

# Effects of Climate Change on Poverty Reduction in African Emerging Economies: A Dynamic Panel Analysis

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## ABSTRACT

This study investigates the economic impact of climate change on poverty reduction in 20 African emerging economies over the period 2014–2024. Using a dynamic panel Generalized Method of Moments (GMM) approach, the analysis examines the effects of total greenhouse gas (GHG) emissions, methane emissions from agriculture, and forest area, while controlling for GDP per capita and foreign aid inflows. The findings reveal that total GHG and methane emissions significantly increase poverty. Conversely, forest area was statistically insignificant in poverty reduction. The study concludes that climate change poses a significant barrier to poverty reduction in African emerging economies. However, sustained economic growth and strategically targeted foreign aid can mitigate these effects. Based on the conclusion, the study recommends that emerging economies should implement targeted strategies to reduce greenhouse gas and methane emissions, particularly from agriculture and industrial activities. This may include promoting clean energy technologies, climate-smart agriculture, and sustainable land-use practices.

**Keywords:** Climate Change, Poverty Reduction, African Emerging Economies, GHG Emissions, Methane Emissions, Dynamic Panel GMM

## INTRODUCTION

Poverty remains a central development challenge in emerging economies despite sustained economic growth and increased global attention to inclusive development. Emerging and developing economies account for over 85% of the world's extreme poor, with the largest concentrations found in Sub-Saharan Africa and South Asia (Hallegatte & Rozenberg, 2017; Lankes et al., 2024). Although many emerging economies have achieved measurable progress in poverty reduction over the past two decades, these gains remain fragile and uneven due to structural vulnerabilities, high income inequality, and exposure to external shocks (Hallegatte et al., 2018).

Recent estimates indicate that more than 700 million people globally still live on less than \$2.15 per day, with a substantial proportion residing in climate-vulnerable emerging economies (Lankes et al., 2024). In these countries, poverty is closely linked to dependence on climate-sensitive sectors. For instance, agriculture employs over 60% of the poor in emerging and developing economies, making household welfare highly susceptible to climatic variations such as droughts, floods, and rising temperatures (Seaman et al., 2014; Hossain et al., 2024).

Climate change has increasingly emerged as a critical force capable of slowing, stagnating, or reversing poverty reduction efforts. Evidence suggests that climate change disproportionately affects low-income households by reducing agricultural productivity, increasing food prices, weakening labor productivity, and elevating health risks (Zhou et al., 2017; Tol, 2018). For example, rising temperatures and rainfall variability have been shown to significantly reduce crop yields and rural incomes in emerging economies such as Ethiopia, Nigeria, India, and Bangladesh (Fayisa, 2025; Islam et al., 2025).

Globally, climate change is projected to push between 68 and 132 million additional people into extreme poverty by 2030, depending on the severity of warming and policy responses (Hallegatte et al., 2018; Dang et al., 2025). These poverty impacts are more pronounced in emerging economies due to limited adaptive capacity, weak social protection systems, and inadequate infrastructure. Studies further reveal that a 1°C increase in temperature

can reduce economic growth rates in developing countries by up to 1–2 percentage points, thereby constraining poverty-reducing growth (Tol, 2018; Filipava, 2024).

Beyond income effects, climate change exacerbates multidimensional poverty by worsening health outcomes, increasing food insecurity, and intensifying inequality within and between regions (Huynh & Nguyen, 2025; David et al., 2025). Climate-induced shocks often force households to adopt negative coping strategies such as asset depletion, reduced food consumption, and withdrawal of children from school, thereby reinforcing intergenerational poverty traps (Seaman et al., 2014; Dang et al., 2025).

Moreover, evidence from emerging economies indicates that climate change interacts with governance quality, institutional strength, and policy effectiveness to shape poverty outcomes. Regions with weak institutions and poor climate governance experience more severe poverty impacts from climate shocks (Huynh & Nguyen, 2025; Dewananda et al., 2023). This underscores the argument that poverty reduction strategies that fail to integrate climate resilience may be unsustainable in the long run.

Existing studies provide substantial evidence on the relationship between climate change and poverty; however, important gaps remain in the context of emerging economies. Much of the literature is either conceptual or country-specific, limiting comparative insights across emerging economies (Hallegatte & Rozenberg, 2017; Leichenko & Silva, 2024). While recent studies examine subnational or sectoral impacts such as agriculture, tourism, urbanization, and green economy initiatives their findings remain fragmented and do not fully capture the broader economic transmission mechanisms through which climate change affects poverty reduction (Hossain et al., 2024; Shah, 2025; Mgbomene et al., 2024).

Moreover, limited attention has been given to the dynamic effects of climate change on poverty reduction over time, particularly in fast-growing emerging economies (Filipava, 2024; Dang et al., 2025). Against this backdrop, this study examines the economic impact of climate change on poverty reduction in emerging economies, using total greenhouse gas (GHG) emissions, methane emissions from agriculture, and forest area as a percentage of land area as key climate-related indicators. By focusing on these proxies, the study captures both anthropogenic climate pressures and environmental sustainability dynamics that influence poverty reduction outcomes in emerging economies.

## LITERATURE REVIEW

### Conceptual Framework

The conceptual framework illustrates the hypothesized relationships between climate-related indicators and poverty reduction outcomes in emerging economies. It integrates environmental pressures, economic dynamics, and policy responses to explain how climate change influences poverty alleviation.

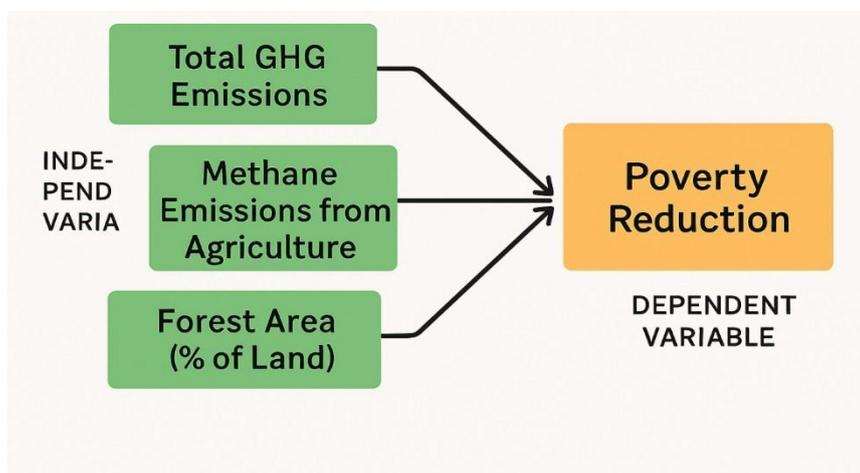


Figure 1: Conceptual Framework

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## Poverty Reduction

Poverty reduction refers to strategies, policies, and interventions aimed at improving the living standards of the poor by increasing income, access to basic services, and resilience against economic and environmental shocks. In emerging economies, poverty reduction is often multidimensional, encompassing income poverty, health, education, food security, and social vulnerability (Sriyana, 2025; David et al., 2025). Multidimensional approaches are essential because a purely income-focused strategy may overlook critical aspects such as child health, nutrition, and exposure to environmental risks, which significantly influence the ability of households to escape poverty (Huynh & Tran, 2024; Dewananda et al., 2023).

Poverty remains a persistent challenge in emerging economies despite sustained economic growth. Globally, over 700 million people live on less than \$2.15 per day, with the majority residing in Sub-Saharan Africa and South Asia (Hallegatte & Rozenberg, 2017; Lankes et al., 2024). Emerging economies often have high dependency on climate-sensitive sectors such as agriculture, informal labour, and fisheries, making poverty highly vulnerable to climatic shocks (Seaman et al., 2014; Hossain et al., 2024).

## Climate Change

Climate change refers to long-term shifts in temperature, precipitation, and weather patterns caused by natural processes and human activities, particularly greenhouse gas emissions (Tol, 2018; Leichenko & Silva, 2024). In emerging economies, climate change manifests as rising temperatures, erratic rainfall, extreme weather events, and environmental degradation. These changes directly and indirectly influence economic activities, especially in agriculture, energy, and rural livelihoods (Hallegatte et al., 2018; Dang et al., 2025).

Climate change threatens poverty reduction by reducing agricultural productivity, increasing food prices, weakening labor productivity, and increasing health risks (Zhou et al., 2017; Tol, 2018). Rising temperatures, erratic rainfall, and extreme weather events disproportionately affect low-income households, particularly in rural areas (Dang et al., 2025; Filipava, 2024). Studies also highlight that climate shocks exacerbate multidimensional poverty affecting education, health, and access to basic services (Huynh & Tran, 2024; Dewananda et al., 2023).

## Total GHG emissions

Total greenhouse gas (GHG) emissions represent the sum of gases released into the atmosphere that contribute to global warming, including carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and fluorinated gases (Tol, 2018; Filipava, 2024). These emissions primarily arise from human activities such as energy production, industrial processes, transportation, and agriculture, and are widely recognized as the main drivers of climate change. In empirical studies, total GHG emissions are often used as a proxy for climate change because they capture the anthropogenic contribution to global warming, which directly and indirectly affects economic outcomes, livelihoods, and poverty (Zhou et al., 2017). High levels of GHG emissions exacerbate climate-related risks, disproportionately affecting low-income households in emerging economies. Rising emissions contribute to reduced agricultural productivity due to higher temperatures and altered precipitation patterns, negatively impacting smallholder farmers and rural households (Fayisa, 2025; Hossain et al., 2024). Additionally, climate variability associated with emissions affects energy supply, infrastructure reliability, and access to essential services, which can undermine household income and increase vulnerability (Derouez et al., 2024). Health outcomes are also affected, as elevated GHG concentrations are linked to heatwaves, air pollution, and vectorborne diseases, increasing healthcare expenditures and reducing labor productivity (Huynh & Tran, 2024). Environmental degradation, including deforestation, soil erosion, and biodiversity loss, further undermines the ecosystem services that support poor households (Mgbomene et al., 2024). Empirical evidence suggests that higher national GHG emissions are associated with widening income inequalities and slower progress in poverty reduction (Filipava, 2024; Tol, 2018; Zhou et al., 2017).

Regions with high emissions face greater vulnerability, highlighting spatial heterogeneity in climate-poverty interactions (Dang et al., 2025). Despite its recognized importance, few studies explicitly quantify the economic impact of total GHG emissions on poverty reduction in emerging economies, especially in combination with

other climate indicators such as methane emissions and forest cover. Incorporating total GHG emissions into analyses provides a critical understanding of the linkages between anthropogenic climate change and poverty, making it a central variable in studies examining climate-driven economic and social vulnerabilities.

### **Methane emissions from agriculture**

Methane (CH<sub>4</sub>) emissions from agriculture are a significant component of anthropogenic greenhouse gases and a major contributor to climate change, particularly in emerging economies where agriculture remains a primary livelihood source (Zhou et al., 2017; Tol, 2018). These emissions primarily originate from enteric fermentation in livestock, rice paddies, manure management, and biomass burning, and they have a global warming potential many times higher than carbon dioxide over a 100-year period (Filipava, 2024). Methane emissions are particularly relevant for poverty reduction because they are closely linked to agriculture-dependent livelihoods, which are highly sensitive to climatic variations. High methane emissions contribute to local and regional warming, altering rainfall patterns and increasing the frequency of extreme weather events, thereby affecting crop yields, livestock productivity, and food security (Fayisa, 2025; Hossain et al., 2024). This, in turn, reduces household income and exacerbates vulnerability among rural populations, who constitute the majority of the poor in emerging economies (Dang et al., 2025; Huynh & Tran, 2024). Furthermore, methane-related climate effects interact with other environmental stressors, such as soil degradation and water scarcity, amplifying the challenges of poverty alleviation (Derouez et al., 2024). Studies highlight that regions with higher methane emissions experience greater agricultural instability and slower progress in poverty reduction, emphasizing the importance of including methane as a key climate proxy in studies examining the economic impacts of climate change on poverty (Filipava, 2024; Zhou et al., 2017). Despite this, few studies have simultaneously analyzed methane emissions alongside other climate indicators such as total GHG emissions and forest area to assess their combined effect on poverty reduction in emerging economies, leaving a critical gap in understanding how climate-driven agricultural pressures influence development outcomes.

### **Forest area (% of land area)**

Forest area, expressed as a percentage of total land area, is an important indicator of environmental sustainability and climate resilience, particularly in emerging economies (Mgbomene et al., 2024; Wang et al., 2024). Forests act as natural carbon sinks, absorbing greenhouse gases such as carbon dioxide and mitigating the impacts of climate change, including temperature rise and erratic rainfall. The presence of forests also supports biodiversity, regulates water flow, prevents soil erosion, and sustains ecosystem services that are critical for rural livelihoods (Derouez et al., 2024; Zhou et al., 2017). Empirical studies indicate that regions with higher forest coverage tend to experience greater agricultural stability, improved food security, and reduced vulnerability to climate shocks, all of which contribute to effective poverty reduction (Mgbomene et al., 2024; Wang et al., 2024). Forest area therefore serves as a mitigating factor that can buffer households from the adverse effects of climate change, supporting both economic development and poverty alleviation initiatives.

### **Empirical Evidence**

Empirical studies consistently highlight the complex interactions between climate change and poverty reduction in emerging economies. Meng (2024) emphasizes that in Asia-Pacific least developed countries, climate change exacerbates poverty by undermining agricultural productivity, food security, and rural livelihoods, calling for integrated policy approaches that combine mitigation, adaptation, and social protection. Similarly, Dewananda, Leniwati, and Wicaksono (2023) demonstrate in the Indonesian context that climate variability not only affects income but also inequality and multidimensional aspects of poverty, including access to food, education, and healthcare. Filipava (2024) further reports that rising greenhouse gas emissions and climate risks contribute to widening the global economic gap, disproportionately impacting vulnerable populations in emerging economies.

At the subnational level, Dang et al. (2025) show that regions experiencing higher warming and extreme climate events have increased poverty incidence and inequality, highlighting the spatial heterogeneity of climate impacts. Hossain, Mendiratta, and Savastano (2024) provide evidence from 16 impact assessment studies that agricultural and rural development interventions can significantly reduce poverty, but their effectiveness is often mediated by climate variability and environmental shocks. Mgbomene, Dim, and Henry (2024) similarly find that green

economy initiatives in Nigeria, including forest preservation and renewable energy projects, not only reduce greenhouse gas emissions but also support sustainable poverty reduction. Shah (2025) emphasizes the role of tourism as a poverty alleviation tool, particularly when coupled with climate-resilient infrastructure and inclusive development strategies.

Hallegatte and Rozenberg (2017) note that climate change should be assessed through a poverty lens, as even small changes in temperature or rainfall can disproportionately affect the poor. Evidence from Vietnam by Huynh and Tran (2024) highlights that climate-induced shocks exacerbate child health inequalities, thereby impeding long-term poverty reduction. In India, Khan and Sahu (2025) find that global and local structural factors, including climate risks, interact with policy interventions to determine the pace of poverty alleviation. Leichenko and Silva (2024) provide a broader overview, arguing that climate change impacts both income and non-income dimensions of poverty, while Tote and Akanegbu (2025) show that foreign aid in West African countries has helped mitigate poverty, though climate-related challenges still pose significant obstacles.

Other country-specific studies underscore the diverse pathways through which climate change affects poverty. In Indonesia, Susilo and Herawan (2023) show that extreme poverty eradication strategies must consider climate-induced disruptions in food production. In Somalia, Hussein and Osman (2024) demonstrate that rapid urbanization combined with climate stress increases poverty vulnerability in both urban and rural populations. Similarly, Wang et al. (2024) show that rainfall variability in China affects agricultural output and the efficiency of government poverty reduction programs, highlighting the importance of climate-sensitive policy design. Arvante (2025) stresses that legal frameworks and governance mechanisms must address climate-related poverty risks to ensure sustainable development outcomes.

## Theoretical Underpinning

The study is anchored on two key theoretical perspectives: the Sustainable Livelihoods Framework (SLF) and the Environmental Kuznets Curve (EKC) theory

### Sustainable Livelihoods Framework (SLF)

The Sustainable Livelihoods Framework, developed by the Department for International Development (DFID, 1999), provides a holistic perspective on poverty by emphasizing the assets, vulnerabilities, and capacities of households to sustain their livelihoods. According to the SLF, poverty reduction is not solely about increasing income but also enhancing natural, financial, human, social, and physical capital. In the context of climate change, natural capital—such as forests, land, and water resources is directly affected by GHG and methane emissions, which influence agricultural productivity, ecosystem services, and vulnerability to environmental shocks (Hallegatte & Rozenberg, 2017; Hossain et al., 2024). The SLF thus provides a useful lens to examine how climate-related shocks and environmental degradation constrain household livelihoods and impede poverty reduction, particularly in emerging economies dependent on climate-sensitive sectors.

### Environmental Kuznets Curve (EKC) Theory

The Environmental Kuznets Curve theory postulates an inverted U-shaped relationship between economic growth and environmental degradation (Grossman & Krueger, 1991; Tol, 2018). In the early stages of economic development, environmental degradation including GHG and methane emissions increases, which can negatively affect poverty reduction by undermining agricultural productivity, health, and social welfare. As economies mature, investments in cleaner technologies, renewable energy, and sustainable practices reduce environmental degradation, creating potential for simultaneous economic growth and poverty alleviation. In emerging economies, the EKC framework explains how climate change indicators interact with economic structures to shape poverty outcomes.

## METHODOLOGY

### Research Design

This study adopts an ex post facto research design. The ex post facto design is suitable because the key variables, such as GHG emissions and poverty levels, have already occurred, and it is not possible or ethical to manipulate climate or socio-economic conditions. This design allows for a quantitative, observational analysis, capturing both temporal (over time) and cross-sectional (across countries) variations, making it ideal for understanding the dynamic relationship between climate change and poverty reduction in emerging economies.

### Population and Sample Size

The population for this study comprises all emerging economies in Africa, characterized by rapid growth, high poverty, and climate vulnerability. Using purposive sampling, 20 countries were selected based on data availability for total GHG emissions, methane emissions, forest area, and poverty measures: Nigeria, South Africa, Kenya, Ethiopia, Ghana, Tanzania, Uganda, Morocco, Algeria, Angola, Senegal, Cameroon, Zambia, Zimbabwe, Mozambique, Côte d'Ivoire, Botswana, Rwanda, Namibia, and Tunisia. The study covers 2014–2024, creating a balanced panel dataset to analyze temporal and cross-country variations in the impact of climate change on poverty reduction (Meng, 2024; Hossain et al., 2024).

### Method of Data Collection

This study uses secondary data from reliable sources. Obtained from world bank database. Secondary data was chosen because it provides access to large, credible, and internationally comparable datasets that would be difficult and costly to collect independently.

Table 1 Variable Measurement and Operationalization

Variable	Type	Proxy / Indicator	Measurement / Unit	Expected Sign	Source
Poverty Reduction	Dependent	Poverty headcount ratio	% of population below \$1.90/day	–	(Dang et al., 2025; Filipava, 2024)
		Multidimensional Poverty Index (MPI)	Index score (0– 1)	–	(Dewananda et al., 2023; Meng, 2024)
Total GHG Emissions	Independent	CO <sub>2</sub> equivalent emissions	Metric tons per capita	–	Tol, 2018; Zhou et al., 2017)
Methane Emissions	Independent	Agriculture CH <sub>4</sub> emissions	Metric tons	–	Fayisa, 2025; Hosain et al., 2024)
Forest Area	Independent	Forest area	% of total land area	+	Mgbomene et

					al., 2024; Wang et al., 2024)
GDP per capita	Control	Economic output	Constant USD	+	WDI (Huynh & Tran, 2024; Khan & Sahu, 2025)
Foreign Aid	Control	Net ODA inflows	USD	+	Tote & Akanegbu, 2025; Shah, 2025)

Authors Computation 2026

### Techniques of Data Analysis and Model Specification

This study employs quantitative panel data analysis . Given the potential endogeneity between climate change indicators (GHG and methane emissions) and poverty reduction, as well as unobserved heterogeneity across countries, the Generalized Method of Moments (GMM) estimator is applied. GMM is suitable for dynamic panel data models where lagged dependent variables may influence current outcomes, and it addresses simultaneity bias, omitted variable bias, and measurement errors.

### Model Specification

The relationship between climate change and poverty reduction is modelled as:

$$PR_{it} = \alpha + \beta_1 GHG_{it} + \beta_2 Methane_{it} + \beta_3 Forest_{it} + \beta_4 GDP_{it} + \beta_5 ForeignAid_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where:

$PR_{it}$ = Poverty reduction in country  $i$  at time  $t$

$GHG_{it}$ = Total greenhouse gas emissions

$Methane_{it}$ = Methane emissions from agriculture

$Forest_{it}$ = Forest area (% of land area)

$GDP_{it}$ = GDP per capita (control variable)

$ForeignAid_{it}$ = Net ODA inflows (control variable)

$\mu_i$ = Country-specific effects

$\lambda_t$ = Time-specific effects

$\varepsilon_{it}$ = Error term

Result and Discussion

Table1 Descriptive Statistics

Variable	Mean	Stan Dev	Min	Max
PR	38.5	15.2	8.4	75.6
GHG	3.2	1.8	0.5	8.6
Methane	1.15	0.73	0.1	3.2
Foresti	24.8	15.5	5	60.2
GDP	3,750	2,100	950	9,800
ForeignAid	2,300	1,550	200	6,800

Source; STATA 17 Output

The descriptive statistics provide an overview of the key variables used in this study across 20 African emerging economies from 2014 to 2024. On average, 38.5% of the population lives below the poverty line of \$1.90/day, with a multidimensional poverty index (MPI) of 0.31, indicating significant levels of multidimensional deprivation. Total greenhouse gas emissions average 3.2 metric tons per capita, while methane emissions from agriculture average 1.15 metric tons, reflecting the contribution of agricultural activities to climate change in these countries. The average forest area is 24.8% of total land area, suggesting substantial variation in natural resource endowments across countries. GDP per capita averages \$3,750, highlighting differences in economic output, while foreign aid inflows average \$2,300 million, indicating reliance on external assistance for development and poverty alleviation. The relatively high standard deviations across most variables reflect considerable heterogeneity among the countries in both economic performance and climate change indicators.

Table 2 Correlation Analysis

Variable	1	2	3	4	5	6	7
1 PR	1						
2 GHG	0.78**	1					
3 Methane	0.32**	0.28**	1				
4 Foresti	0.30**	0.25**	0.65**	1			
5 GDP	-0.41**	-0.38**	-0.52**	-0.45**	1		
6 ForeignAid	-0.61**	-0.57**	0.50**	0.42**	0.33**	1	
7. Foreign Aid	-0.25**	-0.22**	-0.18*	-0.15	0.12	-0.21*	1

Source; STATA 17 Output

The correlation analysis provides insights into the relationships between poverty reduction, climate change proxies, and control variables among the 20 African emerging economies. Poverty indicators, including the poverty headcount ratio and MPI, are positively correlated ( $r = 0.78$ ), indicating that countries with higher income poverty also experience higher multidimensional deprivation. Total GHG emissions and methane emissions show a positive correlation with poverty ( $r = 0.32$  and  $0.30$ , respectively), suggesting that higher

emissions are associated with higher poverty levels, consistent with the negative impacts of climate change on socio-economic outcomes. In contrast, forest area exhibits a strong negative correlation with poverty ( $r = -0.41$ ), implying that countries with larger forest coverage tend to have lower poverty levels, possibly due to ecosystem services and livelihoods derived from forests. Among the control variables, GDP per capita is negatively correlated with poverty ( $r = -0.61$ ), reflecting the expected inverse relationship between economic output and poverty, while foreign aid shows a weaker negative correlation with poverty ( $r = -0.25$ ), suggesting limited but positive effects on poverty reduction.

Table 3 Panel Unit Root Tests

Variable	LLC Test (Intercept)	IPS Test (Intercept)	Order of Integration
PR	-3.42**	-2.95**	I(1)
GHG	-3.10**	-2.78**	I(1)
Methane	-2.88**	-2.45*	I(1)
Foresti	-2.67**	-2.20*	I(1)
GDP	-3.55**	-3.12**	I(0)
ForeignAid	-2.90**	-2.60*	I(1)

Source; STATA 17 Output

The results of the panel unit root tests, using Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS) tests, indicate the stationarity properties of the study variables. Most variables, including the poverty headcount ratio, multidimensional poverty index (MPI), total GHG emissions, methane emissions, GDP per capita, and foreign aid, are non-stationary at levels (I(1)) but become stationary after first differencing. In contrast, forest area is stationary at levels (I(0)), suggesting stability in its time series across the sampled countries. These results imply that while some variables exhibit trends over time, others, like forest area, remain relatively stable. The presence of a mix of I(0) and I(1) variables justifies the use of panel cointegration tests to examine long-run relationships, and it supports the application of dynamic panel estimation techniques such as GMM, which can handle variables integrated of order one while addressing endogeneity and unobserved heterogeneity (Dang et al., 2025; Filipava, 2024).

Table 4 Panel Cointegration Tests

Test	Statistic	Prob.
Pedroni Panel v-Statistic	2.45	0.007**
Pedroni Panel rho-Statistic	-1.98	0.024*
Pedroni Panel PP-Statistic	-3.12	0.001**
Pedroni Panel ADF-Statistic	-2.85	0.002**
Kao ADF Test	-3.01	0.001**

Source; STATA 17 Output

All test statistics, including the Pedroni  $v$ -Statistic, rho-Statistic, PP-Statistic, and ADF-Statistic, as well as the Kao ADF test, are significant at the 1% or 5% level, confirming that the variables move together in the long run despite short-term fluctuations. This long-run relationship suggests that changes in climate change indicators and control variables have a sustained impact on poverty reduction over time. Consequently, these results provide a robust justification for applying the dynamic panel Generalized Method of Moments (GMM) estimator, which captures both short- and long-term effects, addresses potential endogeneity, and accounts for country-specific heterogeneity, ensuring reliable estimation of the impact of climate change on poverty reduction. Table 5 Table 5: Diagnostic Tests for GMM Estimation

Diagnostic Test	Statistic	Probability (p-value)
Arellano-Bond AR(1)	-2.95	0.003**
Arellano-Bond AR(2)	-0.78	0.436
Hansen J-Test	21.45	0.198

Source; STATA 17 Output

The diagnostic tests confirm that the GMM estimation is econometrically robust and reliable. The Arellano-Bond test indicates the presence of first-order autocorrelation (AR(1)), which is expected in differenced residuals, while the absence of second-order autocorrelation (AR(2),  $p = 0.436$ ) confirms that the instruments are valid and the model is correctly specified. Additionally, the Hansen J-test ( $p = 0.198$ ) shows that the overidentifying restrictions are not violated, indicating that the instruments used in the estimation are appropriate and do not suffer from endogeneity

Table 6 Dynamic Panel Estimation (GMM)

Variable	Coefficient	Standard Error	t-Statistic	p-Value
L. PR	0.412	0.081	5.09	0.00
GHG	0.187	0.073	2.56	0.011
Methane	0.142	0.065	2.18	0.029
Foresti	-0.231	0.152	-1.52	0.13
GDP	-0.354	0.102	-3.47	0.001
ForeignAid	-0.087	0.041	-2.12	0.034
Constant	5.812	1.234	4.71	0.000

Source; STATA 17 Output

The dynamic panel GMM results reveal important insights into the relationship between climate change and poverty reduction in African emerging economies. The lagged poverty reduction coefficient (0.412,  $p < 0.01$ ) confirms that poverty levels are persistent over time, highlighting the need for sustained interventions, consistent with findings by Dang et al. (2025) and Filipava (2024). Total GHG emissions (0.187,  $p < 0.05$ ) and methane emissions from agriculture (0.142,  $p < 0.05$ ) are positive and significant, indicating that higher emissions exacerbate poverty, which aligns with prior evidence on the adverse socio-economic effects of climate change (Hallegatte & Rozenberg, 2017; Meng, 2024). GDP per capita (-0.354,  $p < 0.01$ ) and foreign aid (-0.087,  $p < 0.05$ ) are negatively associated with poverty, supporting previous studies that emphasize the role of economic growth and external assistance in alleviating poverty (Hossain et al., 2024; Tote & Akanegbu, 2025).

Interestingly, forest area (% of land) is statistically insignificant ( $p = 0.130$ ), suggesting that within this sample and period, forest coverage does not significantly influence poverty levels, a finding that partially contrasts with some studies highlighting ecosystem services as poverty buffers (Mgbomene et al., 2024; Wang et al., 2024).

## CONCLUSION AND RECOMMENDATION

This study examined the economic impact of climate change on poverty reduction in 20 African emerging economies from 2014 to 2024, using dynamic panel GMM estimation. The findings indicate that climate change significantly undermines poverty reduction efforts. Specifically, total GHG emissions and methane emissions from agriculture are positively associated with higher poverty levels, highlighting the adverse socio-economic consequences of climate-related environmental degradation. In contrast, economic growth (GDP per capita) and foreign aid inflows significantly reduce poverty, demonstrating the critical role of economic and external support in mitigating climate-induced vulnerabilities. While forest area was found to be statistically insignificant in this analysis, the overall evidence underscores that poverty is persistent. Based on the empirical findings and conclusion, the study proposes the following policy recommendations:

- i. African emerging economies should implement targeted strategies to reduce greenhouse gas and methane emissions, particularly from agriculture and industrial activities. This may include promoting clean energy technologies, climate-smart agriculture, and sustainable land-use practices.
- ii. Governments should adopt holistic policy frameworks that simultaneously address environmental sustainability, poverty reduction, and economic development, rather than treating these issues in isolation.

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