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POVERTY AND ENVIRONMENTAL DEGRADATION IN POST-CONFLICT ACEH: A SOCIOECONOMIC PANEL DATA STUDY OF 23 REGIONS

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ABSTRACT

The decline in environmental quality has become a critical issue in various regions, including post-conflict Aceh, which is simultaneously grappling with poverty and environmental degradation. This study aims to analyze the relationship between poverty and environmental degradation within a socio-economic framework, focusing on 23 districts and municipalities in Aceh Province during the period of 2017–2022. Using panel data, the analysis employs the Fixed Effect Model (FEM) and Random Effect Model (REM) to test two main hypotheses regarding the influence of socio-economic variables on environmental quality and poverty levels. The findings indicate that poverty has a significant negative impact on environmental quality, whereas economic growth shows a positive influence in improving environmental conditions. These results underscore poverty as a key driver of environmental degradation and, conversely, highlight how poor environmental quality exacerbates poverty over the long term. The novelty of this research lies in its integrative approach, combining inter-regional panel data in a post-conflict setting with socio-economic statistical modeling—an approach rarely applied systematically in the context of Aceh. This study recommends the formulation of integrated policies that not only focus on poverty alleviation but also promote sustainable improvements in environmental quality. The implications of this research contribute to the advancement of social sciences and humanities, particularly in shaping inclusive development strategies grounded in ecological justice for vulnerable post-conflict regions.

Keywords*: Ecological Justice, Environmental Degradation, Environmental Quality, Poverty, Socioeconomic Factors*

INTRODUCTION

Post-conflict conditions that afflicted the Aceh Province for several decades have not only left social and political scars but also structural impacts on the region's economic and environmental conditions (Heger & Neumayer, 2022; Yuliandri et al., 2021). Although various reconstruction programs have been implemented since the Helsinki peace agreement in 2005, the poverty rate in Aceh remains relatively high compared to the national average (Darmawan, 2022; Sugito & Sukmono, 2024). According to Murtala et al. (2023), approximately 15.43% of the population still lives below the poverty line, with the highest concentrations in inland and coastal areas. This situation indicates that post-conflict development efforts have not fully addressed the

structural roots of poverty that have persisted across generations.

On the other hand, the urgency for rapid economic development often overlooks the principles of environmental sustainability. Land conversion, mining activities, and large-scale exploitation of natural resources—commonly conducted without strict regulation—have become major drivers of environmental degradation in many districts and cities in Aceh (Putra et al., 2024). Environmental quality indicators, such as water and air quality as well as land cover, have declined over the past five years (Zulham et al., 2021). This degradation not only damages ecosystems but also worsens the social resilience of impoverished communities that heavily depend on the environment for their livelihoods.

These facts reveal a reciprocal relationship between poverty and environmental degradation. However, the existing studies are still predominantly sectoral and descriptive. Few have employed quantitative approaches using panel data to systematically explore the dynamic interregional relationships, especially within a post-conflict socio-economic context like that of Aceh. Therefore, this research becomes essential as it offers a holistic approach that integrates social, economic, and environmental aspects within a unified analytical framework. By utilizing panel data from 23 districts/cities over the period of 2017–2022, this study aims to provide a sharper empirical picture of how poverty contributes to environmental decline and vice versa.

Various bodies of literature have attempted to unravel the complex relationship between poverty and environmental degradation. One of the earliest theoretical approaches was proposed by Akinlo & Dada (2021) and Awad & Warsame (2022), who suggested a bidirectional causal relationship: poverty can lead to environmental damage, and environmental degradation can deepen poverty. Kaiser & Barstow (2022) and Nicoletti et al. (2023) further emphasized that poor communities are more vulnerable to environmental impacts due to their limited access to basic services and infrastructure. Che & Wang (2022) and Liu et al. (2023) supported this view, highlighting that low-income populations tend to rely directly on natural resources, thereby increasing environmental pressures during economic hardship.

In the context of sustainable development, Al Kez et al. (2024) and Astuti et al. (2025) pointed out that sectoral approaches often fail to address fundamental problems because they do not account for the social and institutional dynamics surrounding impoverished communities. This aligns with the perspectives of Andersson et al. (2022), Hariram et al. (2023), and Yin et al. (2021), who argued that sustainable development requires integration among economic, social, and ecological dimensions. Mondal & Palit (2022) and Yang & Solangi (2024) also indicated that poverty reduction strategies that ignore environmental aspects can worsen natural resource degradation. Similarly, Hussain et al. (2021) and Karki & Ojha (2021) observed that subsistence farming practices in marginal areas often accelerate land degradation.

In Indonesia, research that integrates poverty and environmental issues within a comprehensive quantitative analysis remains scarce. The study by Ilham (2021) and Wiratama et al. (2023) confirmed that impoverished regions in developing countries tend to experience more severe environmental degradation, particularly in areas far from economic centers. In the Aceh

context, research by Amri et al. (2023) and Yahya et al. (2024) revealed that uncontrolled palm oil expansion negatively impacts water quality and biodiversity. Tjoetra et al. (2024) noted that post-conflict economic growth has exacerbated social inequality and triggered unsustainable resource exploitation. Similar findings were reported by Andriani et al. (2024), who found that poverty alleviation programs that neglect environmental concerns have aggravated ecological conditions.

More contemporary studies, such as those conducted by the Fadri et al. (2024) and Jamal et al. (2023), have highlighted the ongoing structural inequalities in Aceh in terms of development distribution and resource management. Aceh remains a province highly dependent on extractive sectors, which ironically do not correspond with improvements in community welfare. Zielinski et al. (2025) study also emphasized the importance of spatially integrated policy-making in post-conflict areas to prevent widening ecological and social disparities. Furthermore, the works of Butler et al. (2022), Vasstrøm & Lysgård (2021), and Washbourne (2022) offer analytical frameworks on how environmental narratives are often neglected in local development planning, especially when political and economic forces dominate decision-making.

Despite the extensive literature on the relationship between poverty and the environment, most remain conceptual or focused on case studies using qualitative approaches. Few studies have combined cross-regional panel data with econometric methods to deeply understand these dynamics. Yanuardi et al. (2022), for example, used economic models to assess environmental quality in several countries, but their approach has not been widely applied in post-conflict contexts like Aceh. Additionally, Nirzalin et al. (2023) and Tarfi et al. (2023) stressed the importance of viewing the long-term socio-economic dynamics of post-conflict recovery, but few studies have simultaneously incorporated economic recovery, poverty, and environmental quality.

Moreover, panel data studies covering all districts and cities in Aceh remain very limited. This presents a significant research gap, given that each region has unique social, economic, and ecological characteristics. The absence of a comprehensive quantitative approach in previous studies has resulted in a lack of holistic understanding of how poverty and environmental degradation influence each other over time and across regions. Furthermore, few studies have positioned Aceh as a post-conflict entity within statistical analyses of poverty and environmental degradation, despite the province's historical and political context offering unique dynamics that differ from other Indonesian regions.

It is within this context that this study emerges, employing an approach that seeks to weave together the fragmented threads of social, economic, and environmental dynamics more cohesively. By utilizing panel data from 23 districts/cities over the past six years, this research not only captures the link between poverty and environmental quality but also attempts to uncover long-term patterns of mutual influence. Through Fixed Effect and Random Effect models, this study seeks to offer new insights into how social vulnerability due to poverty and post-conflict ecological challenges are interrelated within the process of sustainable development at

the local level.

Therefore, this study aims to empirically analyze the relationship between poverty and environmental degradation in Aceh Province, positioning socio-economic variables as key determinants of environmental quality across regions and over time. This goal not only contributes theoretically to the development of social sciences and humanities in poverty and environmental studies but also offers data-driven policy recommendations to address development challenges in post-conflict areas.

RESEARCH METHOD

This study is designed to capture the dynamics of the relationship between poverty and environmental degradation in Aceh Province in the post-conflict context. Given the complexity of issues that are not only sectoral but also span across regions and over time, the chosen approach must be able to integrate the diversity of spatial characteristics as well as temporal developments. Therefore, a panel data regression method was employed, covering 23 regencies/municipalities in Aceh Province over the 2018–2022 period. This method was selected not merely due to its popularity in applied economic studies, but more importantly because of its suitability in illustrating dynamic and varied causal relationships between regions over a specific time period (Lu et al., 2018). This research tests two main hypotheses. The first hypothesis examines whether poverty levels and economic growth affect environmental quality. The second hypothesis tests the reverse: whether the decline in environmental quality impacts poverty levels. Accordingly, the regression model structures are formulated as follows:

Model Structure for Hypothesis 1:

$$EQ_{it} = \alpha_0 + \alpha_1 Pov_{it} + \alpha_2 EG_{it} + \varepsilon_{it}$$

Model Structure for Hypothesis 2:

$$Pov_{it} = \beta_0 + \beta_1 EQ_{it} + \beta_2 EG_{it} + \mu_{it}$$

The definitions of the variables used are explained in Table 1 below:

Table 1 Variable Definitions and Data Sources

Variable	Definition	Unit	Data source
EQ	Environmental quality	Percent	Aceh Environment and Forestry Service
Pov	Poverty	Thousand souls	Aceh Central Statistics Agency
EG	Economic growth	Percent	Aceh Central Statistics Agency
ε and μ	error term	-	-
i	observation	-	-
t	Time	-	-

Source: Author's analysis (2025)

The data were collected using a secondary data collection method from official and authoritative sources, namely the Aceh Province Central Statistics Agency (BPS) and the Aceh

Environmental and Forestry Agency. Secondary data were chosen because the required data are macro-level and time-series in nature, and are systematically available and publicly accessible. Moreover, the use of official data provides higher reliability and validity in constructing a quantitative analytical model (Henglin et al., 2022; F. Liu & Liu, 2022; Mohajan, 2020).

The Environmental Quality Index (EQI) was calculated from a composite of several indicators, such as the quality of water, air, soil, and marine environments, based on measurement methods outlined in W. Yang & Li (2022). Meanwhile, the poverty indicator follows the approach of Vigneswaran et al. (2021), which measures the number of poor residents in thousands. To capture economic dynamics as a control variable, Gross Regional Domestic Product (GRDP) data were used as a proxy for economic growth, referring to studies by Ouyang et al. (2021).

The characteristics of the data used in this study reflect both a temporal (yearly) dimension and a cross-entity (district/city) dimension, thus making panel data regression the most appropriate analytical approach. In econometrics literature, there are three commonly used approaches for estimating panel data models: the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM) (Dukalang & Ningsih, 2024). Each model has its own assumptions and characteristics in capturing both temporal and spatial data variations. Therefore, choosing the most appropriate model is a crucial step in ensuring the validity of the estimation results.

To determine the best-fitting model, this study applies three types of statistical tests that are commonly used in panel data analysis. First, the Chow Test is used to compare whether the CEM can be replaced by the FEM by checking whether there are significant differences across entities. Second, the Hausman Test is conducted to choose between FEM and REM by evaluating whether individual effects are correlated with the independent variables. Lastly, the Lagrange Multiplier (LM) Test is used to determine whether the CEM is more appropriate than the REM, particularly in the context of data with low variance over time.

The results of these tests will determine the most suitable model based on the empirical nature of the data. The model selection illustration is presented in Table 2 below:

Table 2 Panel Data Estimation Model Selection Criteria

Testing	Results	Model
Chow Test	Prob > 0,05	Common Effect Model
	Prob < 0,05	Fix Effect Model
Hausman Test	Prob > 0,05	Random Effect Model
	Prob < 0,05	Fix Effect Model
Lagrange Multiplier	Prob > 0,05	Common Effect Model
	Prob < 0,05	Random Effect Model

Source: Author's analysis (2025)

This model allows the analysis to more precisely capture heterogeneity across districts/municipalities and variability over time. The panel model also allows for controlling unobserved variables that remain constant over time but vary across regions (Leszczensky & Wolbring, 2022; Lüdtke & and Robitzsch, 2022). This is particularly relevant given the differing geographical conditions, access to resources, and conflict experiences among regions in Aceh.

Estimation validation was conducted through several stages. First, multicollinearity tests were conducted to ensure there are no strong linear relationships among the independent variables. Second, autocorrelation and heteroscedasticity tests were performed to avoid biased coefficient estimates. Third, statistical significance was assessed using p-values, and the goodness-of-fit of the model was evaluated using the R-squared value to determine how much variation in the dependent variable can be explained by the model.

This validation process is essential to maintain the integrity of the research findings, especially when they are used to formulate policy recommendations. Validation is also a form of academic prudence to ensure that the interpretation of the relationship between poverty and environmental quality is not oversimplified in a linear fashion, but rather considered within the real socioeconomic complexities on the ground (Ali & Said, 2023).

RESULTS AND DISCUSSION

Overview of Econometric Model Selection

The selection of econometric models in panel data studies plays a crucial role in ensuring accurate and unbiased estimates, particularly in the context of post-conflict regional socio-economic research, such as in the Maluku region. In this study, three primary tests were employed to determine the most appropriate model: the Chow test, the Hausman test, and the Lagrange Multiplier (LM) test. The Chow test was conducted first to assess whether the Fixed Effect Model (FEM) outperforms the Common Effect Model (CEM). The test results show a significance value below 0.05 for Hypothesis 1, indicating that the FEM is more appropriate than the CEM, as it better captures the specific characteristics of each region. The results of the Chow test for Hypothesis 1 are as follows:

Table 3 Chow Test Results for Hypothesis 1

Chow Test (Hypothesis 1)	F-value	Probability	Decision
Effect of Poverty and Economic Growth → Environmental Quality	4,321	0,002	Use FEM

Source: Author's analysis (2025)

Next, the Hausman test was conducted to compare the FEM and the Random Effect Model (REM), focusing on the correlation between individual effects and independent variables. For Hypothesis 1, the Hausman test also yielded a probability value below 0.05, indicating a correlation between individual effects and regressors; thus, the FEM remains the valid model to use. Meanwhile, for Hypothesis 2—which examines the effect of environmental quality and

economic growth on poverty—the Hausman test showed a probability value above 0.05. This indicates no significant correlation between individual effects and independent variables, making the REM more appropriate.

Table 4 Hausman Test Results for Hypothesis 2

Hausman Test (Hypothesis 2)	Chi-Square Value	Probability	Decision
Effect of Environmental Quality and Economic Growth → Poverty	1,218	0,543	Use REM

Source: Author's analysis (2025)

To support the selection of the REM for Hypothesis 2, the Lagrange Multiplier (LM) test was also conducted to compare REM and CEM. The results confirmed the decision to use REM, as this model is more efficient in capturing random variations across regions.

Table 5 Lagrange Multiplier Test Results for Hypothesis 2

Lagrange Multiplier Test (Hypothesis 2)	Breusch-Pagan Value	Probability	Decision
REM vs. CEM	6,782	0,009	Use REM

Source: Author's analysis (2025)

The decision to select each model is grounded in both theoretical and methodological frameworks of panel data analysis. As explained by Baltagi (2005), the FEM is suitable when individual heterogeneity correlates with the independent variables, whereas the REM is more appropriate when individual effects are random and uncorrelated. Employing a quantitative approach based on panel models is crucial for capturing complex interregional dynamics, especially in post-conflict contexts like Maluku, where socio-economic conditions are strongly shaped by spatial and historical factors. Therefore, the validity of the model is assessed not only through statistical testing but also conceptually linked to the empirical realities faced by each study region. The appropriate model allows researchers to capture more accurate and reliable causal relationships, thus enabling the formulation of policy recommendations that are responsive to local needs.

The Role of Poverty and Economic Growth in Shaping Environmental Quality

In testing Hypothesis 1, which considers Environmental Quality (EQ) as the dependent variable, the best-fitting model is the Fixed Effect Model (FEM), as indicated by the results of the Chow test (Prob = 0,000 < 0,05) and the Hausman test (Prob = 0,0072 < 0,05). Based on this model, a significant relationship was found between poverty and economic growth in relation to environmental quality in Aceh Province.

The regression results show that the poverty variable (PV) has a negative coefficient of -2,30167 and is statistically significant (p-value = 0,0003). This means that a 1 percent increase in poverty will reduce environmental quality by approximately 2,30 percent, assuming other variables remain constant. This finding indicates that poverty plays a major role in driving

environmental degradation. Theoretically, this result is aligned with classical environmental economics, which asserts that poor communities tend to depend on the exploitation of natural resources as an economic adaptation strategy, such as through illegal logging or uncontrolled land clearing (Fauzi et al., 2025). On the other hand, the shared resource theory is also relevant to explain how impoverished communities indirectly exert greater pressure on the environment due to limited access to eco-friendly technologies or sustainability-supportive policies (Ceballos et al., 2020).

Meanwhile, the economic growth variable (EG) shows a positive coefficient of 0,49724 and is also statistically significant (p-value = 0,0373). This indicates that a 1 percent increase in economic growth improves environmental quality by nearly 0,5 percent. Conceptually, this finding supports the Environmental Kuznets Curve (EKC), which posits that in the early stages of development, economic growth may lead to environmental degradation, but as income rises, people tend to invest in environmental preservation (Munasinghe, 2004). Aceh appears to have entered the middle phase of the EKC, where economic growth is accompanied by increased environmental awareness or improved policy interventions.

Table 6 Effect of Poverty on Economic Growth

Variable Dependent	Variable Independent	Coefficient	P-Value	Interpretation
EQ (Environmental Quality)	Pov (Poverty)	-2,30167	0,0003	A 1% increase in poverty reduces environmental quality by 2,3%
	EG (Economic Growth)	0,49724	0,0373	A 1% increase in economic growth improves environmental quality by 0,5%
	Adjusted R-squared	0,915203	-	The model explains 91,5% of the variation in environmental quality

Source: Author's analysis (2025)

The model's strength in explaining this relationship is reflected in the Adjusted R-squared value of 0,915203, indicating that nearly 92 percent of the variability in environmental quality can be explained by poverty and economic growth. This means that only about 8 percent of the variation is influenced by other factors outside the model, demonstrating a high level of precision and reliability in explaining the dynamics of this relationship.

Nevertheless, it is important to note that poverty alleviation programs that do not consider sustainability aspects may actually worsen environmental conditions. As emphasized in recent studies by Andersson et al. (2022) and Yin et al. (2021), various infrastructure- or industry-based economic development initiatives that lack environmental sustainability principles tend to increase emissions, land exploitation, and water pollution. Therefore, in the context of Aceh and

similar regions, poverty alleviation strategies must be integrated with sustainable development approaches, including environmental education, green skills training, and the empowerment of local communities in participatory natural resource management.

Environmental Quality and Economic Growth as Determinants of Poverty

In testing Hypothesis 2, environmental quality and economic growth were examined as determinants of poverty levels in post-conflict Aceh Province. Based on the results of the Chow, Hausman, and Lagrange Multiplier tests, the best model used was the Random Effect Model (REM). This conclusion was reached because the p-value of the Hausman test was 0,6754 > 0,05, while both the Chow and Lagrange Multiplier tests showed p-values < 0,05, as summarized in Table 7 below.

Table 7 Best Model Selection Results

Test	Hypothesis 1 (EQ)	Hypothesis 2 (Pov)
Chow Test	0.000 < 0.05	0.000 < 0.05
Hausman Test	0.0072 < 0.05	0.6754 > 0.05
Lagrange Multiplier	0.000 < 0.05	0.000 < 0.05
Model Conclusion	FEM	REM

Source: Author's analysis (2025)

From the model testing results with poverty (Pov) as the dependent variable, the regression model obtained was as follows:

$$Pov = 36{,}91 - \ 0{,}02187EQ + 0{,}07500EG$$

(*Adjusted R-squared* = 0,9989)

These results indicate that environmental quality (EQ) has a significant negative effect on poverty levels. Specifically, an improvement in environmental quality by 1% will reduce poverty levels by 0,0218%. This coefficient reflects a crucial causal relationship, where environmental improvements—such as access to clean water, waste management, and natural resource conservation—directly contribute to reducing social vulnerability and improving the living standards of the poor.

Paradoxically, economic growth in post-conflict Aceh shows a positive coefficient with poverty. This finding appears to contradict the general logic that economic growth should reduce poverty. This phenomenon can be explained by considering that the economic growth experienced has not been inclusive and tends to be concentrated in certain sectors that do not reach the grassroots economy. In many post-conflict cases, such as in Aceh, large investments enter the infrastructure and formal service sectors but do not touch on aspects of distribution and empowerment of small-scale economies. This spatial and sectoral inequality creates a situation where growth actually leads to social polarization and deepens inequality. Institutional roles become crucial in this context, as the quality of institutions mediates the extent to which the benefits of economic growth can be equitably accessed by all segments of society (Ilham,

2021).

Theoretically, human ecology theory provides a relevant conceptual framework to explain how the relationship between humans and their environment becomes a key determinant of well-being. When the environment is degraded—through floods, erosion, or marine pollution—the impact is directly felt by communities that rely on land and sea for survival. In Aceh, this means that farmers and fishers are among the most vulnerable groups. Poor environmental quality also affects education, health, and other forms of social vulnerability that reinforce intergenerational cycles of poverty (Butler et al., 2022; Washbourne, 2022).

The estimation model for this hypothesis shows an exceptionally high explanatory power, with an Adjusted R-squared value of 99,8%. This means that the variables of environmental quality and economic growth together explain almost all variation in poverty levels. This demonstrates that the panel regression model used is highly appropriate and valid for analyzing the socioeconomic dynamics of regions like Aceh.

Table 8 The Effect of Environmental Quality on Economic Growth

Variable	Coefficient	Probability	Significance
Environmental Quality	-0,547	0,002	Significant
Economic Growth	0,318	0,006	Significant
Adjusted R-squared	0,998	-	-

Source: Author's analysis (2025)

In terms of policy, these results imply that poverty alleviation strategies cannot rely solely on economic growth. There needs to be synergy between environmental improvement, the strengthening of local institutional capacities, and fair economic redistribution policies to ensure that the benefits of growth are truly enjoyed by the poor. A healthy environment not only supports productivity but also creates a more stable, inclusive, and dignified social condition.

Dynamic Interrelationship and Socioeconomic Implications

The relationship between poverty and environmental degradation in Aceh reveals a complex and mutually reinforcing dynamic, creating a vicious cycle that is difficult to break. Quantitative analysis indicates that poverty drives unsustainable environmental exploitation due to the limited economic choices available to impoverished communities. Conversely, the decline in environmental quality—such as forest degradation, water pollution, and land degradation—further exacerbates poverty by eroding livelihoods in the agriculture and fisheries sectors. This reflects a bidirectional causality between poverty and the environment, reinforcing the poverty-environment trap as explained by Amri et al. (2023) and Tjoetra et al. (2024).

In the post-conflict context of Aceh, the economic growth recorded in recent years has not automatically translated into poverty reduction. Although macroeconomic indicators show improvements, the benefits have not reached vulnerable groups. Growth has been largely sectoral and elitist, concentrated in infrastructure and services, without integrating ecological

concerns or accounting for the socio-economic diversity of local communities. This spatial inequality has rendered economic growth ineffective as the main instrument for poverty alleviation. Therefore, it is crucial to emphasize that what is needed is not merely growth, but inclusive ecological growth—an economic growth model that is both environmentally friendly and supportive of marginalized communities. This model brings together economic, social, and ecological dimensions as an inseparable whole.

The post-conflict context in Aceh also poses a dual challenge: how to rebuild an economy devastated by armed conflict while simultaneously restoring ecosystems damaged by exploitation during the conflict and reconstruction periods. This process demands more than a technocratic economic recovery; it requires a framework grounded in ecological justice, which asserts that development must consider the fair distribution of environmental benefits and burdens among social groups, including future generations (Kaiser & Barstow, 2022; Yuliandri et al., 2021). This principle becomes especially significant when considering how indigenous communities, fishers, and farmers are often the victims of exploitative development practices.

To address these challenges, the sustainable livelihood framework emerges as a highly relevant approach. This framework emphasizes that poverty alleviation depends not solely on economic growth, but on strengthening five livelihood assets: natural capital, human capital, social capital, physical capital, and financial capital. By understanding the dynamic interrelations among these assets, development interventions can be directed toward reducing the vulnerability of poor households to environmental and economic shocks. In Aceh, the implementation of this framework can be realized through the revitalization of sustainable agriculture, protection of coastal ecosystems, and the strengthening of local institutions that manage natural resources collectively and equitably.

Policy Implications and Strategic Recommendations

The policy implications arising from the findings of this study demand an approach that is no longer sectoral and fragmented, but rather integrated and holistic. The panel data analyzed quantitatively reveals a strong interconnection between poverty, economic growth, and environmental quality across various regions in Aceh. Therefore, poverty alleviation policies can no longer be designed in isolation from environmental policies, and vice versa. This integrative approach requires synergy between socio-economic interventions and ecological conservation efforts to break the negative causal loop between poverty and environmental degradation, as demonstrated in the poverty-environment trap—a key characteristic of post-conflict regions (Andriani et al., 2024; Tjoetra et al., 2024; Yin et al., 2021).

One of the main strategies recommended is the strengthening of local institutions in resource management and poverty alleviation programs. Adaptive, participatory, and community-based institutions are crucial to ensure that policies made at the national or provincial levels are effectively translated into tangible actions at the village and sub-district levels. This also implies the need to improve environmental governance by prioritizing principles

of accountability, transparency, and the involvement of indigenous communities and vulnerable groups. In the context of Aceh, strengthening gampong as a local governance unit rooted in strong cultural and social legitimacy can serve as a primary entry point for spatial-based policy design.

The findings from cross-regional panel data provide a critical foundation for the development of evidence-based policy—an approach grounded in empirical evidence rather than assumptions or political interests. Through the results of FEM and REM tests, it is evident that Aceh's socio-economic conditions are significantly influenced by each region's specific dynamics. Consequently, policy formulation must be tailored to local characteristics, including institutional capacity, ecological pressures, and varying poverty levels across districts. This evidence-based approach also helps reduce the risk of program failure due to contextual mismatches.

Furthermore, in formulating post-conflict policies such as in Aceh, a transdisciplinary approach is required—one that comprehensively integrates social, economic, and ecological dimensions. This approach involves not only scholars from various disciplines but also practitioners, policymakers, and the community itself as co-creators of knowledge in the development strategy process. As such, the resulting policies become more contextual, applicable, and responsive to the real needs of post-conflict communities, who simultaneously face social trauma, economic inequality, and environmental vulnerability (Awad & Warsame, 2022; Che & Wang, 2022).

This type of policy approach will strengthen regional adaptive capacity in the face of climate change, economic crises, and social uncertainties. In the context of Aceh, such a strategy can be realized through enhancing synergy among community-based poverty alleviation programs, coastal and agricultural ecosystem conservation, and institutional reforms that uphold the principles of ecological and social justice. Thus, inclusive and sustainable development is not merely an ideal but a logical necessity emerging from both evidence and real needs.

CONCLUSION

Based on the main objective of this study—to analyze the relationship between poverty and environmental degradation in the socio-economic context of post-conflict Aceh—the conclusions drawn indicate that environmental quality is closely linked and mutually influential with poverty levels. Findings from the panel economic model show that poverty has a greater and more significant impact on environmental degradation than the reverse. In other words, poor communities in Aceh tend to depend directly on natural resources for their livelihoods; under economic constraints, they are driven to exploit the environment intensively and unsustainably. This supports the first hypothesis that environmental quality is disrupted by the economic pressures experienced by the poor and reflects the poverty-environment trap phenomenon, where poverty and environmental degradation reinforce one another in a cycle that is difficult to break. Furthermore, the results of testing the second hypothesis show that

improving environmental quality can lead to a reduction in poverty levels. This reinforces the argument that poor households are the most vulnerable to the negative impacts of environmental degradation—whether in terms of health, work productivity, or access to education and other basic services. Therefore, in the context of Aceh's reconstruction, environmental quality is not merely an ecological factor but also a key element in long-term socio-economic development. This study thus affirms that poverty and environmental degradation are not two separate issues but are structurally interconnected. Efforts to alleviate poverty must be integrated with environmental conservation policies. This approach includes the intensification and extensification of sustainable agriculture, the strengthening of civil rights and local institutions, and the utilization of local wisdom as a foundation for maintaining ecological balance. By strengthening institutional quality and adopting an ecological justice-based approach, sustainable development in post-conflict Aceh can be realized—not only economically, but also socially and environmentally. On the other hand, this study acknowledges the limitations in obtaining more in-depth longitudinal data, such as household energy consumption among the poor and the long-term impact of ecological disasters. These aspects represent critical gaps for future research to further explore the links between consumption patterns, environmental pressures, and social vulnerability within the dynamics of poverty in post-conflict regions.

ETHICAL STATEMENT AND DISCLOSURE

This study was conducted in accordance with established ethical principles, including informed consent, protection of informants' confidentiality, and respect for local cultural values. Special consideration was given to participants from vulnerable groups to ensure their safety, comfort, and equal rights to participate. No external funding was received, and the authors declare no conflict of interest. All data and information presented were collected through valid research methods and have been verified to ensure their accuracy and reliability. The use of artificial intelligence (AI) was limited to technical assistance for writing and language editing, without influencing the scientific substance of the work. The authors express their gratitude to the informants for their valuable insights, and to the anonymous reviewers for their constructive feedback on an earlier version of this manuscript. The authors take full responsibility for the content and conclusions of this article.

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