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Original Article

Globalization, Urbanization, Energy Consumption, Economic Expansion and Industrialization: Pathway to Tanzania's Environmental Sustainability Agenda 2030

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ABSTRACT

This study delves into a comprehensive analysis of interconnectedness between globalization, urbanization, energy consumption, industrialization, and economic expansion as the pathway towards Tanzania's 2030 environmental sustainability agenda utilizing time series data spanning from 1990 to 2022. This data were sourced from the World Bank (WB) and KOF Swiss Institute. The autoregressive distributed lag (ARDL) model was utilized in this study. Unit root test, ARDL bound cointegration test, Akaike Information Criterion, Serial correlation test, Heteroscedasticity test, and Jarque-Bera test were used for data analysis. The study revealed that the lag of environmental sustainability, industrialization, and economic expansion affects Carbon dioxide (CO2) emissions in the short term by 0.516%, 0.153%, and -0.179% respectively. The study further shows that urbanization increases CO2 emissions by 1.02 percent in the long run, while globalization reduces CO2 by 0.298 percent, which consequently improves environmental sustainability. ECM (Error Correction Mechanisms) suggests 54% speed of adjustment of environmental sustainability within one year after shocks on explanatory variables. The study further recommends an appropriate policy that will encourage conservation of the environment, monitoring and evaluation, technology and innovation of green-friendly energy sources, training and workshops, and community inclusion on matters concerning the environment.

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INTRODUCTION

Environmental sustainability has been a dream of all nations around the world (Khan & Majeed, 2023). Since environment provides the habitat for human being and other biodiversity around the world, it is therefore necessary to protect and conserve the environment so as it can be attractive for life of living organisms (Byaro et al., 2022). Pollution on the environment which is mainly caused by the human activities results into loss of biodiversity, global warming, environmental degradations, diseases like cancer and cholera (Opoku et al., 2024). The world through United Nation (UN) have enacted and enforced number of strategies that tries to protects and reduces the adverse impacts from the environmental pollution and general climatic changes (Kyule & Wang, 2024).

Tanzania is the country endowed with natural resources and tourism recreation areas like national parks, cultural heritages, and recreation forests (Byaro et al., 2022). Tanzania is on the transformative process toward 2025 vision which evaluates the nation into semi-industrialized middle-income countries (Todd & Mamdani, 2017). But also, Tanzania is implementing the Sustainable Development Goals (SDGs) of 2030 with all of its aspects which includes hunger, clean water and sanitation, affordable and clean energy, economic growth, industry, innovation and infrastructure, sustainable cities and communities, and climate actions (National Environment Management Council, NEMC, 2021). Therefore, this ambitious vision brings attention among researchers in navigating the complexity of number of factors that will attributes to this achievement (Byaro et al., 2022).

Population is growing faster; industries are also diversified which energy demand is increasing for domestic consumption and industrial operations. The population of Tanzania is growing rapid (Byaro et al., 2022), with the population projected to grow significantly by 2030. Statistics have shown that Tanzania's population has been growing by 22.6% from 47.79 million people in 2012 to 61.74 million people in 2022 (National Bureau of Statistics, NBS, 2023). urban population in 2022 was 21.54 million people, accounting for 37% of the total population compared to 29% of total population in 2012 (NBS, 2023). Urban population has been increasing from time to time with rate of approximately 3% annually (NBS, 2023). This growth brings a dual sword on one side, a mushrooming population which can be a compound for economic expansion by providing a significant labour force and a growing consumer base (NBS, 2023). On the other side, it imposes substantial demands on natural resources, infrastructure, and social services, thus call for striking strategic planning and sustainable management actions (NBS, 2023). Urbanization, caused by population growth, must be managed to prevent environmental degradation and ensure the provision of essential services such as clean water, sanitation, and healthcare (Todd & Mamdani, 2017).

Globalization involves interconnection and interrelationship in different economic, social, political components around the world (Kivyiro, 2023). This has been increasing faster due to the driving aspects of technology, resources, education, political liberation and international diplomacy, and trade (Ahad & Khan, 2017). According to KOF, Globalization Index (economic, social, and political dimension) in Tanzania is 49 which is expected to rise further over the next years due to technology and innovation in production sectors of the economy (WB, 2023).

Industrialization is a basis of Tanzania's economic strategy, rooted at reducing the nation's dependency from other developed economies (Todd & Mamdani, 2017). Diversifying the industrial sector will enhance economic

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resilience, creating job opportunities, and increases in human innovation and development (Ahad & Khan, 2017). However, this diversification brings with it challenges, particularly in terms of energy consumption and environmental impact (Kyule & Wang, 2024). Industrial activities, tend to increase the demand for energy, regularly obtained from fossil fuels, which contributes to environmental pollution and climate change (International Panel on Climate Change, IPCC, 2023). Thus, there is a crucial need for sustainable action to industrialization, emphasizing energy effectiveness, and adoption of cleaner energy technologies (NEMC, 2021).

Energy consumption is highly correlated with both population growth and industrialization (Khan & Majeed, 2023). Following Tanzania's economic growth and diversification, the demand for energy is inevitable (NEMC, 2021). Currently, Tanzania's main source of energy is fossils fuels that cause a detrimental damage to the environment and greenhouse gases depletions (NEMC, 2021). This calls for the initiative on the use of clean energy sources like solar, wind, hydroelectric energies which are environmentally friendly, and crucial for reducing greenhouse gas emissions and achieving an environmentally sustainable energy (IPCC, 2023).

Economic expansion in Tanzania has been robust at 5.6% in 2024, compared to 5.2% in 2023 and 4.6% in 2022 (WB, 2023). Although its projected to rise further in 2030 to 6.5% due to increased tourism, improved business environment, interest rate tightening monetary policies targets, transport and storages, agriculture sector, enhanced tax revenue collection, and restrained spending WB (2023) and (NBS, 2023).

The integration of these factors; Globalization, Urbanization, Energy consumption, Economic expansion and Industrialization forms a strong backbone toward environmental sustainability agenda of 2030 (Ahad & Khan, 2017). To investigates this complex scenery, it is necessary to adopt holistic strategies and actions that integrates social, economic and environmental considerations (Byaro et al., 2022). Thus, policymakers and government must develop and implement policies that promote sustainable development, balancing the needs of economic growth while ensuring preservation of the environment (NEMC, 2021).

In Tanzania, few studies have been done on describing the factors that subsidise emission of carbon dioxide. Kivyiro (2023) and Luo et al. (2020) studied causal link between urbanization, energy use and carbon emission. However, these studies have ignored the role of globalization and industrialization towards carbon dioxide emissions. On the other hand study by (Byaro et al., 2022) inspected how trade, industrialization, income and urbanization affect environmental conservation but ignored the place of globalization, and energy consumption toward emission of carbon dioxide in Tanzania. Therefore, this study thought to fill the existing research gap by introducing globalization, energy consumption, and industrialization toward environmental sustainability in Tanzania by 2030.

This study draws a bead on comprehensive analysis of the interconnection between globalization, urbanization, energy consumption, economic expansion, and industrialization towards achieving environmental sustainability agenda of 2030. Specifically, to determine whether there exists a relationship between Globalization, Urbanization, Energy consumption, and economic expansion on environmental sustainability. The study further seeks to offer insights and recommendation for Tanzania's economic vision with environmental sustainability. The objective of this study is specifically to ensure that sustainable development goals guarantee economic prosperity, social wellbeing, and environmental health by 2030.

LITERATURE REVIEW

Theoretical Underpinnings

Environmental Kuznets Curve Theory

Grossman and Kruger developed Environmental Kuznets Curve Theory (EKCT) (Mirshojaeian et

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al., 2011). This hypothesis states that there is a U-inverted shaped association between economic progress and environmental degradation (Ahad & Khan, 2017). The theory furthermore involves three phases of economic development, which are the initial stage, the turning point in economic development, and the post-turning point (Rehman & Rehman, 2022). Environmental degradation brought on by urbanization, industrialization, potential human activities, and pollutions characterizes the early stages of economic development (Omri et al., 2019). The turning point stage is when environmental deterioration begins to deteriorate as a result of advanced technology, regulatory measures, and public awareness of environmental preservation (Kyule & Wang, 2024). After-turning point is a phase of reduced environmental deterioration as a result of waste management, cleaner technologies and strict regulatory practices (Byaro et al., 2022).

Sustainable Development Theory

Sustainable development theory (SDT) was pioneered by Gro Brundtland in his report “Our Common Future” 1987. According to Brundland (1987), “sustainable development means development that meets the need of present generation without compromising the ability of the future generation to meet their own need”. Furthermore, the theory emphasizes on the integration among economic, social and environment aspects in order to attain sustainable development (Brundland, 1987). The United nation (UN) and International Conferences (IC) popularized the theory on how best we can attain sustainable development (IPCC, 2023). Example, “Millenium Development Goals (2000)”, “The world Summit of Sustainable Development (2002)”, “Sustainable Development Goals (SDGs) (2015)” (Todd & Mamdani, 2017). The superiority of the sustainable development over Environmental Kuznets Curve theory remains worthwhile (Omri et al., 2019). Firstly; SDT considered integration on social, economic, and environmental dimension of sustainable development where EKCT considered only the economic dimension toward environmental equality (Zahedi, 2019). Secondly; The SDT focuses on both inter and intra generation aspects of sustainable development. It considers fairness mechanisms of addressing current and future generation where EKCT does not consider (Ahad & Khan, 2017) Lastly; The SDT believes that there should be strong policies for institutional and international cooperation all over the world in order to achieve the Sustainable Development Goals (SDGs) in which Kuznets overlooked it (Zahedi, 2019).

Empirical Review

Saidu Musa et al. (2021) explored the causality between industrialization, urbanization, and CO2 in Nigeria. This study employed the time series data running from 1982 to 2018. Yamamoto and Modified Toda causality were employed to analyse the existing causality. The study revealed that there is linkage between economic growth and CO2 and bidirectional causation between industrialization and economic growth. Furthermore, there is unidirectional causation from urbanization to economic expansion, urbanization to industrialization, and urbanization to CO2 emissions.

Ma & Qamruzzaman (2022) examined nexus between renewable energy, consumption, technological innovation, urbanization and environmental quality from Ethiopia and Egypt. This study employed secondary data running 1980-2020 and asymmetric and symmetric methods were employed for data analysis. The study showed that technological innovation and energy consumption affects negatively environmental sustainability in both short and long-run periods.

Nathaniel (2020) examined the role of trade flow, energy consumption and urbanization toward environmental sustainability in Nigeria. This study utilized secondary data spanning from the first quarter of 1980 to fourth quarter of 2016. Autoregressive Distributed Lag model, unit root test, ARDL bound test were employed for data analysis. This study results showed that energy use and urbanization determine CO2 emission in

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short and long runs period while Trade reverse the CO2 emissions. The study further showed that there is unidirectional causation from urbanization to CO2 emission.

Odugbesan & Rjoub (2020) explored the connection between carbon dioxide, urbanization, energy use and economic growth in Mexico, Indonesia, Nigeria, and Turkey countries. The World Bank Development Indicators provided annual data from 1993 to 2017 and ARDL Bounds test was employed to analyse the data. The study's conclusions showed that, whereas Mexico and Turkey adopted the feedback hypothesis, which suggests a bidirectional relationship, Nigeria and Indonesia conformed to the energy-growth hypothesis, which postulated unidirectional causality from energy consumption. In the meantime, every MINT nation demonstrates a long-term correlation between urbanization and economic growth, energy use, and CO2 emissions.

Liu et al. (2022) investigated the association between urbanization and pollution in China. Modified least squares, Granger causality test, impulse response functions, and variance decomposition were employed to examine the association between China's urbanization and air pollution based on the demographic, economic, land, and social dimensions. The findings demonstrated that depending on the stages and strategies of urbanization, there are both positive and negative consequences of urbanization on air quality between 2000 and 2012.

Omri et al. (2019) explored the key determinants of environmental sustainability in Saud Arabia. The study aimed at testing the EKC relevance in Saudi. The empirical results demonstrate that per capita income, financial development, FDI, and foreign trade positively contribute to environmental degradation. Furthermore, the EKC hypothesis was validated in the case of Saudi Arabia and environmental degradation was highly sensitive to the levels of financial development, FDI, and foreign trade. How development of financial systems, trade openness, and foreign direct investment (FDI) catalyzed the environmental sustainability.

Byaro et al. (2022) utilized the ARDL (autoregressive distributed lag) bounds testing approach, to examines the short and long-term dynamic relationship between Tanzania's urban population, industrialization, trade, economic growth (Gross Domestic Product), and carbon dioxide (CO2) emissions from 1990 to 2020. The study discovered that the rise in environmental degradation (carbon dioxide emissions) was caused by urbanization, industry, trade, and economic expansion. Nonetheless, financial credit that is, domestic credit extended to the private sector was found to lower carbon dioxide emissions, though not significantly.

Yusuf (2023) explored the dynamism of international trade, energy consumption, economic expansion, and urbanization towards environmental degradation in Nigeria. The Autoregressive Distributed Lag technique was used in the presence of structural breakdowns in this investigation, and annual time series data encompassing the years 1980 to 2020 were used. The long and short-term environmental Kuznets curve theory for Nigeria is supported by the empirical results and environmental degradation was made worse by energy consumption and total imports, whereas long and short-term environmental quality was improved by total exports. The study further showed that short-term environmental degradation increased due to financial development, while in long-term evidently reduced environmental degradation.

Mose et al. (2024) investigated the catalyst of carbon emission basing on technology in Kenya. A series of time data spanning from 1990 to 2022 were utilized in this study. ARDL model was used to test short-run and long-run association between variables. ARDL bound test, Unit root test and granger causality test were employed to analyse the data. The results showed that economic growth and Foreign direct investment have positive outcome on CO2 emission. While, technology in both periods have a negative impact on CO2 emission. This justifies that technology

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such as the use of clean energy has significant influence towards environmental sustainability.

Kivyiro (2023) examined the causal linkage among energy use, urbanization and emission of CO2 in chosen SADC (Southern African Development Community). The study utilized secondary data from World Bank (WB) from 1988-2020. Full modified ordinary least squares, Pedron cointegration test, and granger causality test were employed to analyse this data set. The study showed that both urbanization and energy consumption pause positive impact towards CO2 emission. Furthermore, result reviled that there's bidirectional relationship flowing from urbanization and energy consumption to CO2 emissions in the long-run.

Khan & Majeed (2023) examined the role of urbanization and industrialization toward zero CO2 emission in Pakistan. The study employed time series data running from 1980-2018 sourced from WB. Johansen cointegration test, Tapio decoupling elasticity, Impulse response function were employed to analyse this data set. The study showed that in the long run carbon emission intensity and the economic expansion are the main cause of severance. Also, the study showed that economic growth and industrialization deteriorates the severance in Pakistan.

Acheampong & Opoku (2023) investigated the potential relationship between the increase in environmental degradation and economic growth, in order to inform the establishment of non-conflicting environmental and structural policies. It further explored, the ways that environmental deterioration could influence economic expansion. The two-step dynamic system-generalized method moment (DGMM), panel of 140 nations spanning the years 1980 to 2021 were employed. The results showed a negative impact of environmental degradation on economic growth. However, additional analysis shows that emissions and economic growth have an inverse U-shape relationship. Economic expansion and ecological footprint indicators of environmental deterioration, however, are correlated in a U-shaped way.

Raihan & Chandra Voumik (2022) investigated how India's carbon dioxide (CO2) emissions are vigorously impacted by financial development, the use of renewable energy, technical innovation, economic expansion, and urbanization. This study utilizes time series data from 1990 to 2020 using an Autoregressive Distributed Lag (ARDL) model. India's CO2 emissions have been positively and significantly impacted by financial development, economic growth, and urbanization, according to ARDL short and long-term results. Contrariwise, renewable energy usage and technical innovation exhibit negative and significant short and long-term coefficients, indicating that increasing these variables will result in reduced CO2 emissions. Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), and Canonical Least Squares were utilized to support the empirical verdicts.

Luo et al. (2020) investigated the future projections of urbanization, residential energy use, and emissions of greenhouse gases in Dar es Salaam. The secondary data source from 2015 to 2020 was employed. Leaf modeling was employed. The study revealed that population growth of Dar es Sallam is expected to rise further by 2050 where, it will increase the greenhouse gases. Furthermore, increased energy access and electricity also increases the emission in the long-run.

Nathaniel and Adeleye (2021) utilized carbon emissions and ecological footprint as two indicators for environmental degradation in order to examine the factors that compromise ecosystem. Employing a variety of static and dynamic econometric techniques on a dataset consisting of forty-four precisely selected African countries from 1992 to 2016, the findings revealed that Energy consumption contributes to the deterioration of the environment, and the impacts of urbanization are not uniform.

METHODOLOGY

Research Design

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The research adopted a quantitative approach, aiming at analysing the interconnectedness between Globalization (GB), Urbanization (UR), Energy Consumption (EC), Economic Expansion (EE), and Industrialization (IND) towards 2030 Tanzania's environmental sustainability agenda over the period of 1990 to 2022. The study uses the granger causation to execute the relationship between variables. The ARDL model, ARDL bound tests, stationarity test, Error correction mechanism (ECM) and diagnostic tests were employed to handle time series data. Further, the study employed Statistical software EViews 12 students' version for data analysis.

Data Collection Methods

This study based on secondary data collected from World Bank and KOF Swiss Economic Institute which are considered to reliable and publicly accessible sources. The data collection process involved downloading datasets in XLS format from the respective websites, covering the period from 1990 to 2022. Data was selected based on availability, completeness, and relevance to the research objectives. The credibility of these sources remains worthwhile, due to data scrutiny and transparency.

Econometric Model

$$ES = f(GB, UR, EC, IND, EE) \ldots\ldots\ldots\ldots\ldots (1)$$

where ES = Environmental Sustainability, GB = Globalization, UR = Urbanization, EC = Energy Consumption, IND = Industrialization, EE = Economic Expansion

The variables are then transformed into natural logarithms in order to be linear, this follows:

$$ln\, ES_t = \lambda_0 + \lambda_1 lnGB_t + \lambda_2 lnUR_t + \lambda_3 lnEC_t + \lambda_4 lnIND_t + \lambda_5 lnEE_t + \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The variables were lagged with their previous values and then, Autoregressive Distributed Lag Model (ARDL) was estimated as:

$$\Delta lnES_t = \alpha_0 + \pi_1 lnGB_{t-1} + \pi_2 lnUR_{t-1} + \pi_3 lnEC_{t-1} + \pi_4 lnIND_{t-1} + \pi_5 lnEE_{t-1} + \sum_{t=1}^{v} \beta_i\, \Delta lnES_{t-1} + \sum_{t=0}^{v} \delta_i\, \Delta lnGB_{t-1} + \sum_{t=0}^{v} \varphi_i\, \Delta lnUR_{t-1} + \sum_{t=0}^{v} \gamma_i\, \Delta lnEC_{t-1} + \sum_{t=0}^{v} \vartheta_i\, \Delta lnIND_{t-1} + \sum_{t=0}^{v} \xi_i\, \Delta lnEE_{t-1} + \epsilon_t \ldots\ldots\ldots\ldots (3)$$

Where α_0 is the intercept, and π_i is the long run variable and ϵt represents white noise errors

ARDL Bound test for cointegration is then tested for existing hypothesis.

H0: $\pi_1 = \pi_2 = \pi_3 = \pi_4 = \pi_5 = 0$ against H1: $\pi_1 \neq \pi_2 \neq \pi_3 \neq \pi_4 \neq \pi_5 \neq 0$

The rejection criterion is if F-statistic is greater than 5% critical values for upper and lower bound, then H0 of no cointegration is rejected otherwise null hypothesis is accepted. ARDL (vo, v1, v2, v3, v4, v5) long run model is written as:

$$\Delta lnES_t = \alpha_0 + \pi_1 lnGB_{t-1} + \sum_{t=1}^{v} \pi_2\, lnUR_{t-1} + \sum_{t=1}^{v} \pi_3\, lnEC_{t-1} + \sum_{t=1}^{v} \pi_4 lnIND_{t-1} + \sum_{t=1}^{v} \pi_5\, lnEE_{t-1} + \cdots + \mu_t \ldots\ldots\ldots\ldots (4)$$

ARDL $(r, s_1, s_2, s_3, s_4, s_5)$ where, r and s_i $(i = 1, 2, 3, 4\ and\ 5)$optimal selection lag using Akaike Information Criteria (AIC), and Schwartz Information Criteria (SIC). Thus, short run dynamic is estimated by error correction term (ECT). This is demonstrated as:

$$\Delta lnES_t = \alpha_0 + \sum_{t=1}^{v} \delta_i\, \Delta lnGB_{t-1} + \sum_{t=0}^{v} \varphi_i\, \Delta lnUR_{t-1} + \sum_{t=0}^{v} \gamma_i\, \Delta lnEC_{t-1} + \sum_{t=0}^{v} \vartheta_i\, \Delta lnIND_{t-1} + \sum_{t=0}^{v} \xi_i\, \Delta lnEE_{t-1} + \mu_t \ldots\ldots\ldots\ldots (5)$$

where μ_t is the error correction adjustment represent the coefficient of the (ECT)term.

FINDINGS AND DISCUSSIONS

Description of the Variable

This segment explains the meaning of variables, unit of measurement, sources of the data and the expected sign of affecting the dependent variable (ES) as per table1

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Table 1: Description of the Variables

Variable	Measurement	Sources	Expected Sign
ES	Environmental Sustainability proxy by Carbon dioxide (CO2) emission (metric tons per capita)	World Bank	NA
GB	Globalization measured by KOF Globalization Index	KOF Swiss Economic Institute	+/-
UR	Urbanization measured by Urban population growth (% of total population)	World Bank	+/-
EC	Energy Consumption measured by energy use (kgs per capita)	World Bank	+/-
IND	Industrialization proxy by industrial valued added (Current US $)	World Bank	+/-
EE	Economic expansion measured by Real GDP per capital (Current US $)	World Bank	+/-

Descriptive Statistics

This section summarizes measure of central tendency and the measure of dispersion. According to Ahad & Khan (2017), descriptive statistics provides the general distribution of the data, variability of the data, and hence provides a foundation for more statistical analysis as indicated in table 2.

Table 2: Summary of Descriptive Statistics

	LNES	LNGB	LNUR	LNEC	LNIND	LNEE
Mean	0.9478	3.7919	0.9841	6.9483	29.0440	7.6969
Median	0.9816	3.8367	1.0041	6.9816	29.0677	7.6704
Maximum	1.2166	3.9380	1.2205	7.1833	30.2363	8.6676
Minimum	0.6726	3.4780	0.7260	6.7505	27.8793	6.7593
Std. Dev	0.2215	0.1355	0.1159	0.1524	0.8208	0.6839
Skewness	-0.0410	-0.8185	-0.4288	-0.0423	-0.0119	0.0235
Kurtosis	1.2285	1.5601	1.9615	1.3634	1.3411	1.3107
Jarque-Bera	4.3242	3.9508	1.0163	3.6925	3.7849	3.9271
Probability	0.1150	0.1387	0.6016	0.1578	0.1507	0.1404
Sum	31.2784	125.1331	32.4765	229.2953	958.3227	253.9987
Sum Sq. Dev	1.5709	0.5872	0.4295	0.7435	21.5615	14.9673
Observations	33	33	33	33	33	33

From table 2, mean and median for LNES, LNGB, LNUR, LNEC, LNIND, LNEE relatively similar showing that the distribution is symmetric and normal. Further standard deviation for all variables is small indicating that no dispersion of the data set and all variables converge around its mean**.** Skewness coefficient is negative for all values and indicating that data set are left tailed skewed while only LNEE shows the right tailed skewed toward large value. Kurtosis is positive and less than 1.96 indicating no presence of outliers and data are mesokurtic. Probability of Jarque-Bera is greater than 5% level of significance justifying that model follows the normality assumptions.

Test for Stationarity

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Table 3: Results of Unit Root Test

Augmented Dickey Fuller (ADF) Test				Phillips-Perron (PP) Test			
Variable	**Test-statistic**	**Critical value**	**Prob.**	**Test-statistic**	**Critical value**	**Prob.**	**Order of integration**
LNES	-4.4278	-3.6032	0.0089*	-4.3467	-3.5578	0.0045**	I (0)
LNGB	-8.2638	-4.2846	0.0000*	-8.7772	-4.2846	0.0000*	I (1)
LNUR	-3.7662	-3.5684	0.0329**	-3.3707	-3.2153	0.0739***	I (1)
LNEC	-3.6110	-3.5629	0.0445**	-3.5863	-3.5629	0.0476**	I (1)
LNIND	-4.3057	-4.2846	0.0095*	-4.2861	-4.2835	0.0100*	I (1)
LNEE	-3.9325	-3.5629	0.0225**	-3.9590	-3.5629	0.0212**	I (1)

*Notes: *, **, *** indicates 1%, 5% and 10% significance level respectively.*

From Table 3, LNES is stationary at level I (0) and the remaining variables were stationary at their first difference I (1). Thus, this confirms an application of ARDL model which necessitates either both variables be I (1) or I (0).

Lag Length Selection

Lag selection is an important step in time series analysis and econometrics, specifically ARDL model requires optimal lag selection (Pesaran et al., 2001). This helps to capture data structure and relationship precisely and hence improves model presentation and predictions (Ahad & Khan, 2017).

Table 4: Optimal Lag Selection Criterion

Lag(s)	LogL	FPE	AIC	SIC	HQ
0	299.1037	1.32e-16	-19.5403	-19.2600	-19.4506
1	486.0994	5.89e-21	-29.6066	-27.6450	-28.9791
2	524.8969	6.70e-21	-29.79312	-26.1500	-28.6277
3	579.5374	5.23e-21*	-31.03583*	-25.7113	-29.3325*

*Notes: * indicate the lag order selected by the criterion: (Each test at 5% level of significance), Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Hanna-Quinn Criterion (HQC), Final prediction error (FPE)*

Table 4 shows that lag 3 was selected by FPE, AIC, HQ criterion which support the ARDL lag selection criterion. Although AIC is best lag selection criteria due to the fact that its best for smallest sample size and it provides the efficient and robust results than any other criterion.

ARDL Estimation Results

Table 5: Cointegration Test Result

F-Bound Cointegration Test		Null Hypothesis: No levels relationship		
Test Statistic	**Value**	**Significance**	**I (0)**	**I (1)**
Asymptotic: n=1000				
F-statistic	8.105626	10%	2.26	3.35
K	5	5%	2.62	3.79
		1%	3.41	4.68

Notes: ARDL Bound- Test for Cointegration at 1%, 5% and 10% levels of significance.

Table 5 shows that F-Bound Test Statistics is larger than upper bound I (1) and the lower bound I (0) for 1%, 5% and 10% level of significance. Therefore, null hypothesis of no relationship is rejected and hence variables are cointegrating and the Error Correction Mechanisms (ECM) can be determined.

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Table 6: ARDL Short run and Error Correction Mechanism (ECM) for ARDL (2, 1, 1, 1, 1, 2)

Variable	Coefficient	Standard Errors	Test-statistic	Probability
C	-12.11108	1.527384	-7.929295	0.0000
D (LNES (-1))	0.515783	0.084498	6.104112	0.0000*
D(LNGB)	0.085951	0.053491	1.606820	0.1265
D(LNUR)	0.010047	0.087591	0.114703	0.9100
D(LNEC)	-0.099859	0.078332	-1.274828	0.2195
D(LNIND)	0.153045	0.079068	1.935600	0.0697***
D(LNEE)	0.103538	0.088476	1.170241	0.2580
D (LNEE (-1))		0.026991	-6.631253	0.0000*
ECM (-1) *	-0.540802	0.068168	-7.933335	0.0000*
R-Squared	0.953872	Mean dependent var		0.014995
Adj. R-Squared	0.937099	S.D. dependent var		0.027719
S.E of regression	0.006952	Akaike info criterion		-6.861909
Sum squared resid	0.001063	Schwarz criterion		-6.445591
Log likelihood	115.3596	Hanna-Quinn criterion		-6.726200
F-statistic	56.86723	Durbin-Watson stat		2.072812
Prob(F-statistic)	0.000000*			

*Notes: *, **, *** indicates 1%, 5% and 10% significance level respectively.*

Table 6 shows the short run results and ECM, where Environmental Sustainability (ES) depends on its previous year lag. That is one percent increase in sustainability in previous year increases the sustainability of the current year by 0.5158 percent. Industrialization (IND) has positive and significant toward Carbon dioxide emission and hence reduces the environmental sustainability in the short run. Economic Expansion has a negative and significant towards Carbon dioxide emission and thus improves the environmental sustainability in the short run. One percent increase in economic expansion in the previous year reduces the carbon dioxide emission by 0.179% in the current time. Where, remaining variables were insignificant in the short-run. Error Correction Mechanism has a negative and significant value, indicating environmental sustainability will adjust to its equilibrium after the shock by speed of 54% in the period of one year. The coefficient of determination (R^2) is 0.953872 indicating that 95.4% variation in the environmental sustainability can be explained by the explanatory variables, suggesting that the model is good fit. F-statistic of 56.86723 (p = 0.0000) indicating that a model is the best fit. This is in line with Ma and Qamruzzaman (2022), Sarkodie et al. (2020) and Byaro et al. (2022).

Table 7: ARDL (2, 1, 1, 1, 1, 2) Long run Result

Variable	Coefficient	Standard Error	Test -statistic	Prob.
LNGB	-0.297638	0.120209	-2.475999	0.0241**
LNUR	1.017425	0.216960	4.689469	0.0002*
LNEC	-0.459384	0.223964	-2.051154	0.0560***
LNIND	1.101840	0.205113	5.371879	0.0001*
LNEE	-0.692978	0.189285	-3.661040	0.0019**
EC = LNES - (-0.2976LNGB + 1.0174LNUR - 0.4594LNEC + 1.1018LNIND - 0.6930LNEE				

*Notes: *, **, *** indicates 1%, 5% and 10% significance level respectively.*

Table 7 shows the ARDL long run estimates, which showed that all variables establish the long run relationships with the carbon dioxide emission and hence affecting the environmental sustainability agenda of 2030. LNGB is negatively and significant toward carbon dioxide emission, one percent increase in globalization index will reduce extent of emission of carbon dioxide by 0.298 percent which consequently increases the environmental sustainability. LNUR has positive and significant impact on carbon dioxide emissions, one percent increase urban

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population growth increases the emission of carbon dioxide by 1.017 percent, as a result it increases environmental degradation and finally detrimental the environmental sustainability. LNEC has negatively and significant effect on carbon dioxide emission, that is one percent increase in energy consumption reduces the carbon dioxide emission by 0.46 percent and consequently enhance the environmental sustainability. LNIND has a significant and positive impact toward carbon dioxides emission, that is one percent increase in industrial value added increases the emissions of carbon dioxide by 1.102 percent and hence reduce the environmentally sustainable goal. LNEE has significant and negative impact towards emission of carbon dioxide, implicitly one percent rise in economic expansion (real GDP per capita) reduces the extent of carbon dioxide emission by 0.693 percent and hence increases the environmental sustainability in the nation. These results are corresponding with Ahad and Khan (2017), Rehman and Rehman (2022), Kwakwa (2020), Khan and Majeed (2023), Kivyiro (2023), Sarkodie et al. (2020) and Saidu Musa et al. (2021).

Table 8: Post-Estimation Diagnostic - Tests

Breusch-Godfrey Autocorrelation LM Test			
Null hypothesis: No serial Correlation			
F-statistic	0.3637	Prob. F (2,15)	0.7011
Obs*R-square	1.4337	Prob. Chi-Square (2)	0.4883
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Null hypothesis: Homoskedasticity			
F-statistic	0.9588	Pro. F (13, 17)	0.5223
Obs*R-squared	13.1138	Prob. Chi-Square (13)	0.4391
Scaled explained SS	4.3429	Prob. Chi-Square (13)	0.9870
Heteroskedasticity Test ARCH			
F-statistic	0.381975	Prob. F (2, 29)	0.5414
Obs*R-squared	0.403009	Pro. Chi-square (2)	0.5255
Jarque-Bera Test for Normality			
Test Statistic	1.2187	Probability of Chi-square (2)	0.5437

Table 8 shows the post-estimation diagnostic test to confirm the results obtained if it adheres to classical linear regression assumptions in order to avoid reporting the spurious regression results. From table 8 it is clearly seen that there is no serial correlation, the residuals are homoscedastic, the Jarque-Bera suggest that the model conforms with the normality assumptions. Thus, these suggest that the estimates are robust and consistency for the selected model.

Mode Stability Test

Figure 1: Model Stability Test by CUSUM at 5% significance.

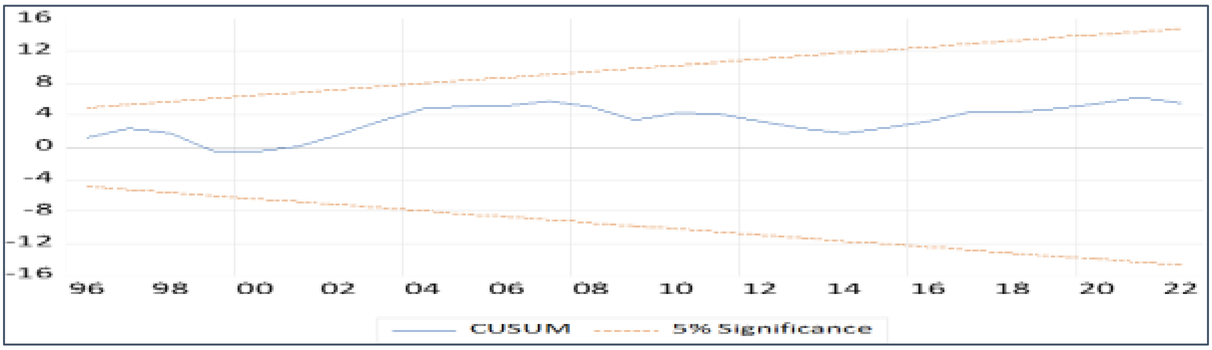

Figure 1 shows that model is stable within 5% critical bound

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Table 9: Granger Causation Test Results.

Null Hypothesis	Obs	F-Statistic	Probability
LNGB does not Granger Cause LNES	31	3.79679	0.0358**
LNES does not Granger Cause LNGB		1.50288	0.2412
LNUR does not Granger Cause LNES	31	1.86262	0.1754
LNES does not Granger Cause LNUR		2.18869	0.1323
LNEC does not Granger Cause LNES	31	0.4776	0.6256
LNES does not Granger Cause LNEC		4.47336	0.0214**
LNIND does not Granger Cause LNES	31	0.98393	0.3873
LNES does not Granger Cause LNIND		2.2067	0.1303
LNEE does not Granger Cause LNES	31	1.1248	0.3400
LNES does not Granger Cause LNEE		3.00491	0.0670
LNUR does not Granger Cause LNGB	31	0.82842	0.4479
LNGB does not Granger Cause LNUR		1.1006	0.3477
LNEC does not Granger Cause LNGB	31	1.44467	0.2541
LNGB does not Granger Cause LNEC		3.09359	0.0623
LNIND does not Granger Cause LNGB	31	1.78792	0.1873
LNGB does not Granger Cause LNIND		0.49835	0.6132
LNEE does not Granger Cause LNGB	31	1.54626	0.2320
LNGB does not Granger Cause LNEE		0.74728	0.4836
LNEC does not Granger Cause LNUR	31	0.78446	0.4669
LNUR does not Granger Cause LNEC		1.12926	0.3386
LNIND does not Granger Cause LNUR	31	2.86899	0.0748
LNUR does not Granger Cause LNIND		0.44785	0.6438
LNEE does not Granger Cause LNUR	31	2.72967	0.0839
LNUR does not Granger Cause LNEE		0.30884	0.7370
LNIND does not Granger Cause LNEC	31	0.74743	0.4835
LNEC does not Granger Cause LNIND		2.25956	0.1245
LNEE does not Granger Cause LNEC	31	0.43529	0.6517
LNEC does not Granger Cause LNEE		2.12573	0.1396
LNEE does not Granger Cause LNIND	31	3.71739	0.0380**
LNIND does not Granger Cause LNEE		4.54752	0.0203**

Table 9 shows the granger causation results among the variables under study. LNGB granger cause LNEC. This shows that there is bi-directional relationship between Globalization and energy consumption, Thus, globalization increases energy consumption in domestic and industrial appliances. Environmental sustainability (ES) granger cause energy consumption (EC) this indicates that the previous value of ES can predict the future energy consumption. If the previous year there is good environmental sustainability practices, then future energy use will be the one that is environmental friendless. The study further shows that LNEE granger cause LNIND and LNIND granger cause LNEE.

DISCUSSIONS

This study on the integration of globalization, urbanization, energy consumption, industrialization, and economic expansion towards the environmental sustainability agenda of 2030 has shown that Environmental Sustainability (ES) depends on its lag from the previous year. A one percent increase in sustainability in the previous year increases the sustainability of the current year by 0.5158 percent. Additionally, Industrialization (IND) has a positive and significant impact on carbon dioxide emissions, thus reducing environmental sustainability in the short run. This is due to industrial pollutions and gas emissions that deplete the environment, thereby negatively impacting environmental sustainability.

Furthermore, the results showed that Economic Expansion (EE) has a negative and significant

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impact on carbon dioxide emissions, thereby improving environmental sustainability in the short run. A one percent increase in economic expansion in the previous year reduces carbon dioxide emissions by 0.179% in the current period. This is because economic growth is associated with advanced technologies, carbon pricing policies, and corporate social responsibility, all of which enhance environmental sustainability. These results are similar with Ma and Qamruzzaman (2022), Sarkodie et al. (2020) and Byaro et al. (2022).

Moreover, the results indicate that all variables exhibit a long-term relationship towards the environmental sustainability agenda of 2030. LNGB is negatively and significantly associated with carbon dioxide emissions, thereby enhancing environmentally sustainable policies. This is unsurprising given the technological advancements in globalization that promote environmentally friendly practices and awareness (Ahad & Khan, 2017). LNUR has a positive and significant impact on carbon dioxide emissions, one percent increase in urban population growth increases carbon dioxide emissions by 1.017 percent, exacerbating environmental degradation and hindering environmental sustainability Byaro et al. (2022) and (NBS, 2023). This is due to rapid urban population growth leading to congestion, increased use of charcoal and firewood, and heightened business activities, all contributing to increased carbon dioxide emissions and environmental degradation (IPCC, 2023).

LNEC has a negative and significant effect on carbon dioxide emissions; a one percent increase in energy consumption reduces carbon dioxide emissions by 0.46 percent, thereby enhancing environmental sustainability. This is because effective and efficient energy consumption can promote environmental sustainability, such as through gas and electricity use in home appliances, innovation in electric vehicles, and public transportation, all reducing reliance on fossil fuels and improving environmental sustainability (WB, 2023). LNIND has a significant and positive impact on carbon dioxide emissions; a one percent increase in industrial value-added increases carbon dioxide emissions by 1.102 percent, thereby undermining environmental sustainability goals (Todd & Mamdani, 2017). This is due to industrial chemicals, resource consumption, and waste pollution associated with industrial operations (Todd & Mamdani, 2017).

Lastly, LNEE has a substantial and adverse impact on carbon dioxide emissions; a one percent increase in economic expansion (real GDP per capita) reduces carbon dioxide emissions by 0.693 percent, thereby enhancing environmental sustainability nationally. This is because green technologies, education, awareness, and regulatory frameworks often accompany economic growth (NEMC, 2021). These findings are congruent with. Ahad & Khan (2017), Rehman & Rehman (2022), Kwakwa (2020), Khan & Majeed (2023), Kivyiro (2023), Sarkodie et al. (2020) and (Saidu Musa et al., 2021).

The study also discovered a bidirectional relationship among variables, as vindicated by pairwise Granger causality tests. LNGB granger-causes LNEC, indicating a bidirectional relationship between globalization and energy consumption. Thus, globalization increases energy consumption in both domestic and industrial settings. Environmental sustainability (ES) granger-causes energy consumption (EC), suggesting that previous levels of environmental sustainability can predict future energy consumption. Good environmental sustainability practices in previous years lead to more environmentally friendly energy use in the future. Additionally, the study found that LNEE granger-causes LNIND and LNIND granger-causes LNEE. This implies that industrialization can predict future economic expansion, and economic expansion may predict future industrialization in Tanzania. These results are reliable with findings from Liu et al. (2022), Kivyiro (2023) and (Kyule & Wang, 2024).

CONCLUSION AND RECOMMENDATION

Conclusion

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The aim of this study was to investigates the interdependence of globalization, urbanization, energy consumption, industrialization, and economic expansion on pathways towards Tanzania environmental sustainability agenda of 2030. The study utilized various analysis methods including Autoregressive Distributed Lags (ARDL) model, Unit Root test and Pairwise granger causality tests. The study showed that only ES, IND, and EE has a negative effect on ES. However, all variables establish a long-term effect towards environmental sustainability. The study also revealed that there is bidirectional causation between IND and EE, GB and EC, EC and ES. The results further Showed that only ES was stationary at zero order while remaining variables was stationary at first difference. Finally, the study concludes that all variables have impacts toward Tanzania environmental agenda of 2030.

Recommendations

The environment is crucial for both flora and fauna. This study has explored the interconnectedness of globalization, urbanization, energy consumtion, economic wxpansion and industrialization toward achieving environmental sustainability and global sustainable development goals. The study has shown that all these variables affect environmental sustainability in the long run. This brings a special attention to the government and policy makers on the best ways to control these variables in order to attain the environmental agenda of 2030. The study recommends the following to the government, policy maker and stakeholders

First: Investing on technology and innovations like adoption of green technologies use such as coal, wind, biomass, gas which will reducethe use of fossils fuels on domestic and industrial activities. . Second: Ensuring proper urban planning and development which will accommodates the rapid growing population in major cities like Dar es Salaam, Mwanza and Arusha. Third: Capacity building through training and workshops in rural and urban areas. This will increase the awareness of the environmental sustainability and its importance for current and future generation. Fourth: Continuous monitoring and evaluation toward 2030 agenda. This includes setting indicators, regular collection of data and assessment on how globalization, urbanization, energy consumptions, industrialization and economic expansion affects the environment as the country is heading to 2030 environmental sustainability agenda. Finally: Enacting the strict environmental laws that will also reduce the extent of CO2 emission. Enforcing these laws will also reduce environmental degradation due to the strong fines against water pollution, deforestation, poor agricultural practices and poaching of animals**.**

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