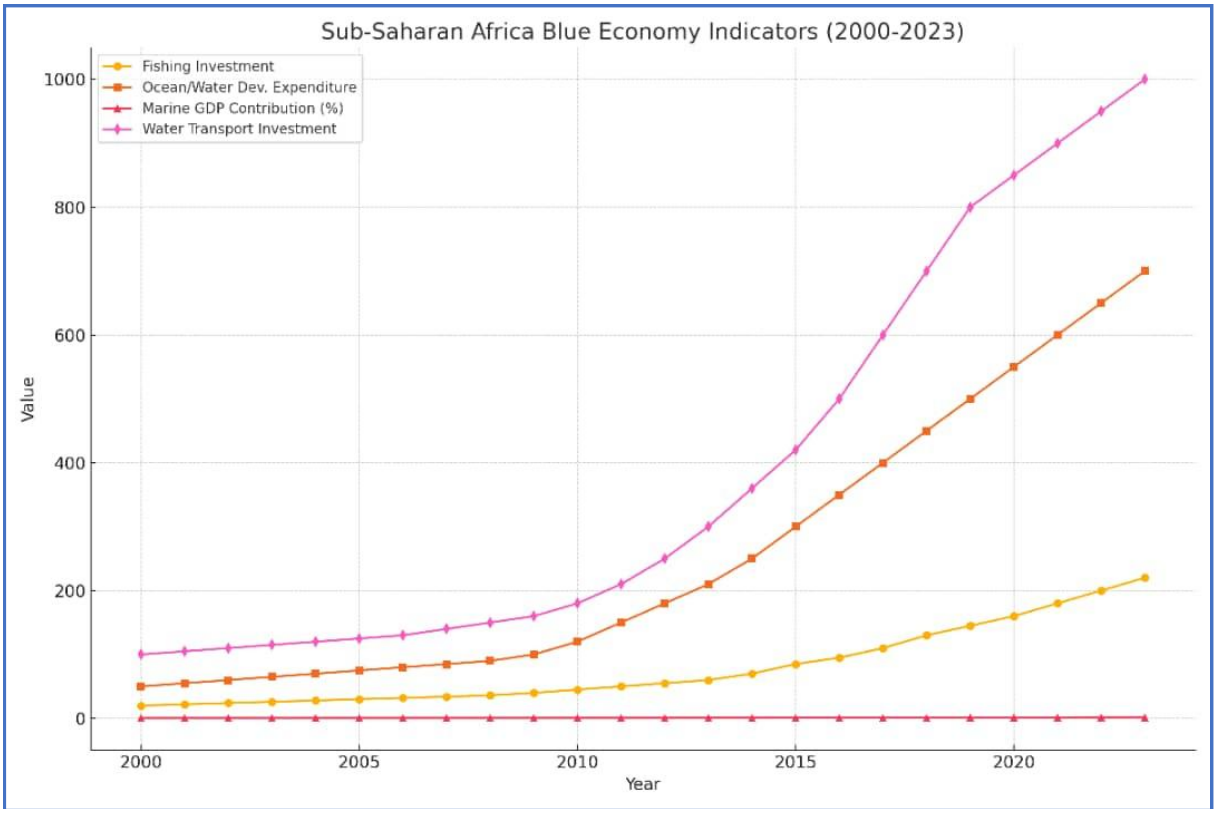

Figure 1: Sub-Saharan Africa Blue Economy Indicators (2000-2023)
Source: *FAO (2024)*

Sub-Saharan Africa is acutely vulnerable to climate-induced ocean threats, rising sea levels, coral bleaching, ocean acidification, and changing fish migration patterns. Karani et al. (2023) argue that climate adaptation must be mainstreamed into all Blue Economy strategies through coastal zoning, risk insurance schemes, and ecosystem restoration. However, only a handful of countries have adopted comprehensive climate-resilient marine frameworks. Sikhunyana and Mishi (2023) provided a systematic review emphasizing the importance of aligning local participation and indigenous knowledge with scientific planning to build resilience in coastal communities. Without these bottom-up approaches, top-down policies may fail to achieve sustainability or equity.

The literature consistently notes the Blue Economy's potential to catalyze poverty reduction, youth employment, and inclusive growth. However, access to blue economy opportunities remains highly unequal. Okafor-Yarwood et al. (2020) emphasized the need for inclusive policies that prioritize small-scale fishers, women, and indigenous coastal populations, whose roles are often marginalized in national development agendas. According to Adam and Olayele (2022), Blue Economy investment in marine biotechnology, digital maritime services, and renewable ocean energy can generate thousands of skilled jobs. Yet, without workforce upskilling and inclusive education, many marginalized groups may be excluded from blue growth dividends.

Some country-specific studies provide grounded perspectives on the implementation of the Blue Economy. Despite Nigeria's vast marine potential, weak policy enforcement and illegal fishing undermine sustainability. Popoola and Olajuyigbe (2023) recommended regional coordination along the Gulf of Guinea to curb IUU fishing. Kiswaa (2020) highlighted Kenya's early adoption of the Blue Economy model but identifies gaps in community participation and data-driven monitoring tools while in Namibia, Haimbala (2019) provided a case study of Walvis Bay Port, illustrating how value-chain development in marine transport and logistics contributes to both sustainability and export competitiveness.

Theoretical Underpinning

The blue economy is conceptually rooted in sustainable development theory, which advocates for a balance economic growth, social inclusion, and environmental protection (Potgieter, 2018)). It extends the green economy paradigm by emphasizing the importance of aquatic ecosystems in development planning. Core theoretical frameworks include ecological economics and the Doughnut Economy model, which propose that economic systems must operate within environmental limits while ensuring equitable social outcomes.

Many Sub-Saharan African countries have integrated blue economy principles into their national development strategies, aligning them with the United Nations' 2030 Agenda and the African Union's Agenda 2063. The Food and Agriculture Organization (FAO) has been instrumental in supporting these initiatives by advising governments on aquaculture policy formulation. These policies underscore the blue economy’s potential in addressing food security, employment generation, and climate resilience.

Aquaculture and sustainable fisheries are central to the blue economy in Sub-Saharan Africa. According to UNECA (2016), these sectors contribute to livelihoods and nutrition, especially in rural and coastal communities. However, the lack of coherent policy frameworks and infrastructure remains a significant barrier. Their study emphasizes the need for regulatory harmonization, investment in cold chain logistics, and stakeholder capacity-building to scale up sustainable aquaculture.

Effective governance is critical for the success of blue economy strategies. Potgieter (2018) argues that weak maritime governance, piracy, and transnational crimes hinder the development of ocean-based economies in the region. The theoretical lens here is institutional economics, which underscores the importance of legal and regulatory frameworks in enabling sustainable resource use. Strengthening maritime security through regional cooperation is essential for unlocking the economic potential of Africa’s oceans.

Blue economy strategies must also address the environmental stressors facing aquatic ecosystems. Agunsoye, et al., 2025) utilize environmental stress models to demonstrate how seasonal variability in green and blue water availability affects agricultural sustainability in Sub-Saharan Africa. This aligns with resilience theory, which advocates for systems that can adapt to shocks and maintain functionality over time.

Technological integration in the blue economy is a relatively new yet promising domain. Ekpemuaka and Odunlade (2025) explored how digital technologies, such as remote sensing, data analytics, and mobile platforms, can enhance resource monitoring, traceability in fisheries, and marine spatial planning. The digital economy's convergence with blue economy efforts points to the need for a transdisciplinary approach that includes ICT infrastructure and digital governance.

An equitable blue economy must consider the socio-economic realities of marginalized groups, including women and indigenous communities.

Empirical Literature

Sub-Saharan Africa (SSA) possesses a significant share of the world's aquatic resources, with a coastline stretching over 30,000 kilometers and access to vast inland water bodies. The blue economy (a framework promoting economic growth, social inclusion, and sustainability from ocean and freshwater resources) has become a strategic avenue for SSA's sustainable development. Empirical research in recent years has explored the multidimensional roles of governance, environmental management, finance, and community engagement in leveraging the blue economy for sustainable outcomes. One of the major empirical studies by Ochieng and Muna (2025) assessed the role of governance practices in Kenya's blue economy through the Kenya Maritime Authority. Using qualitative methods and institutional diagnostics, the study revealed that poor coordination among regulatory bodies and lack of technical capacity significantly hindered effective marine resource governance. It emphasized the importance of coherent policy frameworks and institutional synergy in achieving sustainable maritime economic growth.

Tetteh et al. (2024) assessed how education quality and access influence sustainable development in SSA through instrumental variable models. They identified a significant positive relationship between improved education systems - especially marine education - and economic productivity, suggesting an urgent need to mainstream blue economy curricula at tertiary institutions.

Using a large panel dataset, Musah et al. (2024) empirically tested the effects of industrial activities on marine pollution in SSA. They identified that without strict environmental regulations, industrial expansion leads to degradation of coastal ecosystems, undermining blue economy ambitions. The study proposed strict enforcement of marine pollution standards and marine spatial planning to mitigate adverse effects.

Appiah et al. (2023) conducted a structural equation modeling (SEM) analysis to evaluate how investments in Ghana's territorial waters contribute to sustainable development. Their findings, drawn from surveys and financial datasets, demonstrated a positive correlation between blue economy investments (e.g., ports, fisheries, ecotourism) and indicators such as income generation and community welfare. The study recommended enhancing private sector participation and local stakeholder engagement to maximize inclusive growth.

In a study focusing on environmental-economic linkages, Aminu, et al., (2023) used panel data regression across multiple SSA nations to test the Environmental Kuznets Curve (EKC) hypothesis.

The findings supported an inverted U-shaped relationship between economic growth and pollution, indicating that at higher income levels, environmental degradation slows. This underscores the importance of transitioning SSA economies from exploitation to sustainability by adopting cleaner blue technologies and practices.

Michael (2023) conducted a time-series analysis on Nigeria's blue economy performance and its impact on GDP growth. Using regression analysis, the study found that ports and fisheries significantly contribute to national income. However, the absence of comprehensive ocean data systems and inadequate marine education posed challenges. Similarly, Okafor-Yarwood et al. (2020) highlighted how top-down governance impairs coastal community participation, undermining sustainable outcomes.

Nham (2023) empirically examined the impact of financial development on marine living resources. Using time-series econometrics and case data from SSA coastal nations, the study found that increased financial investments in marine research, monitoring systems, and aquaculture infrastructure positively influenced sustainability outcomes. The study advocates for tailored financial products such as blue bonds to fund ecosystem conservation.

Okafor-Yarwood et al. (2020) explored the intersection between cultural livelihoods and ecosystem conservation using participatory methods. Their study demonstrated that top-down governance approaches often marginalize indigenous practices, leading to ecosystem degradation and social discontent. A bottom-up, inclusive strategy was proposed to harmonize conservation and economic goals.

Verma (2018) integrated gender-based empirical insights into blue economy dynamics, especially from West African contexts. Her study documented how women’s associations in fisheries and mangrove restoration projects contribute to both environmental conservation and household livelihoods. Verma advocated for gender-mainstreaming strategies in blue economy policies to enhance equity and development outcomes.

Renewable energy plays a synergistic role in blue economy sectors such as desalination, cold storage for fish processing, and coastal tourism. Ikejemba et al. (2017) documented empirical failures in renewable energy projects in SSA, emphasizing that weak project management and local participation were recurrent barriers. Their study suggested community-led energy cooperatives and capacity-building programs as solutions for sustainable energy integration into the blue economy.

Ikejemba et al. (2017) offered one of the few empirical assessments of renewable energy integration in SSA’s blue economy. Their findings from project evaluations across East Africa revealed frequent failures due to poor planning, inadequate stakeholder consultation, and corruption. They proposed community-managed renewable energy cooperatives to enhance sustainability.

Ngoran et al. (2015) analyzed how climate change affects water resources crucial to inland blue economy activities. They used GIS and empirical hydrological models to identify regional disparities in vulnerability across West and Central Africa. Their findings showed that investments in water governance and ecosystem-based adaptation are crucial for maintaining aquatic biodiversity and agriculture.

METHODOLOGY

This study employed a qualitative-dominant mixed-methods design to investigate the impact of the blue economy on sustainable development in Sub-Saharan Africa, treated as a unified regional block. A longitudinal case study approach is used to trace the evolution of blue economy initiatives over the past two decades (2000–2023), focusing on aggregate trends in maritime sectors such as fisheries, aquaculture, shipping, and coastal tourism. The sources of data include the African Union, UNECA, the World Bank, UNCTAD, and FAO. The generally expected relationship between blue economy and sustainable development is expressed functionally as:

SUSDV = f(BLUE) ……………………. (i)

Where SUSDV and BLUE connote sustainable development and blue economy respectively. We proxy sustainable development in terms of hunger ratio (HUNG) while blue economy is decomposed into four indicators: credit for fishing investment (CFFI), expenditure on ocean and water maintenance (EOWM), marine production contribution to GDP (MPCG) and water transport investment (WTIN).

The theory underpinning this is the sustainable development theory which extends the green economy paradigm by emphasizing the importance of aquatic ecosystems in development planning ((Potgieter, 2018).

This study adopts the model used by Michael (2023) in his study on "Estimating the impact of blue economy on the growth of Sub-Saharan Africa: Evidence from Nigeria" with modification. The author's model is restated here for confirmation purpose:
RGDPGR=β0 +β1FHG + β2WSWM + β3WTRAN + μ .... (i)
Where
RGDPGR = Growth Rate of RealG ross Domestic Product (%)
FHG = Fishing (NBn)
WSWM = Water Sanitation Waste Management
WTRAN = Water Transport ((NBn))
β_0 = Constant
$\beta_1 ...... \beta_3$ = Coefficients of independent variables
μ = Error Term
For this study, The relationship between SUSDV and BLUE is econometrically expressed as:
$HUNG = \alpha + \mho_1 LOGCFFI + \mho_2 LOGEOWM + \mho_3 LOBMPCG + \mho_4 LOGWTIN + \varepsilon$ …… (ii)
α = Intercept
LOG = Logarithm
$\mho_{1,}\ \mho_4$ = Regression coefficients
Ɛ = Stochastic error term.

The Generalized Method of Moments (GMM) is used to analyze the research data. This technique is appropriate because the dependent variable, HUNG, exhibits non-stationarity even after first differencing, violating the classical Ordinary Least Squares (OLS) assumptions. GMM effectively handles endogenous regressors, autocorrelation, and heteroskedasticity, making it suitable for addressing potential endogeneity bias and ensuring consistency in parameter estimation despite non-stationary series. Additionally, the model's robustness against weak exogeneity and its efficiency in small samples, like the current 24 observations, justify its application in examining the relationships between blue economy indicators and hunger levels.

4. RESULTS AND DISCUSSION

First, we examine the statistical properties of the variables and the correlations among them. Tables 1 and 2 presents the results of these two pre-estimation tests.

Descriptive Statistics

The descriptive statistics presented in Table 1 provide a foundational understanding of the characteristics of the key variables under study: Hunger (HUNG), Credit for Fishing Investment (CFFI), Expenditure on Ocean and Water Maintenance (EOWN), Marine Production Contribution to GDP (MPCG), and Water Transport Investment (WTIN), based on 24 observations.

Table 1: Descriptive Statistics

	HUNG	CFFI	EOWN	MPCG	WTIN
Mean	9.988750	79.04167	255.8333	0.869167	386.8750
Median	9.250000	52.50000	165.0000	0.690000	230.0000
Skewness	1.261302	0.982127	0.781588	1.116355	0.798926
Kurtosis	3.686229	2.660028	2.180308	2.933045	2.083930
Jarque-Bera	6.834441	3.973872	3.115412	4.989474	3.392317
Probability	0.032803	0.137115	0.210619	0.082518	0.183387
Obs	24	24	24	24	24

Source: *Author (2025).*

Starting with HUNG, the mean value is approximately 9.99, with a median of 9.25. The slight difference between the mean and median suggests a moderate positive skew, which is confirmed by the skewness coefficient of 1.26. The kurtosis value of 3.69 indicates a leptokurtic distribution, meaning the data are more peaked than a normal distribution. The Jarque-Bera probability value of 0.0328 is statistically significant, implying that the null hypothesis of normal distribution is rejected. This indicates a non-normal, right-skewed distribution of hunger levels, suggesting that while most regions experience moderate hunger, a few areas suffer from extremely high levels.

For CFFI, the mean is recorded at 79.04 million dollars, while the median is much lower at 52.5 million dollars. The positive skewness of 0.98 again implies a right-skewed distribution, although the Jarque-Bera probability of 0.1371 suggests that the distribution does not significantly deviate from normality. This indicates that while a few countries receive very high fishing investment credit, overall distribution remains fairly typical, although with noticeable outliers.

For EOWN, the mean expenditure stands at 255.83 million dollars, substantially higher than the median of 165 million dollars. The skewness of 0.78 signals a rightward tail, and the kurtosis of 2.18 suggests a slightly flatter distribution compared to the normal. The Jarque-Bera test ($p = 0.2106$) indicates no significant departure from normality. This points to varied but not extreme levels of ocean and water maintenance expenditures across the countries.

The variable MPCG shows a mean contribution to GDP of 0.869%, with a median of 0.69%. The positive skewness (1.12) and a moderately peaked kurtosis (2.93) highlight some dispersion in the contribution levels, leaning towards higher outliers. Although the Jarque-Bera probability (0.0825) is close to significance, it does not conclusively indicate non-normality. This demonstrates that while marine production's share of GDP is generally small, some countries manage to leverage marine resources better than others.

Finally, WTIN records a mean investment of 386.88 million dollars with a median of 230 million dollars, again suggesting right skewness (skewness = 0.80). The kurtosis value (2.08) indicates a relatively flat distribution, and the Jarque-Bera probability (0.1834) supports normality. This hints at a few major investments in water transport infrastructure while most countries invest moderately.

Correlations

Table 2 delves into the interrelationships among the key variables using Pearson correlation coefficients. One of the most striking features of this table is the consistently high positive correlations across all variable pairs.

Table 2: Correlation Coefficients

	HUNG	CFFI	EOWN	MPCG	WTIN
HUNG	1				
CFFI	0.940495	1			
EOWN	0.924991	0.995460	1		
MPCG	0.948593	0.997263	0.987560	1	
WTIN	0.920148	0.992992	0.997796	0.9866045	1

Source: *Author (2025).*

Starting with the relationship between HUNG and other variables, the hunger ratio correlates strongly with CFFI (0.94), EOWN (0.92), MPCG (0.95), and WTIN (0.92). These strong positive correlations suggest that, paradoxically, higher investments and contributions in the blue economy are associated with higher hunger levels. This counterintuitive finding could imply that blue economy investments have not yet sufficiently trickled down to impact food security, possibly due to structural inefficiencies, governance issues, or misalignment between economic gains and social welfare outcomes.

Examining the interrelationships among the independent variables, we observe near-perfect correlations: CFFI and EOWN (0.9955), CFFI and MPCG (0.9973), EOWN and MPCG (0.9876), EOWN and WTIN (0.9978), and MPCG and WTIN (0.9866). Such extreme correlations suggest a significant problem of multicollinearity. In econometric terms, this means that these variables tend to move together, making it difficult to isolate their individual effects on hunger through regression analysis. The implications of this table are twofold: firstly, while investments are high, their positive correlation with hunger implies ineffectiveness or delayed effects; secondly, the severe multicollinearity among predictors could bias or inflate the standard errors in subsequent econometric modeling, necessitating careful model specification and interpretation.

Effect of Blue Economy on Sustainable Development

The GMM model is used to estimate the effect of the selected blue economy indicators on sustainable development in the SSA. The results from the Generalized Method of Moments (GMM) estimation, presented in Table 3, provide crucial insights into the causal effects of blue economy-related investments and outputs on hunger levels in Sub-Saharan Africa.

Table 3: GMM Results

Dependent Variable: HUNG				
Method: Generalized Method of Moments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.

CFFI	-0.107217	0.082810	-1.294731	0.2109
EOWN	0.027389	0.022867	1.197752	0.2457
MPCG	-21.48987	7.058840	-3.044391	0.0067
WTIN	-0.015186	0.009024	-1.682910	0.0088
C	-1.346736	2.563824	-0.525284	0.6055
R-squared	0.713252	J-statistic		4.51E-39
Adjusted R^2	0.694990	Durbin-Watson stat		1.881750
Instrument rank	5			

Source: *Author (2025).*

Looking first at the coefficients, CFFI has a negative coefficient of -0.1072, suggesting that higher credit for fishing investments tends to reduce hunger; however, the associated p-value (0.2109) indicates that this relationship is statistically insignificant. Similarly, EOWN exhibits a positive coefficient (0.0274), implying that greater expenditure on ocean and water maintenance may be associated with a slight increase in hunger, though again, this result lacks statistical significance (p = 0.2457). In sharp contrast, MPCG (Marine Production Contribution to GDP) stands out with a significant and economically substantial negative effect on hunger, with a coefficient of -21.4899 and a p-value of 0.0067. This means that even a small increase in marine production's share of GDP can lead to a significant reduction in hunger levels, highlighting the critical role of the productive side of the blue economy in achieving sustainable development goals. WTIN (Water Transport Investment) also shows a statistically significant negative impact (-0.0152, p = 0.0088), implying that investments in water transport infrastructure effectively reduce hunger, likely by improving trade flows, food distribution, and economic connectivity.

The constant term is insignificant, indicating no notable fixed effects outside the included variables. The model as a whole performs well, with an R-squared of 0.713 and an adjusted R-squared of 0.695, suggesting that approximately 71% of the variation in hunger can be explained by the model. The Durbin-Watson statistic of 1.88 indicates that autocorrelation is not a concern, and the J-statistic is virtually zero, confirming that the instruments used are valid.

Post-estimation Test

The result of the Jarque-Bera test of residual normality is presented as shown in Figure 2.

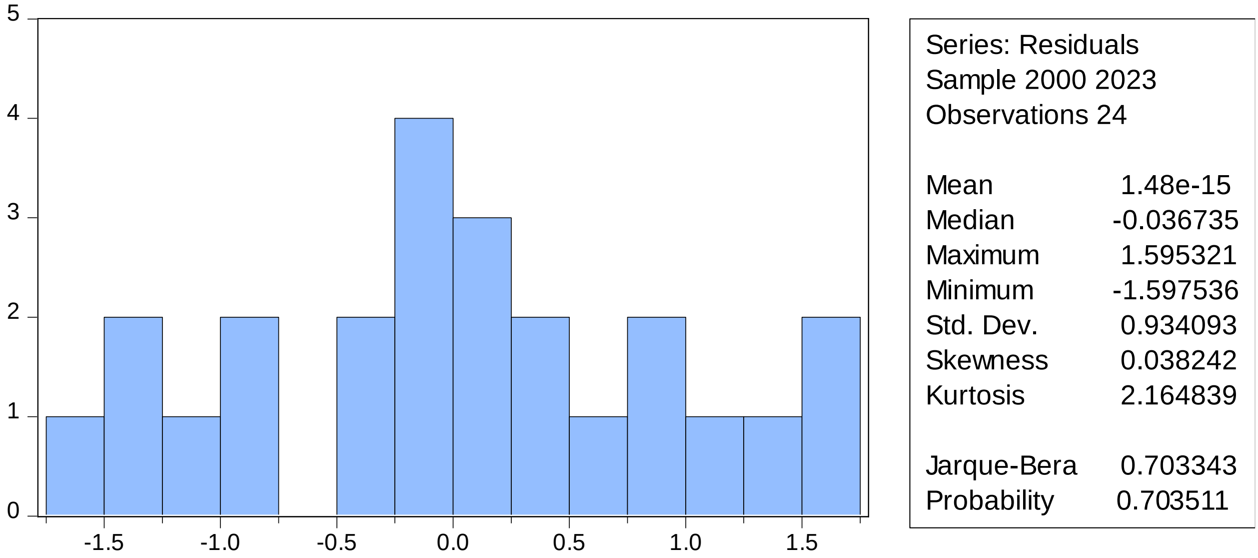

Figure 2: Residual Normality Test
Source: *Author (2025).*

The Jarque-Bera Statistics and its probability (0.703343 and 0.703511>0.05 respectively) signify that the residuals of the GMM estimates are normally distributed. This is validated by earlier findings, particularly the non-significant Jarque-Bera tests for several variables and the good Durbin-Watson statistic. This visual test likely corroborates the econometric validity of the GMM results and supports the robustness of the effects claims made in Table 3. The normality of residuals strengthens confidence in the model, suggesting that statistical inferences drawn from the estimates are reliable and that the model assumptions hold reasonably well.

Discussion of Findings

Findings from our analysis offer compelling insights into the role of the blue economy in promoting sustainable development, particularly through its effects on hunger reduction in Sub-Saharan Africa. One of the most salient findings is the critical influence of the productive dimension of the blue economy, rather than mere investment levels, in addressing food security challenges.

The negative but statistically insignificant impact of credit for fishing investment (CFFI) suggests that simply providing financial support to the fishing sector does not automatically translate into reduced hunger. This finding aligns with the observations of Bennett et al. (2019), who argued that unless financial investments are accompanied by capacity-building initiatives, governance reforms, and sustainable fishing practices, their impact on socio-economic outcomes remains limited. Financial credit alone may fail to reach marginalized fishing communities or may be misallocated, thereby diluting its potential effects on improving livelihoods and food availability.

Similarly, the positive and statistically insignificant relationship between expenditure on ocean and water maintenance (EOWN) and hunger highlights a critical disconnect between environmental spending and direct social outcomes. While investments in environmental preservation are undoubtedly essential for the long-term sustainability of marine resources

(UNCTAD, 2020), such expenditures may not yield immediate benefits for food security unless they are integrated with community-based resource management and local development initiatives. This disconnect emphasizes the need for a more holistic approach to blue economy investments, where environmental sustainability and socio-economic objectives are pursued simultaneously rather than in isolation.

In contrast to the foregoing, the marine production contribution to GDP (MPCG) demonstrates a significant and substantial negative relationship with hunger, indicating that the productive use of marine resources plays a pivotal role in achieving food security. This finding corroborates earlier studies, such as those by World Bank Group (2017) and Silver et al. (2015), which emphasize that the effective harnessing of marine sectors, including fisheries, aquaculture, and coastal tourism, can drive economic growth while providing critical sources of nutrition and income for vulnerable populations. It suggests that policy focus should shift from merely allocating funds toward enhancing the productivity and value-added capacity of marine sectors, particularly small-scale fisheries and aquaculture, which are more directly linked to local food systems.

Furthermore, the significant negative impact of water transport investment (WTIN) on hunger reduction reinforces the centrality of infrastructure development in sustainable development strategies. Improved water transport infrastructure enhances market access, reduces transaction costs, and facilitates the efficient distribution of food and marine products, thereby mitigating hunger, especially in remote and underserved areas (African Development Bank, 2018). Efficient transportation networks not only bolster trade within coastal and riverine communities but also integrate them into broader national and regional food supply chains, enhancing resilience against food insecurity shocks.

The findings bring to the fore the multidimensional nature of the blue economy's effect on sustainable development. Mere capital allocation, whether in the form of credit or environmental expenditure, appears insufficient to tackle complex socio-economic issues like hunger. Instead, what matters is how effectively these investments translate into tangible productivity gains and improved connectivity for local populations. This points to the necessity of adopting integrated blue economy policies that combine financial investments with targeted interventions in productivity, value-chain development, infrastructure, and inclusive governance.

Moreover, the evidence presented emphasizes the urgency of addressing systemic barriers such as corruption, inefficiencies in resource allocation, and the marginalization of smallholder communities that often hinder the translation of investments into sustainable outcomes (Pauly & Zeller, 2016). Future policy efforts should prioritize capacity development, technology transfer, inclusive financing mechanisms, and participatory governance models to amplify the benefits of the blue economy for food security.

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

This study examined the effect of the blue economy on sustainable development in Sub-Saharan Africa, using hunger reduction as the key indicator. Focusing on variables such as credit for fishing investment (CFFI), expenditure on ocean and water maintenance (EOWN), marine production contribution to GDP (MPCG), and water transport investment (WTIN), the study employed the Generalized Method of Moments (GMM) to account for the non-stationarity of hunger levels and potential endogeneity among predictors.

The descriptive statistics revealed substantial variability across the variables, with evidence of positive skewness in hunger and investment levels, suggesting inequality in distribution. Correlation analysis indicated strong positive relationships among all variables, raising concerns about multicollinearity. Importantly, the GMM results distinguished between investments that were merely financial inputs and those that translated into tangible economic outputs.

The analysis showed that while CFFI and EOWN exhibited expected directional effects on hunger, they were not statistically significant, highlighting that financial allocations alone do not necessarily yield improved food security outcomes. In contrast, both MPCG and WTIN displayed significant negative impacts on hunger, demonstrating that productive use of marine resources and the development of transport infrastructure are critical pathways through which the blue economy can drive sustainable development and reduce hunger levels in the region.

In conclusion, the study affirms that a strong blue economy has the potential to contribute meaningfully to sustainable development goals, particularly hunger alleviation. However, it also underscores that the effectiveness of the blue economy depends not merely on the volume of investments but on how those investments translate into real economic productivity, improved infrastructure, and inclusive growth.

Based on these findings, we find it necessary to make pertinent recommendations. First, policymakers should prioritize enhancing the productivity and efficiency of blue economy sectors rather than focusing solely on financial inputs. Also, marine investments should target small-scale fisheries, aquaculture, and value-added processing industries that directly affect local food security. Further, enhanced connectivity through better water transport systems can significantly reduce hunger by improving food distribution networks. This is apart from the need to link ocean and water maintenance programmes with community-based development initiatives to deliver dual environmental and socio-economic benefits.

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