

Highlights



Climate vulnerable countries collectively account for less than 7 per cent of global GHG emissions yet suffer disproportionately from the impact of climate change.



Environmental stressors such as PM2.5 and high temperature have a negative impact on household consumption expenditure, thus exacerbating the poverty in climate vulnerable countries.



A comprehensive heat action plan will be crucial for climate vulnerable countries in the coming days.



Social Protection Programmes should be integrated with Climate Adaptation and Mitigation strategies



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Climate Change, Air Pollution, and the Poverty Trap

Evidence from 32 Climate Vulnerable Countries

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1. Introduction

Climate change is not an abstract, distant risk for low-income countries. It is an active, systemic force that shapes how households earn, spend, and survive. It is already reshaping poverty dynamics in many countries specially for climate vulnerable countries. (Moyer, et al., 2023) Hence, it is important to examine how climate change exacerbates the vulnerabilities and can reverse developmental gains. Global assessments show climate impacts represent a major obstacle to sustained poverty reduction (Winsemius, et al., 2018), and it could increase the number of people in extreme poverty without stronger adaptation and mitigation measures (Lankes, et al., 2023). The World Bank's synthesis work on climate and poverty highlights that climate shocks and gradual warming can significantly increase poverty exposure and slow down poverty reduction efforts (Bangalore, et al., 2016).

Moreover, ambient air pollution and its intersection with poverty are acute global problems. Recent global mapping estimates that millions of poor people live in areas with unsafe PM2.5 concentrations, concentrating health and economic risks among most vulnerable. Rentschler and Leonova (2023) demonstrate that 7.3 billion people worldwide (80 per cent of whom reside in low- and middle-income nations) are directly exposed to dangerous average annual PM2.5 concentrations using the World Health Organization's (WHO) 2021 revised fine particulate matter (PM2.5) criteria. Furthermore, Rentschler and Leonova (2023) also finds that 716 million of the world's poorest people, those who make less than USD 1.90 a day, live in regions with dangerously high air pollution, mostly in Sub-Saharan Africa.

It is worth noting that climate vulnerable countries' contribution to global greenhouse gas (GHG) emission is very insignificant, yet these countries suffer the most. For instance, Bangladesh contributes only 0.52 per cent of total GHG emissions (Climate Watch, 2025), but it suffers the consequence of recurring floods, cyclones, sea-level rise, and pro-longed heat stress. Moreover, Letsch et al. (2023) find the number of extreme weather events in Bangladesh increased by 46 per cent between 2017 and 2021. In 2024, Bangladesh suffered a total of BDT 14, 421.5 crore damage during the floods in eastern regions in late August and early September of 2024 (Khatun, et al., 2024). This amounted to 1.8 per cent

of national budget in FY2025. This illustrates the immediate welfare consequences for millions of households.

Across the wider climate vulnerable group, similar dynamics is seen. In Mozambique, Cyclone Idai (2019) caused damages of about USD 3 billion (Nhundu, et al., 2021), affecting 15,01,500 (EM-DAT, 2025) and erasing years of local development gains. In Tonga, the 2022 volcanic eruption and tsunami inflicted damages of USD 90 million, equivalent to 18.5 per cent of the country's gross domestic product (GDP), demonstrating how small island economies suffer outsized shocks (World Bank, 2022a). In Pakistan, the 2022 floods affected about 33 million people, with estimated 7.9 million displaced from their homes and further caused losses and damages exceeding USD 30.1 billion, pushing millions into poverty (National Disaster Management Authority, 2025). Even middle-income climate-vulnerable country such as Philippines faces annual losses from typhoons equivalent to 1.2 per cent of GDP (World Bank, 2022b). Taken together, the 32 CVF countries contribute less than 7 per cent of global GHG emissions (Climate Watch, 2025) but bear disproportionate damages year after year, making climate resilience an urgent poverty-reduction agenda.

Against this backdrop, this policy brief aims to quantify the long-run relationship between climate stressors and household consumption, define the channels through which climate risks translate into deeper and more persistent poverty and propose evidence-based actionable policy measures. A panel data of 32 climate-vulnerable countries (1996-2020) have been used to estimate how total GHG emissions, environmental stressors such as, PM2.5 air pollution, extreme heat, together with

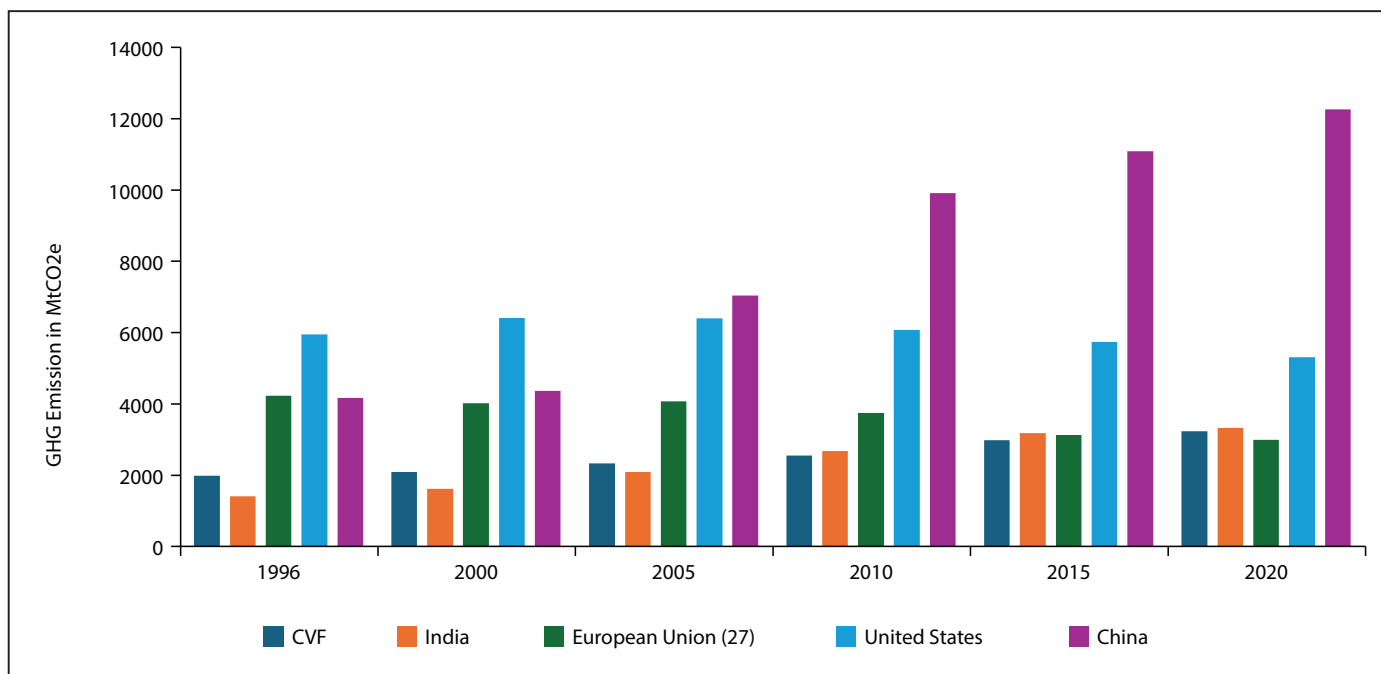
macroeconomic controls (GDP per capita and unemployment) affect poverty. This policy brief, based on the findings, provides recommendations for adaptive social protection, pollution control, and heat-health measures to protect household welfare now and to steer growth on a cleaner, more inclusive path.

2. Climate Change and Poverty Landscape

Climate vulnerable countries collectively account for less than 7 per cent of global GHG emissions yet suffer disproportionately from the impact of climate change. By contrast, our calculation showed that the top three emitters - China, the United States, and the European Union (27 countries) account for over 50 per cent of total global emissions. To illustrate this divergence, Figure 1 presents total GHG emissions (1996-2020) for the 32 selected climate vulnerable countries combined, alongside major emitters such as China, India, the United States, and the EU27.

Whilst emissions from climate vulnerable countries have remained relatively low and gradual, rising from around 2,000 MtCO₂e in 1996 to just over 3,000 MtCO₂e in 2020, China's emissions surged more than threefold over the same period, exceeding 12,000 MtCO₂e by 2020. The United States and EU27 have seen modest declines since the mid-2000s but still emit at levels far above the entire climate vulnerable countries' block. India's emissions have steadily increased, surpassing both climate vulnerable countries and EU27 levels by 2020. Climate vulnerable countries, despite contributing minimally to global emissions, face severe impact of climate change through floods, droughts, and heat stress that undermine household welfare.

Figure 1: Total GHG emissions of climate vulnerable countries vs major emitters (1996-2020)



Source: Software generated result compiled by authors using data from the Climate Watch 2025.

Climate change threatens poverty reduction by acting through multiple, reinforcing channels that decrease households' ability to earn, cope with climatic shocks and stresses, and invest. Rising temperatures, worsening air quality, and intensified hydrometeorological shocks reduce labour productivity and increase health expenditures, whilst floods and droughts destroy productive assets and raise the price of staples, all of which lower household consumption and increase poverty incidence (Rabassa, et al., 2011; Leichenko & Silva, 2014; Rozenberg & Hallegatte, 2015). These effects are highly regressive, low-income households are more exposed and possess weaker buffers, creating feedback that can trap families in persistent poverty (Barbier & Hochard, 2018; Hallegatte, et al., 2018). It is not only gradual climate change but also volatility in temperature and rainfall that deepens poverty vulnerability, with disproportionate impacts on the poorest groups (Ahmed, et al., 2009).

Food insecurity is another critical transmission channel through which climatic shocks worsen household welfare. In rural Bangladesh, climate shocks such as floods and droughts disrupt agricultural production, heightening household vulnerability, with disproportionate impacts on women and intra-household welfare outcomes (Alston & Akhter, 2016). Household responses to these shocks are mixed: evidence from coastal Bangladesh shows that climate-smart adaptation in agriculture can reduce food insecurity, whereas coping strategies such as borrowing or distress asset sales often deepen long-term vulnerability (Rahman, et al., 2023). At the food system level, rising temperatures, erratic rainfall, sea-level rise, and flooding threaten the stability of food supply chains, driving up prices and reinforcing malnutrition risks across climate-vulnerable countries like Bangladesh (Rahman, et al., 2024). In Sub-Saharan Africa, similar vulnerabilities emerge: Niger and Burkina Faso face recurrent droughts that not only devastate harvests but also exacerbate child malnutrition (Sultan, et al., 2025), whilst in Central America, Guatemala and Nicaragua are caught in the 'Dry Corridor' cycle of erratic rainfall and crop failure, amplifying rural poverty and migration pressures (Beveridge, et al., 2019).

Mitigation and adaptation policies influence these dynamics. Well-designed interventions can deliver benefits, such as improved air quality and the creation of new green livelihoods. Conversely, poorly targeted measures risk worsening vulnerability unless accompanied by social protection (Barbier, 2014; Bangalore, et al., 2014). Thus, climate and poverty policy must be seen as mutually reinforcing agendas.

The relationship between climate change, environmental degradation, and poverty has become a focal concern in achieving sustainable development goals. A growing body of literature highlights the multiple channels through which environmental stressors exacerbate poverty dynamics, particularly in low- and middle-income countries.

Baloch et al. (2020) examine the interplay between poverty, inequality, and carbon dioxide emissions across Sub-Saharan Africa, finding that rising poverty contributes to greater environmental degradation. This underscores the two-way linkage between welfare and emissions: poverty not only makes households more vulnerable to climate impacts but also perpetuates reliance on polluting activities. Similarly, Rentschler & Leonova, (2023) provide global evidence that ambient air pollution (PM_{2.5}) disproportionately affects low-income groups, both through higher exposure and greater vulnerability to health shocks, thus reinforcing poverty traps. Considering the facts mentioned, air pollution (PM_{2.5}) has been included in the present analysis, capturing one of the most direct channels through which climate change affects human welfare.

Temperature extremes represent another critical pathway. Dang et al. (2023) used a global subnational panel to show that a one-degree Celsius rise increases poverty by 9.1 per cent and inequality by 1.4 per cent, with the strongest effects in South Asia and Sub-Saharan Africa. These findings justify the inclusion of the heat index (HI35) as a proxy for climate-induced thermal stress, reflecting how hotter environments reduce labour productivity, undermine agricultural output, and erode welfare for poor and climate vulnerable households.

At the macroeconomic level, GHGs remain a central driver of global warming. Prior studies linking GHGs and welfare such as, Baloch, et al., (2020) point to the need to consider aggregate emissions alongside household-level impacts. GHG emissions thus serve as a structural determinant of long-run climate pressure. Meanwhile, GDP per capita is a conventional control for economic development, but existing work such as, Dang, et al. (2023) shows that income growth alone may not offset climate-driven poverty unless accompanied by adaptation.

Finally, the literatures emphasise the socioeconomic mediators of climate-poverty dynamics. Unemployment has been shown to deepen vulnerability, as job loss reduces household coping capacity in the face of environmental shocks. In contrast, household final consumption expenditure per capita (HFCE) is widely recognised as a robust proxy for welfare, especially when consistent poverty headcount data are unavailable (Wollburg, et al., 2023; Pinkovskiy & Sala-i-Martin, 2016). Because poverty is fundamentally a matter of inadequate consumption, HFCE captures the average welfare level of households and non-profit institutions serving households (NPISHs), providing a comparable measure across countries and over time.

Thus, poverty and welfare cannot be analysed in isolation from environmental stressors. Air pollution, temperature extremes, and GHG emissions directly shape poverty outcomes, whilst macroeconomic conditions and labour market factors determine the extent of household vulnerability. By integrating these variables into a panel framework, this study contributes to

understanding how climate change determines poverty dynamics in climate-vulnerable economies.

3. Data and Methodology

Based on Novignon et al. (2018), Baloch et al. (2020), Malerba (2020), and Açı et al. (2024), the following model has been considered in this paper.

$$LNHCE=f(LNPM2.5, LNUNEMP, LNGHG, LNGDPP, LNHI35).....(1)$$

In this study, panel data from 1996 to 2020 of 32 climate vulnerable countries have been used. The list of the countries is given in the annex table. The description of the variables used in equation 1 is summarised in the table 1 below.

Table 1: Description and Source of Data Used in the Analysis

Variable	Description	Source
LNHCE	Households and NPISHs Final consumption expenditure per capita (constant 2015 USD)	WDI, WB
LNPM2.5	PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	WDI, WB
LNUNEMP	Unemployment, total (per cent of total labour force) (modelled ILO estimate)	WDI, WB
LNGHG	Total GHG emissions by sector (MtCO ₂ e) - Total including LUCF	Climate Watch
LNGDPP	GDP per capita (constant 2015 USD)	WDI, WB
LNHI35	Heat Index 35	ESG, WB

Source: Compiled by authors.

Note: All variables were transformed to logarithmic form before analysis.

Several methodologies were employed to conduct the study. Firstly, Pesaran (2004) CD test was used to check the cross-sectional dependency among the variables in the model. To assure robustness, the study also employed Breusch-Pagan LM and Pesaran Scaled LM cross-section dependence.

Secondly, Cross-sectional Augmented Dickey Fuller (CADF) and Cross-sectional Im, Pesaran, Shin (CIPS) unit root tests by Pesaran (2007) were used to examine the stationarity of the variables since cross-sectional dependency were found by Pesaran CD test. The CADF and CIPS contain an assumption of cross-sectional dependency. Therefore, the information

provided by these experiments about the stationary properties is reliable.

Thirdly, a simple panel cointegration test developed by Westerlund (2005) was also employed. This cointegration test is straightforward and does not necessitate adjustments for temporal dependencies within the dataset. It allows for individual-specific short-term dynamics, as well as unique intercepts, trend components, and slope coefficients for each entity. The asymptotic distributions of the test statistics are derived and demonstrated to be independent of nuisance parameters.

Finally, Panel Dynamic Ordinary Least Square (PDOLS) developed by Kao & Chiang (2001) was used to estimate the long-run cointegrating factors. The PDOLS test provides a more accurate long-run estimate of the variables than conventional panel estimators by holding the long-run parameters constant across countries while permitting the short-run parameters to vary.

4. Result Analysis

Firstly, we check for cross-sectional dependency in the data using Breusch-Pagan LM, Pesaran scaled LM and Pesaran CD tests. Table 2 summarises the results from these tests. The results show that cross-sectional dependency exists in the data.

Table 2: Results from Cross Sectional Dependency Tests

Tests	Test Static
Breusch-Pagan LM	3554.44***
Pesaran scaled LM	73.41***
Pesaran CD	35.06***

Source: Software generated result compiled by authors.

Note: *** and ** refers significance level at 99 and 95 per cent. Null hypothesis for these tests is that there is no cross-section dependence in residuals against the alternative hypothesis of cross section dependence in residuals.

Since cross-sectional dependency exist, hence we used second generational panel unit root tests, such as CADF and CIPS for examining the stationarity of the data. The results show that all variables are stationary at their first-differenced form. The results are summarised in the Table 3 below.

Table 3: Results from Panel Unit Root Tests

CIPS				
Variable	Level		First Difference	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
LNHCE	-1.90	-2.21	-4.47***	-4.53***
LNPM2.5	-1.89	-2.35	-4.84***	-4.89***
LNUNEMP	-1.17	-1.10	-3.81***	-3.46***
LNGHG	-1.90	-2.21	-4.47***	-4.43***
LNGDPP	-0.98	-1.29	-2.97***	-3.18***
LNHI35	-1.63	-1.93	-4.65***	-4.93***

CADF				
Variable	Level		First Difference	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
LNHCE	-1.82	-1.54	-2.76***	-2.82***
LNPM2.5	-1.58	-1.94	-3.15***	-3.24***
LNUNEMP	-1.35	-2.35	-3.06***	-3.11***
LNGHG	-1.87	-2.23	-3.17***	-3.24***
LNGDPP	-1.01	-1.34	-2.10**	-2.34
LNHI35	-1.28	-1.62	-4.08***	-4.23***

Source: Software generated result compiled by authors.

Note: ***, ** and * refer significance level at 99, 95 and 90 per cent respectively. Critical values are not reported for the sake of brevity, however, can be delivered on request.

After stationarity check, a cointegration test was conducted to examine the long-run association among the variables in the model. The Westerlund Panel Cointegration test confirms the long-run association among the variables. The results are presented in Table 4.

Table 4: Results from Westerlund Panel Cointegration Test

Model Specification	Test Statistics
No Trend	2.12**
With Trend	12.29***

Source: Software generated result compiled by authors.

Note: ***, ** and * refer significance level at 99, 95 and 90 per cent respectively.

The results show that all the variables are cointegrated in the long run. Now, since the variables have long-run association, we estimate the empirical relationship between climate change and poverty using Panel Dynamic Ordinary Least Square (PDOLS) and the results are given in the table 5 below.

The PDOLS result shows that environmental stressors such as PM2.5 and heat index have a negative impact on household consumption expenditure. The result shows that a 1 per cent increase in PM2.5 decreases the household final consumption expenditure by 0.32 per cent. Besides, a 1 per cent increase in

Table 5: Estimation of Cointegrating Factors

Variables	PDOLS Estimation
LNPM2.5	-0.32** (0.12)
LNUNEMP	0.11 (0.09)
LNGHG	1.39*** (0.13)
LNGDPP	0.35*** (0.13)
LNHI35	-0.49*** (0.07)

Source: Software generated result compiled by authors.

Note: ***, ** and * refer significance level at 99, 95 and 90 per cent respectively.

heat index decreases the household final consumption expenditure by 0.49 per cent.

The intuition behind the empirical findings is that increased air pollution (which is measured by PM2.5) reduces health and worker productivity, increases medical expenditures, and may suppress labour supply or wages for the most vulnerable, all of which lower household consumption. This magnitude is consistent with recent micro and macro studies showing that

PM2.5 reduces income and labour supply, with stronger effects for low-skilled workers (He & Ji, 2021; Lin, et al., 2024).

Besides, heat exposure reduces physical labour capacity and increases rest and recovery needs, translating into lower productivity and incomes in heat-sensitive sectors (agriculture, construction). Meta-analyses and empirical studies document meaningful productivity losses at high temperatures. The result aligns with the literature on heat-related productivity and economic burdens (Borg, et al., 2021; Chavaillaz, et al., 2019).

GDP Per Capita and GHG emissions are found to have positive and significant relationships with consumption expenditure. A 1 per cent increase in per capita GDP and GHG emissions, increase household consumption per capita by 0.35 per cent and 1.39 per cent respectively. The findings are consistent with the expected positive effect of higher average income on consumption. At the macro level, greater GHG emissions are positively correlated with higher consumption per capita, reflecting the fact that emissions often rise with economic activity and industrial output. However, this positive association hides distributional and long-term trade-offs: whilst emissions move together with growth reflecting short-run welfare gains, they also feedback into higher temperatures and other hazards that reduce welfare through the channels above (Bangalore, et al., 2016).

Finally, unemployment is found to have positive but statistically insignificant impact on household consumption expenditure. The statistically significant negative elasticities for PM2.5 and heat index indicate that environmental stressors directly reduce household welfare, while GDP is associated with higher welfare. This underscores the policy objective: protect welfare from environmental damages whilst steering growth onto a cleaner trajectory.

5. Way Forward and Recommendations

From the analysis, it is found that environmental stressors such as PM2.5 air pollution and heat significantly reduce household consumption, with a 1 per cent increase in PM2.5 lowering consumption by 0.32 per cent and a 1 per cent rise in heat index reducing it by 0.49 per cent. At the same time, GDP per capita and GHG emissions are positively correlated with consumption, highlighting the tension between short-term growth and long-term climate risks. These findings confirm that climate-related hazards, such as prolonged heat stress and air pollution, directly impact households, particularly in climate vulnerable countries. They reduce household consumption expenditure, undermining welfare and exacerbating poverty, especially among low-income populations.

Climate-poverty nexus requires a multidimensional policy response that addresses immediate vulnerabilities whilst promoting long-term resilience. Based on these findings and the broader evidence on climate-poverty linkages, the following recommendations are proposed for climate vulnerable

countries to protect household welfare while promoting resilient and inclusive development:

Heat-Health and Urban Resilience strategies should be developed and implemented for the growing urban demographic

With escalating temperatures, cities and urban areas need strong and proactive heat action plans. The study analysis shows that a 1 per cent increase in heat index reduces household consumption expenditure by 0.49 per cent, highlighting the significant welfare impact of thermal stress. Cities across climate vulnerable countries should expand shaded public spaces, introduce worker protection measures (cooling breaks, hydration support), and strengthen hospital preparedness for heat-related illnesses. Protecting workers of informal sectors from heat stress is vital to sustaining household incomes, particularly in regions where livelihoods are heavily outdoor based. Dhaka's initiatives such as, green belts, reflective roofing, and urban cooling programmes provide a model to build upon.

Air Pollution control should be strengthened by transitioning into Clean Energy and Green Transportation

Regular exposure to PM2.5 reduces household welfare and must be tackled alongside climate goals. The study finds that a 1 per cent increase in PM2.5 reduces household consumption by 0.32 per cent, reflecting the direct economic burden of poor air quality. Climate vulnerable countries should accelerate the transition to clean energy and transportations, drawing on successful models such as India's clean cooking fuel programme and Nepal's household solar schemes. Policies should include stricter regulation of industrial emissions, expanded solar home systems, and subsidies or microloans for improved cookstoves and biogas systems.

Social Protection Programmes should be integrated with Climate Adaptation and Mitigation strategies

Climate vulnerable countries should move towards adaptive social protection, aligning social safety nets (SSNs) with climate adaptation and disaster management. This means prioritising poor households in climate-vulnerable regions and linking cash transfers with climate-smart inputs (saline-tolerant seeds, disaster preparedness training, etc.). Regular reviews of SSNs are needed to avoid overlaps, improve targeting, and strengthen resilience against recurrent shocks.

Climate-Smart Agriculture should be promoted for Livelihood Diversification and Resilience

Scaling up climate-smart agriculture (CSA) is essential to stabilise food security and rural incomes. Evidence from coastal Bangladesh shows CSA adoption significantly reduces poverty. For instance, Islam and Farjana (2024) finds adoption of

climate-smart agriculture can reduce multidimensional poverty by 41 per cent. Policies should expand access to stress-tolerant crop varieties, improved irrigation, agroforestry, and conservation farming. Beyond agriculture, investment in green jobs (renewable energy, waste management, reforestation) and skills training can diversify income sources and reduce vulnerability among the affected population.

Financial Resilience Mechanisms should be expanded

Vulnerable households need greater access to credit, insurance, and savings to withstand climate shocks. The study findings indicate that climate shocks directly reduce consumption, reinforcing the need for financial instruments such as weather-index insurance, microfinance guarantees, and digital savings platforms. Scaling up these programmes and platforms can reduce reliance on harmful coping strategies such as distress asset sales after climatic shocks. Pilot projects in Bangladesh and South Asia show that climate-linked financial tools encourage productive investment while strengthening resilience.

Investment in Resilient Infrastructure and Locally Led Adaptation should be done

Continued investment in resilient infrastructures—such as cyclone shelters, embankments, flood-proof roads, and safe

drinking water— remain critical. Bangladesh's success in reducing cyclone fatalities illustrates the payoff of such measures. Community-led adaptation initiatives and nature-based solutions (NbS) like raised water points, mangrove replantation, and elevated housing, should be scaled up across climate vulnerable countries, ensuring local ownership and strong benefit-cost returns.

Policy Coordination should be enhanced for Inclusive Governance

Effective climate–poverty policy requires aggregation across ministries and levels of government. Establishing a unified framework that integrates vulnerability mapping, social protection, and climate finance will improve targeting by directing resources to the poorest and most climate-exposed areas and enhance efficiency by aligning budgets and delivery systems across programmes. Policies must also prioritise women, children, and other marginalised groups disproportionately affected by climate shocks. Regional cooperation within the CVF and South Asia such as, early warning systems and seed distribution can further strengthen resilience.

References

- Açci, Y., Uçar, E., Uçar, M., & Açci, R. (2024). Evaluating the relationship between climate change, food prices, and poverty: empirical evidence from underdeveloped countries. *Environment, Development and Sustainability*. <https://doi.org/10.1007/s10668-024-05611-4>
- Ahmed, S. A., Diffenbaugh, N. S., & Hertel, T. W. (2009). Climate volatility deepens poverty vulnerability in developing countries. *Environmental Research Letters*.
- Alston, M., & Akhter, B. (2016). Gender and food security in Bangladesh: the impact of climate change. *Gender, Place & Culture*.
- Baloch, M. A., Danish, Khan, S. U.-D., Ulucak, Z. Ş., & Ahmad, A. (2020). Analyzing the relationship between poverty, income inequality, and CO2 emission in Sub-Saharan African countries. *Science of The Total Environment*.
- Bangalore, M., Hallegatte, S., Bonzaingo, L., Kane, T., Fay, M., Narloch, U., . . . Vogt-Schilb, A. (2016). *Shock Waves: Managing the Impacts of Climate Change on Poverty*. World Bank.
- Bangalore, M., Hallegatte, S., Bonzanigo, L., Fay, M., Narloch, U., Rozenberg, J., & Vogt-Schlib, A. (2014). *Climate Change and Poverty—An Analytical Framework*. World Bank Group.
- Barbier, E. B. (2014). Climate change mitigation policies and poverty. *WIREs Climate Change*, 483-491.
- Barbier, E. B., & Hochard, J. P. (2018). The Impacts of Climate Change on the Poor in Disadvantaged Regions. *Review of Environmental Economics and Policy*.
- Beveridge, L., Whitfield, S., Fraval, S., Van Wijk, M., Van Etten, J., Mercado, L., . . . Challinor, A. (2019). Experiences and Drivers of Food Insecurity in Guatemala's Dry Corridor: Insights From the Integration of Ethnographic and Household Survey Data. *Frontiers in Sustainable Food Systems*, 65.
- Borg, M. A., Xiang, J., Anikeeva, O., Pisaniello, D., Hansen, A., Zander, K., . . . Bi, P. (2021). Occupational heat stress and economic burden: A review of global evidence. *Environmental Research*.
- Chavaillaz, Y., Roy, P., Partanen, A.-I., Da Silva, L., Bresson, É., Mengis, N., . . . Matthews, H. D. (2019). Exposure to excessive heat and impacts on labour productivity linked to cumulative CO2 emissions. *Scientific Reports*.
- Climate Watch. (2025). *Data Explorer: Climate Watch*. Retrieved from Climate Watch: www.climatewatchdata.org
- Dang, H.-A. H., Cong Nguyen, M., & Trinh, T.-A. (2023). *Does hotter temperature increase poverty and inequality? Global evidence from subnational data analysis*. London School of Economics and Political Science.
- EM-DAT. (2025). *Public EM-DAT*. Retrieved from EM-DAT: International Disaster Database: <https://public.emdat.be/data>
- Hallegatte, S., Fay, M., & Barbier, E. B. (2018). Poverty and climate change: introduction. *Environment and Development Economics*.
- He, Q., & Ji, X. (. (2021). The Labor Productivity Consequences of Exposure to Particulate Matters: Evidence from a Chinese National Panel Survey. *International Journal of Environmental Research and Public Health*.
- Islam, M. K., & Farjana, F. (2024). Does e-agriculture practice matter for poverty reduction among coastal farm households? *Journal of Agriculture and Food Research*. <https://doi.org/10.1016/j.jafr.2024.101212>
- Kao, C., & Chiang, M.-H. (2001). On the estimation and inference of a cointegrated regression in panel data. In B. Baltagi, T. Fomby, & R. Hill, *Advances in Econometrics Nonstationary Panels, Panel Cointegration, and Dynamic Panels* (pp. 179-222). Emerald Group Publishing Limited. [https://doi.org/10.1016/S0731-9053\(00\)15007-8](https://doi.org/10.1016/S0731-9053(00)15007-8)

- Khatun, F., Kamal, M., Kabir, F. A., & Huq, P. K. (2024). *Eastern Bangladesh Floods in 2024: Analysis of Immediate Damages and Recovery Efforts*. Centre for Policy Dialogue.
- Lankes, H. P., Macquarie, R., Soubeyran, É., & Stern, N. (2023). The Relationship between Climate Action and Poverty Reduction. *The World Bank Research Observer*, 1-46. <https://doi.org/10.1093/wbro/lkad011>
- Leichenko, R., & Silva, J. A. (2014). Climate change and poverty: vulnerability, impacts, and alleviation strategies. *WIREs Climate Change*.
- Letsch, L., Dasgupta, S., & Robinson, E. J. (2023). *Tackling flooding in Bangladesh in a changing climate*. Centre for Climate Change Economics and Policy.
- Lin, J., Wan, H., & Yu, Y. (2024). What you breathe makes you poor: The effect of air pollution on income. *China Economic Review*.
- Malerba, D. (2020). Poverty alleviation and local environmental degradation: An empirical analysis in Colombia. *World Development*, 127(2020). <https://doi.org/10.1016/j.worlddev.2019.104776>
- Moyer, J. D., Pirzadeh, A., Irfan, M., Solórzano, J., Stone, B., Xiong, Y., . . . Hughes, B. B. (2023). How many people will live in poverty because of climate change? A macro-level projection analysis to 2070. *Climate Change*.
- National Disaster Management Authority. (2025). *A Comprehensive Study of Flood Events in Pakistan (1950-2025)*. National Institute of Disaster Management.
- Nhundu, K., Sibanda, M., & Chaminuka, P. (2021). Economic Losses from Cyclones Idai and Kenneth and Floods in Southern Africa: Implications on Sustainable Development Goals. In G. Nhamo, & D. Chikodzi, *Cyclones in Southern Africa* (pp. 289-303). Cham: Springer International Publishing.
- Novignon, J., Nonvignon, J., & Mussa, R. (2018). The poverty and inequality nexus in Ghana: A decomposition analysis of household expenditure components. *International Journal of Social Economics*, 45(2), 246-258. <https://doi.org/10.1108/IJSE-11-2016-0333>
- Pesaran, M. (2004). *General Diagnostic Tests for Cross Section Dependence in Panels*. Bonn, Germany: University of Cambridge.
- Pesaran, M. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2007), 265-312. <https://doi.org/10.1002/2Fjae.951>
- Pinkovskiy, M., & Sala-i-Martin, a. (2016). Lights, Camera ... Income! Illuminating the National Accounts-Household Surveys Debate. *The Quarterly Journal of Economics*, 579-631.
- Rabassa, M., Skoufias, E., & Oliveieri, S. (2011). *The poverty impacts of climate change: A review of the evidence*. World Bank.
- Rahman, M. M., Chowdhury, M. M., Al Imran, M. I., Malik, K., Abubakar, I. R., Aina, Y. A., . . . Rahman, s. M. (2024). Impacts of climate change on food system security and sustainability in Bangladesh. *Journal of Water and Climate Change*, 2162-2187.
- Rahman, M. S., Zulfikar, F., Ullah, H., Himanshu, S. K., & Datta, A. (2023). Farmers' perceptions, determinants of adoption, and impact on food security: case of climate change adaptation measures in coastal Bangladesh. *Climate Policy*, 1257-1270.
- Rentschler, J., & Leonova, N. (2023). Global air pollution exposure and poverty. *Nature Communications*.
- Rozenberg, J., & Hallegatte, S. (2015). *The Impacts of Climate Change on Poverty in 2030 and the Potential from Rapid, Inclusive, and Climate-Informed Development*. World Bank.
- Sultan, B., Barriquault, A., Brouillet, A., Lavarenne, J., & Pongsiri, M. (2025). Malnutrition and Climate in Niger: Findings from Climate Indices and Crop Yield Simulations. *International Journal of Environmental Research and Public Health*, 551.
- Westerlund, J. (2005). *New Simple Tests for Panel Cointegration*. 25(3), 297-316. <https://doi.org/10.1080/07474930500243019>

Winsemius, H. C., Jongman, B., Veldkamp, T. I., Hallegatte, S., Bangalore, M., & Ward, P. J. (2018). Disaster risk, climate change, and poverty: assessing the global exposure of poor people to floods and droughts. *Environment and Development Economics*, 328-348. <https://doi.org/10.1017/S1355770X17000444>

Wollburg, P., Hallegatte, S., & Mahler, D. G. (2023). Ending extreme poverty has a negligible impact on global greenhouse gas emissions. *Nature*.

World Bank. (2022a). *Country Climate and Development Report*. World Bank Group.

World Bank. (2022b). *Global Rapid Post Disaster Damage Estimation (GRADE) Report*. World Bank Group.

Disclaimer: *The findings and conclusions contained within this policy brief are those of the authors and do not necessarily reflect the views of the Centre for Policy Dialogue (CPD).*

Annex

Table 6: List of Countries in the Analysis and their GHG Emissions

Country	Total GHG Emission in 2022 (MtCO ₂ e)	% of Total GHG Emission in 2022
Bangladesh	262.09	0.52
Benin	26.35	0.05
Bhutan	0.85	0.00
Burkina Faso	60.42	0.12
Chad	122.33	0.24
Colombia	300.94	0.59
Comoros	0.75	0.00
Democratic Republic of the Congo	707.61	1.39
Dominican Republic	44.94	0.09
Gabon	22.19	0.04
Guatemala	44.4	0.09
Kenya	83	0.16
Lebanon	15.7	0.03
Madagascar	43.45	0.09
Morocco	101.02	0.20
Mozambique	119.49	0.24
Namibia	22.23	0.04
Nicaragua	40.16	0.08
Niger	47.05	0.09
Pakistan	606.92	1.19
Paraguay	89.92	0.18
Philippines	253.07	0.50
Rwanda	9.8	0.02
Senegal	36.62	0.07
Sierra Leone	10.41	0.02
Sudan	133.01	0.26
Tanzania	179.23	0.35
Togo	10.1	0.02
Tonga	0.3	0.00
Tunisia	40.26	0.08
Uganda	63.84	0.13
CVF Countries Combined	3498.45	6.89
World	50809.05	100

Source: Author's calculation based on data from Climate Watch (2025).

This policy brief investigates how climate change and air pollution deepen poverty in the selected 32 climate vulnerable countries. The objective is to analyse the long-run relationship between environmental stressors and household welfare, and to recommend policy intervention that can break this climate–poverty trap.

Using panel data for 1996–2020, the study models household final consumption expenditure per capita as a function of PM2.5 exposure, heat index 35 (HI35), total GHG emissions, GDP per capita and unemployment. The study further employs cross-sectional dependence test, second generation panel unit root test, cointegration test, and Panel Dynamic Ordinary Least Square (PDOLS) method for estimating long-run cointegrating factors.

The study finds that selected 32 climate vulnerable countries collectively account for less than 7 per cent of global GHG emissions yet suffer disproportionately from the impact of climate change. Besides, the study also highlights that environmental stressors such as PM2.5 and high temperature have a negative impact on household consumption expenditure, thus exacerbating the poverty in climate vulnerable countries.

The policy brief also proposes a set of recommendations which include implementing comprehensive urban heat resilience plan; controlling air pollution strictly by transitioning into clean energy and green transportation; integrating social protection with climate adaptation; scaling climate-smart agriculture and green jobs; enhancing access to finance of climate-vulnerable households; investing in locally led adaptation; and strengthening regional cooperation targeting the poorest and most climate-exposed households.

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