

The Impact of Environmental Quality Index and Environmental Degradation on Poverty Risk: Evidence from 23 Districts/Cities in Aceh, Indonesia

Rollis Juliansyah^{1*}, Noval Suhendra², Helmi Noviar³, Mauliza⁴, Hidayatul Fitri⁵

^{1,2,3} Department of Development Economics, Faculty of Economics and Business, Teuku Umar University, Indonesia

^{4,5} Department of Economics and Islamic Studies, State Islamic College (STAIN) Teungku Dirundeng Meulaboh, Indonesia

*Corresponding Author: rollisjuliansyah@utu.ac.id

Received: 02/07/2026 | Revised: 29/08/2026 | Accepted: 05/09/2026 | Publication: 21/09/2026

Abstract: This study examines the effects of environmental quality and environmental degradation on poverty risk across 23 districts/cities in Aceh, Indonesia. Unlike most Indonesian poverty studies that primarily emphasize socioeconomic determinants, this study integrates environmental quality and environmental degradation simultaneously within a district-level panel data framework to broaden the analysis of regional poverty. Using district-level panel data for 2019-2023, the study applies a fixed-effects model with year controls, selected based on the Hausman test, to account for unobserved regional heterogeneity and time-specific shocks. The district poverty rate measures poverty risk. Environmental quality is represented by a composite Environmental Quality Index based on sanitation, safe drinking water, and land-cover quality. In contrast, environmental degradation is measured using a composite index of disaster exposure and land pressure. Data are obtained from Statistics Indonesia, the Ministry of Environment and Forestry, and the National Disaster Management Agency. The results show that environmental quality significantly reduces poverty risk, whereas environmental degradation significantly increases it, after controlling for regional income, unemployment, and education. A ten-point increase in environmental quality reduces the poverty rate by about 0.6 percentage points, whereas a ten-point increase in environmental degradation increases it by about 0.5 percentage points. These findings indicate that poverty reduction in Aceh requires not only economic growth and labor-market interventions but also stronger environmental governance, particularly in districts facing persistent ecological stress and weak environmental services.

Keywords: *environmental quality, environmental degradation, poverty, panel data, Aceh*

How to Cite: Juliansyah, R., Suhendra, N., Noviar, H., Mauliza, & Fitri, H. (2026). The Impact of Environmental Quality Index and Environmental Degradation on Poverty Risk: Evidence from 23 Districts/Cities in Aceh, Indonesia. *Journal of Economics and Management*, 4(3), 1137-1151. <https://doi.org/10.70716/ecoma.v4i3.700>

INTRODUCTION

Poverty remains a central issue in regional development because it reflects not only low income but also unequal access to productive assets, public services, and risk protection. In development economics, poverty is closely linked to environmental conditions because poor households are usually more exposed to climate shocks, ecosystem decline, health hazards, and resource scarcity than better-off groups (Sen, 1999; Haughton & Khandker, 2009; Hallegatte et al., 2016). This relationship is especially

important in regions where livelihoods still depend on agriculture, fisheries, forests, and climate-sensitive informal activities.

Aceh provides a relevant setting for studying this issue. The province has continued to record a poverty rate above the national average in recent years, and it remains one of the provinces with the highest poverty incidence in Sumatra (BPS Provinsi Aceh, 2024; BPS, 2024a). At the same time, Aceh shows strong ecological variation across districts and cities. Some districts are more urbanized and service-oriented, while others depend heavily on natural resources, face disaster exposure, or experience pressure on forests, land, and local environmental services (KLHK, 2024a; BNPB, 2024; Saputra et al., 2021; Juliansyah et al., 2025). This combination makes Aceh suitable for analyzing whether environmental quality and environmental degradation help explain cross-district differences in poverty risk.

Theoretically, better environmental quality can reduce poverty through several channels. Safer drinking water and better sanitation improve health and labor productivity. Better land cover and ecosystem quality support agriculture, reduce exposure to flooding and erosion, and stabilize local livelihoods. Environmental quality can also reduce private coping costs because households spend less on illness, water procurement, housing repairs, and temporary relocation (Barbier, 2010; Dasgupta et al., 2005; UNEP, 2011). By contrast, environmental degradation can deepen poverty by damaging assets, reducing agricultural yields, disrupting mobility, and increasing vulnerability to repeated shocks (Ahmed et al., 2011; Hallegatte et al., 2016; IPCC, 2022).

The poverty-environment nexus has been widely discussed in global development literature, but empirical evidence remains mixed and context-dependent. Some studies show that environmental stress and climate volatility worsen welfare outcomes, especially among households with limited savings and low adaptive capacity (Skoufias et al., 2011; Islam & Winkel, 2017; IPCC, 2022; Miswa & Kartiasih, 2025; Ssekibaala & Kasule, 2023). Other studies argue that the relationship is not automatic because it depends on institutions, infrastructure, access to services, and local economic structures (Barbier & Hochard, 2018; Béné et al., 2014; Fadhil et al., 2025; Ssekibaala & Kasule, 2023). In practice, this means that the same environmental shock may produce very different poverty outcomes across regions.

For Indonesia, many empirical studies on poverty primarily emphasize conventional socioeconomic determinants, including economic growth, income, human capital, labor markets, inflation, government expenditure, and social assistance (Fauzi et al., 2025; Farlian et al., 2025). Although these studies have provided valuable insights into the drivers of regional poverty, they generally examine environmental conditions separately or treat them as contextual factors rather than integrating environmental quality and environmental degradation simultaneously within a regional poverty framework. Consequently, evidence on how improvements in environmental quality and increasing environmental degradation jointly influence poverty at the district/city level remains limited (Saputra et al., 2021). This gap is more visible at the subnational level, particularly for Aceh, where environmental conditions vary substantially across districts and where livelihoods remain closely linked to natural resources and disaster exposure. Most policy discussions continue to treat environmental management and poverty reduction as separate agendas, even though they interact through livelihoods, health, disaster exposure, and fiscal pressure (Bappenas, 2021; KLHK, 2024b; Saputra et al.,

2021). Therefore, an empirical study that places environmental conditions within a regional poverty framework is needed.

This study addresses that gap by examining the impact of the Environmental Quality Index and Environmental Degradation on poverty risk across 23 districts/cities in Aceh. Its primary contribution is not the use of panel data, which has become common in regional economic research, but the simultaneous integration of environmental quality and environmental degradation into a regional poverty analysis using district-level evidence. This approach broadens the analytical perspective beyond conventional socioeconomic determinants by explicitly incorporating environmental conditions as an integral component of regional welfare dynamics. In addition, the study operationalizes environmental quality and environmental degradation through a transparent, replicable composite indicator framework based on official secondary statistics, enabling consistent measurement across districts and over time. These contributions provide additional empirical evidence for regional economics, development management, and environmental policy, particularly in regions facing persistent ecological pressures. Therefore, an empirical study that places environmental conditions within a regional poverty framework is needed, particularly because recent evidence increasingly emphasizes that environmental quality should be analyzed together with socioeconomic development rather than as an isolated ecological issue (Miswa & Kartiasih, 2025; Huang et al., 2024; Shen & Xin, 2026).

Based on this background, the study asks four questions. First, how has poverty risk evolved across Aceh's 23 districts/cities from 2019 to 2023? Second, does environmental quality significantly affect poverty risk? Third, does environmental degradation significantly affect poverty risk? Fourth, do these effects remain significant after accounting for income, unemployment, and education? In line with these questions, the study tests the hypothesis that higher environmental quality reduces poverty risk, while higher environmental degradation increases poverty risk.

RESEARCH METHODS

Research Design and Unit of Analysis

This study uses a quantitative explanatory design with panel data for 23 districts/cities in Aceh during 2019–2023. The district/city is the unit of cross-sectional analysis, while the year is the time dimension. The panel approach is appropriate because it allows the estimation to control for unobserved district-specific characteristics that do not change over time, such as geography, historical infrastructure inequality, or institutional legacies (Baltagi, 2021; Wooldridge, 2010).

The study period begins in 2019 because district-level environmental and socioeconomic indicators become more consistent after that year in many official publications. The period ends in 2023 because several environmental indicators for 2024 are not yet published in a complete district-by-year format across all relevant institutions. This choice improves comparability and reduces the need for aggressive data imputation.

Data Sources

The study relies on official secondary data. Poverty, regional income, unemployment, education, and demographic variables are compiled from Statistics Indonesia, including Aceh in Figures, district/city statistical yearbooks, and national poverty profiles (BPS Provinsi Aceh, 2024; BPS, 2024a; BPS, 2024b; Farlian et al., 2025; Juliansyah et al., 2025). Environmental indicators are drawn from the Ministry of

Environment and Forestry and related environmental statistical reports, especially for land-cover and environmental status information (KLHK, 2024a; KLHK, 2024b; Saputra et al., 2021). Disaster-related indicators are taken from the National Disaster Management Agency database, especially flood and landslide frequency by district/city (BNPB, 2024; Juliansyah et al., 2025). The indicator construction also follows the logic of composite index design in applied policy research (OECD, 2008).

For transparency and reproducibility, the component indicators are mapped to their respective official data sources as follows: access to improved sanitation and safe drinking water is obtained from Statistics Indonesia (BPS) district/city statistical publications and related welfare statistics; land-cover quality and degraded land pressure are obtained from environmental statistics published by the Ministry of Environment and Forestry (KLHK); while flood and landslide occurrence are obtained from the National Disaster Management Agency (BNPB) disaster database. The same source structure is applied consistently across districts/cities and years to the extent that the indicators are available.

Variable Measurement

The dependent variable is poverty risk, proxied by the poverty rate, measured as the percentage of the poor population in each district/city-year. This measure is standard in Indonesian poverty statistics and remains the most policy-relevant indicator for regional comparison (BPS, 2024a; Haughton & Khandker, 2009). As a robustness check, the analysis also considers the poverty depth index and poverty severity index where the series are available.

In this study, "poverty risk" refers to regional exposure to poverty, as represented by the district/city poverty rate, rather than an individual-level probability of becoming poor. Accordingly, interpret the estimated coefficients as changes in the regional poverty rate associated with changes in the explanatory variables, conditional on the other variables in the model.

The first core explanatory variable is the Environmental Quality Index (EQI). Because district-level annual environmental quality is not always published as a single ready-to-use official index, the study constructs a composite measure based on official indicators that directly reflect local environmental service quality. The EQI includes access to improved sanitation, access to safe drinking water, and land-cover quality. These indicators capture household-level environmental services and ecological support conditions, both of which matter for welfare outcomes (UNEP, 2011; KLHK, 2024b).

The second core explanatory variable is the Environmental Degradation Index (EDI). This index combines indicators of ecological pressure and environmental risk that are available in official administrative statistics, namely flood occurrence, landslide occurrence, and degraded land pressure. These indicators capture recurrent environmental stress that may increase household vulnerability and poverty exposure (Ahmed et al., 2011; IPCC, 2022; BNPB, 2024).

The control variables are GRDP per capita, open unemployment rate, and mean years of schooling. GRDP per capita reflects regional economic capacity and is expected to reduce poverty risk. Unemployment is expected to increase poverty risk because weaker labor-market absorption reduces household income stability. Education is expected to reduce poverty risk through productivity gains, employability, and adaptive capacity (Ravallion, 2016; Alkire & Foster, 2011; UNDP, 2022).

Composite Index Construction



All component indicators are normalized to a 0–100 scale. The normalization procedure uses the minimum and maximum values calculated from the pooled panel dataset covering all districts/cities and years (2019–2023), rather than normalizing each year separately. This approach preserves comparability across both the cross-sectional and temporal dimensions of the panel, ensuring that observed changes in the composite indices reflect actual differences in environmental conditions rather than shifts in annual scaling. For a positive environmental quality indicator, the normalization is:

$$Z_{it} = \frac{X_{it} - X_{min}}{X_{max} - X_{min}} \times 100$$

For a degradation indicator where a higher raw value reflects a worse environmental condition, the same normalization is retained for the EDI so that a higher index always means greater degradation. The Environmental Quality Index is constructed as:

$$EQI_{it} = \frac{Sanitation_{it} + DrinkingWater_{it} + LandCover_{it}}{3}$$

The Environmental Degradation Index is constructed as:

$$EDI_{it} = \frac{Flood_{it} + LandSlide_{it} + LandPressure_{it}}{3}$$

For both indices, each component receives an equal weight of one-third. Thus, EQI is the arithmetic mean of the normalized sanitation, drinking-water, and land-cover indicators. Similarly, EDI is the arithmetic mean of the normalized flood, landslide, and degraded-land indicators. Because all component indicators are expressed on the same 0–100 scale before aggregation, the resulting composite indices remain directly comparable across districts/cities and years. A higher EQI therefore indicates better environmental conditions, whereas a higher EDI indicates greater environmental degradation.

The study uses equal weighting to maintain transparency and avoid arbitrary weight selection when no strong theoretical or institutional basis supports differential weighting. Equal weighting is common in applied composite index studies when the purpose is policy comparison rather than engineering calibration (OECD, 2008; Juliansyah et al., 2025). Alternative weighting approaches, such as Principal Component Analysis (PCA), Entropy Weighting, and the Analytic Hierarchy Process (AHP), were considered conceptually but were not adopted in this study. PCA and Entropy Weighting derive weights from statistical variation, making the resulting index dependent on the observed sample distribution. In contrast, AHP relies on expert judgments beyond the scope of this research. Because this study aims to develop a transparent, replicable, policy-oriented composite index based on official district-level indicators, equal weighting provides a straightforward, consistent approach that facilitates comparisons across districts and over time while remaining consistent with OECD (2008) guidelines. Transparent composite indicators also align with recent studies examining multidimensional relationships between environmental quality and poverty, where indicator transparency and policy interpretability are prioritized over statistically derived weighting schemes (Miswa & Kartiasih, 2025).

Econometric Model

The main estimation equation is:

$$PR_{it} = \beta_0 + \beta_1 EQI_{it} + \beta_2 EDI_{it} + \beta_3 \ln(GRDPpc_{it}) + \beta_4 UMP_{it} + \beta_5 EDU_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$
where (PR_{it}) is poverty risk in district/city (i) in year (t), (EQI_{it}) is the Environmental Quality Index, (EDI_{it}) is the Environmental Degradation Index, ($\ln(GRDPpc_{it})$) is the natural logarithm of GRDP per capita, (UMP_{it}) is the open unemployment rate, and (EDU_{it}) is mean years of schooling. The term (μ_i) captures district fixed effects, and (λ_t) captures year effects.

The estimation begins with pooled ordinary least squares, followed by fixed-effects and random-effects models. The Hausman test then selects the preferred specification. Robust standard errors clustered at the district/city level reduce the risk of biased inference under heteroskedasticity and within-panel serial correlation (Wooldridge, 2010; Baltagi, 2021; Juliansyah et al., 2025).

For interpretation, the fixed-effects coefficients represent conditional within-district associations after accounting for time-invariant district characteristics and common year effects. They should not be interpreted as definitive causal effects because the present design cannot fully rule out reverse causality and time-varying omitted factors.

Although the fixed-effects estimator controls for time-invariant unobserved heterogeneity across districts/cities, it cannot fully rule out endogeneity. Environmental quality and poverty may influence each other through dynamic relationships, including public investment capacity, environmental management, and household resource use. Consequently, interpret the estimated coefficients as conditional associations rather than definitive causal effects. Addressing potential endogeneity through instrumental-variable techniques or dynamic panel estimators is beyond the scope of the present study and represents an important direction for future research.

The study estimates the main relationships using a fixed-effects model with cluster-robust standard errors to mitigate heteroskedasticity and within-panel serial correlation (Wooldridge, 2010; Baltagi, 2021). Nevertheless, we did not implement additional diagnostic procedures, including multicollinearity assessment through Variance Inflation Factors (VIF), cross-sectional dependence tests, and alternative estimators such as Driscoll-Kraay or Panel Corrected Standard Errors (PCSE), because they were beyond the scope of the available empirical framework. Future studies with more extensive datasets are encouraged to incorporate these diagnostic and robustness procedures to strengthen model validation further.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 1 reports the descriptive statistics for the study variables. The authors computed these statistics from official secondary sources and the composite-index procedure described in the Data Sources and Composite Index Construction sections; the resulting panel dataset has not been published separately. The district-level poverty rate in Aceh varies substantially, indicating that poverty is not evenly distributed across the province. Environmental quality and environmental degradation also vary considerably, which supports the use of panel estimation to capture local differences.

Table 1. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Poverty rate (%)	115	14.82	4.66	6.15	28.12
Environmental Quality Index	115	61.47	9.53	39.22	81.36
Environmental Degradation Index	115	48.90	11.24	24.10	79.83
ln(GRDP per capita)	115	10.89	0.54	9.78	12.11
Unemployment rate (%)	115	7.41	1.94	3.62	12.48
Mean years of schooling	115	8.92	1.12	6.77	11.34

The descriptive patterns suggest three important points. First, poverty remains structurally high in several districts, even though some districts have performed better than others over time. Second, environmental quality does not move uniformly with economic development. Some districts with stronger income indicators still show poorer environmental-service quality, particularly in sanitation and ecological support conditions. Third, environmental degradation varies sharply across districts, especially where disaster exposure and land pressure are more frequent. These patterns are consistent with the broader literature showing that environmental risk and poverty vulnerability are often spatially uneven (Dasgupta et al., 2005; Hallegatte et al., 2016; Saputra et al., 2021; Juliansyah et al., 2025).

The descriptive statistics indicate sufficient variation across districts and over time to support panel-data estimation. Before estimating the model, we examined relationships among the explanatory variables as part of the preliminary assessment to ensure the variables represented distinct dimensions of regional socioeconomic and environmental conditions. Because the Environmental Quality Index and Environmental Degradation Index were constructed from different conceptual components and capture different aspects of environmental conditions, we specified them simultaneously in the regression model to evaluate their independent associations with poverty risk.

Model Selection

The pooled model produces significant coefficients in the expected directions, but it does not control for time-invariant district heterogeneity. The random-effects model improves on pooled OLS, yet the Hausman test rejects the null hypothesis that the random-effects estimator is consistent. The test statistic is 24.38 with a p-value below 0.01, so we select the fixed-effects model as the main specification (Baltagi, 2021; Wooldridge, 2010). The fixed-effects specification is therefore more appropriate because it controls for unobserved district-specific characteristics that remain constant over time, reducing omitted-variable bias from time-invariant regional differences.

Main regression results

Table 2. Fixed-effects estimation results

Variables	Model 1: Pooled OLS	Model 2: Random Effects	Model 3: Fixed Effects
Environmental Quality Index	-0.048** (0.020)	-0.054*** (0.019)	-0.061*** (0.018)
Environmental Degradation Index	0.033* (0.019)	0.039** (0.018)	0.047** (0.021)
ln(GRDP per capita)	-1.412* (0.781)	-1.566** (0.742)	-1.834** (0.742)
Unemployment rate	0.072* (0.041)	0.081** (0.039)	0.094** (0.039)
Mean years of schooling	-0.271* (0.156)	-0.343** (0.151)	-0.401** (0.167)
Constant	35.772*** (8.954)	37.486*** (8.321)	40.125*** (9.114)
District fixed effects	No	No	Yes
Year effects	Yes	Yes	Yes
Observations	115	115	115

Variables	Model 1: Pooled OLS	Model 2: Random Effects	Model 3: Fixed Effects
R-squared / within R-squared	0.54	0.59	0.69

Notes: Robust standard errors in parentheses.

*p < 0.10, ** p < 0.05, *** p < 0.01.*

The fixed-effects results show that environmental quality has a negative and statistically significant coefficient. A one-point increase in the Environmental Quality Index is associated with a 0.061 percentage-point decline in the poverty rate, holding other factors constant. This implies that a ten-point improvement in environmental quality is associated with a poverty reduction of about 0.61 percentage points. This magnitude is economically meaningful in a province where poverty remains above the national average and where reductions often occur gradually rather than sharply (BPS Provinsi Aceh, 2024; BPS, 2024a).

Environmental degradation shows the opposite pattern. The coefficient is positive and statistically significant, indicating that districts with worsening environmental stress experience higher poverty risk. Quantitatively, a ten-point increase in the Environmental Degradation Index is associated with an increase of about 0.47 percentage points in the poverty rate. This finding is consistent with the argument that ecological stress raises the probability of income loss, asset depletion, and repeated coping costs among vulnerable households (Ahmed et al., 2011; IPCC, 2022; Hallegatte et al., 2016; Saputra et al., 2021; Juliansyah et al., 2025).

The control variables also behave as expected. Higher GRDP per capita reduces poverty risk, suggesting that regional income capacity still matters even after controlling for environmental conditions. Higher unemployment increases poverty risk, which confirms the importance of labor-market absorption for welfare outcomes. Mean years of schooling carries a negative coefficient, implying that human capital remains an effective protection against poverty. These results align with standard poverty theory and empirical development literature (Ravallion, 2016; UNDP, 2022; Alkire & Foster, 2011; Farlian et al., 2025; Saputra et al., 2021).

Taken together, the estimated coefficients suggest that environmental conditions remain statistically relevant even after incorporating conventional socioeconomic variables into the model. This finding indicates that environmental quality and environmental degradation provide additional explanatory power beyond regional income, labor-market conditions, and educational attainment. Accordingly, environmental factors should not be viewed merely as contextual characteristics but as integral components of regional poverty dynamics.

Robustness Checks

To evaluate the consistency of the main findings, the study re-estimates the model using poverty depth and poverty severity as alternative dependent variables. This robustness strategy examines whether the estimated relationships remain stable across different dimensions of poverty rather than relying solely on the poverty headcount ratio. The signs and statistical significance of the principal explanatory variables remain broadly consistent across the alternative specifications. Environmental quality continues to reduce both poverty depth and poverty severity, whereas environmental degradation continues to increase them.

Table 3. Robustness checks using poverty depth and poverty severity

Variables	Poverty Depth (P1)	Poverty Severity (P2)
Environmental Quality Index	-0.023** (0.010)	-0.011** (0.005)
Environmental Degradation Index	0.017** (0.008)	0.008** (0.004)
ln(GRDP per capita)	-0.912* (0.478)	-0.438* (0.241)
Unemployment rate	0.041** (0.018)	0.021** (0.010)
Mean years of schooling	-0.173* (0.093)	-0.082* (0.045)
District fixed effects	Yes	Yes
Year effects	Yes	Yes
Observations	115	115
Within R-squared	0.62	0.58

Notes: Robust standard errors in parentheses.

$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The robustness results support the main specification. Environmental quality remains negatively associated with poverty depth and poverty severity, while environmental degradation remains positively associated with both indicators. This means the environmental effect is not limited to the poverty headcount alone. It also extends to the intensity and severity of deprivation among poor households. This means that environmental conditions influence not only how many people are poor, but also the depth of their deprivation and the extent to which poverty is concentrated among households experiencing larger shortfalls from the poverty line. This pattern is consistent with multidimensional poverty reasoning, which emphasizes that welfare deprivation is shaped by simultaneous constraints in income, services, risk exposure, and adaptive capacity (Alkire & Foster, 2011; UNDP, 2022; Juliansyah et al., 2025).

Although the robustness analysis is limited to alternative poverty indicators, consistent coefficient signs and statistical significance across specifications further support the stability of the principal findings; future studies may extend this assessment by applying alternative panel-data estimators, such as Driscoll-Kraay standard errors, Panel Corrected Standard Errors (PCSE), or dynamic panel specifications, particularly when longer time-series observations become available.

Discussion

The results indicate that environmental quality is an economically and statistically meaningful determinant of poverty risk in Aceh. Districts with better access to sanitation, safer drinking water, and stronger land-cover quality tend to record lower poverty rates, even after controlling for income, unemployment, and education. This finding supports the argument that environmental services are not peripheral to development. They are part of households' welfare production function because they affect health, productivity, time allocation, and the cost of coping with environmental stress (Barbier, 2010; Dasgupta et al., 2005; UNEP, 2011). This relationship is particularly relevant in Aceh because substantial differences in environmental infrastructure and ecosystem conditions persist across districts. While several urban districts benefit from better public services and infrastructure, many rural and resource-dependent districts still rely heavily on agriculture, fisheries, and forest-related activities. In these areas, improvements in environmental quality directly enhance household productivity, reduce health-related expenditures, and strengthen livelihood resilience, making environmental services an important mechanism for poverty reduction beyond conventional economic interventions. These findings are consistent with recent empirical evidence showing that

improvements in environmental quality contribute to poverty reduction by enhancing public health, ecosystem services, and household resilience. Recent regional studies similarly emphasize that environmental quality should be regarded as an essential component of sustainable regional development rather than merely an environmental outcome (Miswa & Kartiasih, 2025; Huang et al., 2024).

The sanitation and drinking water components are especially important in the context of poverty. Poor households are more sensitive to environmental health risks because they have fewer resources to substitute private solutions for inadequate public services. When water access is unsafe, or sanitation is weak, households bear higher costs through disease incidence, lower labor productivity, school absenteeism, and reduced time for paid work. These mechanisms are widely recognized in development and environmental-health literature, and they help explain why environmental quality can translate into measurable poverty outcomes at the regional level (Leichenko & Silva, 2014; Hallegatte & Rozenberg, 2017; World Bank, 2023; Juliansyah et al., 2025).

The positive coefficient on environmental degradation further strengthens the poverty-environment nexus. In Aceh, repeated floods, landslides, and land pressure can damage housing, local infrastructure, small-scale agriculture, and market access. These effects are rarely neutral across income groups. Poor households usually have weaker housing quality, fewer savings, lower insurance coverage, and stronger dependence on local natural resources. As a result, environmental degradation raises vulnerability and prolongs welfare recovery after a shock (Noy, 2009; Rodriguez-Oreggia et al., 2013; Arouri et al., 2015). This result also aligns with the climate-poverty literature, which shows that ecological stress often functions as a poverty multiplier rather than an isolated sectoral problem (Hertel et al., 2010; Hallegatte et al., 2016; IPCC, 2022). The findings also align with Aceh's environmental characteristics, where floods, landslides, and land degradation recur in several districts with relatively high poverty rates. These environmental disturbances often disrupt agricultural production, transportation networks, and local market activities that provide many households with their primary income. Consequently, repeated ecological shocks may reinforce existing socioeconomic vulnerabilities and slow poverty reduction, even as other development indicators improve.

The negative coefficient on GRDP per capita confirms that economic growth still matters for poverty reduction, but the environmental variables remain significant after controlling for income. This is a critical result. It suggests that growth alone is insufficient when environmental services are weak, or degradation pressures are high. In other words, regional income gains may be partially offset by environmental deficits that increase living costs, health burdens, and livelihood instability. This interpretation aligns with literature that critiques growth-only approaches to welfare improvement and emphasizes resilience, public goods, and risk management as complementary elements of poverty reduction (Sen, 1999; Ravallion, 2016; Béné et al., 2014). These findings generally reinforce previous international studies demonstrating that environmental conditions play a significant role in shaping poverty outcomes, particularly in regions characterized by high ecological vulnerability (Ahmed et al., 2011; Hallegatte et al., 2016; IPCC, 2022). At the same time, this study extends the Indonesian literature by showing that environmental quality and environmental degradation retain explanatory power even after controlling for regional income, unemployment, and education in a district-level panel framework. This suggests that environmental conditions should be considered

complementary rather than secondary to conventional socioeconomic determinants of poverty.

The positive unemployment effect is also intuitive. Districts with weaker labor-market absorption face higher poverty risk because households rely more on irregular earnings and have less capacity to smooth consumption. Education, by contrast, reduces poverty risk by improving access to productive employment and increasing households' ability to adapt to ecological and economic shocks. This interaction between labor-market constraints, human capital, and environmental risk is particularly relevant in peripheral and resource-dependent regions (Haughton & Khandker, 2009; Alkire & Foster, 2011; UNDP, 2022; Farlian et al., 2025; Saputra et al., 2021).

From a regional-policy perspective, the results imply that poverty reduction in Aceh should not be designed as a narrow social-assistance agenda. It should also include environmental service delivery and risk reduction. Districts with weaker sanitation coverage, weaker water security, and higher ecological stress may require integrated interventions that combine infrastructure, disaster mitigation, ecosystem restoration, and livelihood protection. This policy direction aligns with development planning logic that links social resilience, environmental governance, and local economic transformation (Bappenas, 2021; Dartanto et al., 2020; KLHK, 2024b; Fadhil et al., 2025; Fauzi et al., 2025). Accordingly, regional poverty alleviation strategies should be designed through closer coordination between environmental agencies, regional development planning institutions, and social protection programs. Integrating environmental management into regional development planning may improve the effectiveness and sustainability of poverty reduction efforts, particularly in environmentally vulnerable districts.

This study contributes to the Indonesian regional development literature by extending the analytical perspective on regional poverty. While previous studies have largely emphasized fiscal policy, labor markets, education, inflation, or economic growth as the principal determinants of poverty, the present study shows that environmental quality and environmental degradation are also significant regional drivers of poverty risk. Rather than treating environmental conditions merely as contextual variables, this study incorporates them as core explanatory variables within a regional poverty framework using district-level panel evidence from Aceh. In this respect, the study contributes empirical evidence that environmental governance and poverty reduction should be viewed as mutually reinforcing components of regional development rather than as separate policy domains. This broader perspective complements existing regional development literature and supports more integrated policy formulation (Castañeda et al., 2018; Hallegatte & Rozenberg, 2017; Winsemius et al., 2016).

At the same time, interpret the findings with appropriate caution. First, the environmental indices are composite measures that depend on indicator availability and normalization choices. Although the construction is transparent and replicable, alternative weighting schemes could produce somewhat different magnitudes. Second, some district-level environmental indicators in Indonesia are more complete than others, which may create an unbalanced evidence base across dimensions. Third, although the fixed-effects estimator controls for time-invariant district heterogeneity, potential endogeneity between environmental conditions and poverty cannot be entirely ruled out because environmental quality, public investment, and household welfare may evolve simultaneously over time; therefore, interpret the estimated relationships as robust conditional associations rather than definitive causal effects. Future studies should use

longer panel datasets, spatial econometric approaches, instrumental-variable techniques, or dynamic panel estimators to strengthen causal identification.

CONCLUSION

This study examines the relationship between environmental quality, environmental degradation, and poverty risk across 23 districts/cities in Aceh using panel data for 2019-2023. The findings consistently show that better environmental quality is associated with lower poverty risk. In contrast, greater environmental degradation is associated with higher poverty risk, even after accounting for regional income, unemployment, and education. Beyond confirming these empirical relationships, the study contributes to the regional development literature by demonstrating that environmental conditions constitute an important dimension of poverty analysis alongside conventional socioeconomic determinants. This finding broadens the analytical perspective on regional poverty by integrating environmental quality and environmental degradation into a single empirical framework.

The empirical relationships reported in this study are interpreted as conditional associations rather than definitive causal effects. This interpretation aligns with the fixed-effects design and the acknowledged possibility of endogeneity among environmental conditions, public investment, and poverty outcomes.

These findings have important implications for regional development policy in Aceh. Poverty reduction strategies should not rely solely on economic growth, labor-market expansion, or social assistance. However, they should also strengthen environmental governance through improved sanitation services, safe drinking water provision, ecosystem protection, and disaster-risk reduction. Integrating environmental management into regional development planning will help improve the effectiveness and sustainability of poverty alleviation efforts, particularly in districts experiencing persistent ecological pressures and high environmental vulnerability.

The study has several limitations, particularly in constructing district-level environmental indices from available official indicators and in capturing dynamic interactions between environmental conditions and poverty that the current empirical framework cannot fully address. Future research may extend the observation period, incorporate spatial econometric techniques, employ alternative weighting schemes for composite indices, or apply econometric approaches that explicitly address potential endogeneity and dynamic relationships. Despite these limitations, the study provides empirical evidence that environmental governance should be regarded not only as an ecological objective but also as an integral component of regional poverty reduction and sustainable regional development.

REFERENCES

- Ahmed, S. A., Diffenbaugh, N. S., Hertel, T. W., Lobell, D. B., Ramankutty, N., Rios, A. R., & Rowhani, P. (2011). Climate volatility and poverty vulnerability in Tanzania. *Global Environmental Change*, 21(1), 46–55. <https://doi.org/10.1016/j.gloenvcha.2010.10.003>
- Alkire, S., & Foster, J. (2011). Counting and multidimensional poverty measurement. *Journal of Public Economics*, 95(7–8), 476–487. <https://doi.org/10.1016/j.jpubeco.2010.11.006>

- Arouri, M., Nguyen, C., & Youssef, A. B. (2015). Natural disasters, household welfare, and resilience: Evidence from rural Vietnam. *World Development*, 70, 59–77. <https://doi.org/10.1016/j.worlddev.2014.12.017>
- Badan Nasional Penanggulangan Bencana. (2024). *Data informasi bencana Indonesia (DIBI)*. BNPB.
- Badan Perencanaan Pembangunan Nasional. (2021). *Rencana pembangunan jangka menengah nasional 2020–2024*. Bappenas.
- Baltagi, B. H. (2021). *Econometric analysis of panel data* (6th ed.). Springer.
- Barbier, E. B. (2010). Poverty, development, and environment. *Environment and Development Economics*, 15(6), 635–660. <https://doi.org/10.1017/S1355770X1000032X>
- Barbier, E. B., & Hochard, J. P. (2018). Land degradation and poverty. *Nature Sustainability*, 1(11), 623–631. <https://doi.org/10.1038/s41893-018-0155-4>
- Béné, C., Newsham, A., Davies, M., Ulrichs, M., & Godfrey-Wood, R. (2014). Review article: Resilience, poverty and development. *Journal of International Development*, 26(5), 598–623. <https://doi.org/10.1002/jid.2992>
- BPS Provinsi Aceh. (2024). *Provinsi Aceh dalam angka 2024*. BPS Provinsi Aceh.
- BPS. (2024a). *Profil kemiskinan di Indonesia Maret 2024*. BPS-Statistics Indonesia.
- BPS. (2024b). *Indikator kesejahteraan rakyat 2024*. BPS-Statistics Indonesia.
- Castañeda, A., Doan, D., Newhouse, D., Nguyen, M. C., Uematsu, H., & Azevedo, J. P. (2018). A new profile of the global poor. *World Development*, 101, 250–267. <https://doi.org/10.1016/j.worlddev.2017.08.002>
- Dartanto, T., Moeis, F. R., Otsubo, S., & Ikhsan, M. (2020). Role of government transfers and the poverty reduction agenda in Indonesia. *Journal of Southeast Asian Economies*, 37(2), 219–241. <https://doi.org/10.1355/ae37-2d>
- Dasgupta, S., Deichmann, U., Meisner, C., & Wheeler, D. (2005). Where is the poverty–environment nexus? Evidence from Cambodia, Lao PDR, and Vietnam. *World Development*, 33(4), 617–638. <https://doi.org/10.1016/j.worlddev.2004.10.003>
- Fadhil, M., Zulkarnain, Z., Zulkarnaini, Z., & Juliansyah, R. (2025). Between state and society: Government communication strategies and stakeholder collaboration for tourism development in the Pantai Batee Puteh Area, West Aceh. *Baileo: Jurnal Sosial Humaniora*, 3(1), 49–66. <https://doi.org/10.30598/baileofisipvol3iss1pp49-66>
- Farlian, T., Aidar, N., Handayani, M., & Juliansyah, R. (2025). The nexus between economic growth and inflation on unemployment in Aceh Province. *Journal of Management Science*, 6(2), 159–167. <https://doi.org/10.52103/jms.v6i2.2217>
- Fauzi, A., Rosmiati, S., & Juliansyah, R. (2025). Building farmers' economic resilience: The role of quality seeds, fertilizers, and land size in increasing farmers' income. *Baileo: Jurnal Sosial Humaniora*, 2(2), 211–224. <https://doi.org/10.30598/baileofisipvol2iss2pp211-224>
- Hallegatte, S., & Rozenberg, J. (2017). Climate change through a poverty lens. *Nature Climate Change*, 7(4), 250–256. <https://doi.org/10.1038/nclimate3253>
- Hallegatte, S., Bangalore, M., Bonzanigo, L., Fay, M., Kane, T., Narloch, U., Rozenberg, J., Treguer, D., & Vogt-Schilb, A. (2016). *Shock waves: Managing the impacts of climate change on poverty*. World Bank.
- Haughton, J., & Khandker, S. R. (2009). *Handbook on poverty and inequality*. World Bank.

- Hertel, T. W., Burke, M. B., & Lobell, D. B. (2010). The poverty implications of climate-induced crop yield changes by 2030. *Global Environmental Change*, 20(4), 577–585. <https://doi.org/10.1016/j.gloenvcha.2010.07.001>
- Huang, W., Gao, S., Hu, P., Han, Y., & Ding, S. (2024). Is the coupling and coordination of economic, social and environmental development crucial to the governance of relative poverty? *PLOS ONE*, 19(8), e0306641. <https://doi.org/10.1371/journal.pone.0306641>
- Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Impacts, adaptation and vulnerability*. Cambridge University Press.
- Islam, S. N., & Winkel, J. (2017). *Climate change and social inequality* (DESA Working Paper No. 152). United Nations Department of Economic and Social Affairs.
- Juliansyah, R., Salim, J. F., Fitri, H., & Noviar, H. (2025). Poverty and environmental degradation in post-conflict Aceh: A socioeconomic panel data study of 23 regions. *Baileo: Jurnal Sosial Humaniora*, 2(3), 365–381. <https://doi.org/10.30598/baileofisipvol2iss3pp365-381>
- Kementerian Lingkungan Hidup dan Kehutanan. (2024a). *Statistik lingkungan hidup dan kehutanan Indonesia 2024*. KLHK.
- Kementerian Lingkungan Hidup dan Kehutanan. (2024b). *Indeks kualitas lingkungan hidup Indonesia 2024*. KLHK.
- Leichenko, R., & Silva, J. A. (2014). Climate change and poverty: Vulnerability, impacts, and alleviation strategies. *Wiley Interdisciplinary Reviews: Climate Change*, 5(4), 539–556. <https://doi.org/10.1002/wcc.287>
- Miswa, S., & Kartiasih, F. (2025). Nexus between rural poverty and environmental quality: Empirical evidence from Indonesia. *Asia-Pacific Journal of Regional Science*, 9(1), 57–81. <https://doi.org/10.1007/s41685-024-00370-6>
- Noy, I. (2009). The macroeconomic consequences of disasters. *Journal of Development Economics*, 88(2), 221–231. <https://doi.org/10.1016/j.jdeveco.2008.02.005>
- OECD. (2008). *Handbook on constructing composite indicators: Methodology and user guide*. OECD Publishing.
- Ravallion, M. (2016). *The economics of poverty: History, measurement, and policy*. Oxford University Press.
- Rodriguez-Oreggia, E., De La Fuente, A., De La Torre, R., & Moreno, H. A. (2013). Natural disasters, human development and poverty at the municipal level in Mexico. *Journal of Development Studies*, 49(3), 442–455. <https://doi.org/10.1080/00220388.2012.700398>
- Saputra, J., Zulham, T., Juliansyah, R., Dawood, T. C., & Hadi, F. (2021). The nexus of human development index, economic and population growth on environmental degradation in Aceh Province, Indonesia. *WSEAS Transactions on Environment and Development*, 17, 314–320. <https://doi.org/10.37394/232015.2021.17.31>
- Sen, A. (1999). *Development as freedom*. Oxford University Press.
- Shen, L., & Xin, C. (2026). From scarcity to sustainability: Impact of environmental poverty on green growth in developing countries. *Natural Resources Forum*, 50(2), 925–949. <https://doi.org/10.1111/1477-8947.70002>
- Skoufias, E., Rabassa, M., & Olivieri, S. (2011). *The poverty impacts of climate change: A review of the evidence* (World Bank Policy Research Working Paper No. 5622). World Bank.

- Ssekibaala, S. D., & Kasule, T. A. (2023). Examination of the poverty-environmental degradation nexus in Sub-Saharan Africa. *Regional Sustainability*, 4(3), 296–308. <https://doi.org/10.1016/j.regsus.2023.08.007>
- UNDP. (2022). *Human development report 2021/2022: Uncertain times, unsettled lives: Shaping our future in a transforming world*. United Nations Development Programme.
- UNEP. (2011). *Towards a green economy: Pathways to sustainable development and poverty eradication*. United Nations Environment Programme.
- Winsemius, H. C., Aerts, J. C. J. H., van Beek, L. P. H., Bierkens, M. F. P., Bouwman, A., Jongman, B., Kwadijk, J. C. J., Ligtoet, W., Lucas, P. L., van Vuuren, D. P., & Ward, P. J. (2016). Global drivers of future river flood risk. *Nature Climate Change*, 6(4), 381–385. <https://doi.org/10.1038/nclimate2893>
- Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). MIT Press.
- World Bank. (2023). *World development report 2023: Migrants, refugees, and societies*. World Bank.