

## **Analysis of the Impact of the Peatland Moratorium on Poverty: Evidence from a Difference-in-Differences Analysis**

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**Abstract:** This study examines whether Indonesia's peatland moratorium policy influenced poverty outcomes in Riau Province. Enacted through Presidential Instruction No. 10/2011, the moratorium suspended the issuance of new land-use permits in primary forests and peatland areas as part of the government's commitment to environmental conservation. Using a quasi-experimental Difference-in-Differences (DiD) framework, the study designates districts with peatland coverage exceeding 100,000 hectares as the treatment group, while districts below this threshold serve as the control group. The analysis spans both the pre-moratorium period (2009–2011) and the post-moratorium period (2012–2024). The DiD coefficient of 2.407 ( $p = 0.228$ ) reveals no statistically significant divergence in poverty trajectories between treated and control areas, indicating that the moratorium lacked direct, measurable effects on household welfare. This outcome underscores the inherent limitations of single-sector environmental governance in resolving the multidimensional character of poverty. Among all covariates examined, educational attainment measured as average years of schooling emerges as the most powerful determinant of poverty reduction ( $\beta = -2.468$ ,  $p < 0.001$ ). Unemployment exhibits a positive association with poverty approaching conventional significance thresholds ( $\beta = 0.444$ ,  $p = 0.053$ ), while GDP per capita shows a statistically significant negative effect. Economic growth, though directionally consistent with poverty reduction theory, does not reach significance, suggesting structural impediments to inclusive growth in the province. These findings call for complementary socioeconomic policies that address human capital deficits and labor market constraints alongside environmental conservation measures.

**Keywords:** moratorium, peatland, poverty, DiD analysis

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## **INTRODUCTION**

The Riau Province presents a striking paradox: it is simultaneously one of Indonesia's most resource abundant regions and one in which poverty persists at notable levels. The plantation and forestry industries form the backbone of the provincial economy, generating considerable revenues for both local communities and regional governments. Yet, according to the Central Statistics Agency (BPS), the province's poverty rate reached 6.67 percent in 2024 a figure that reveals a persistent disconnect between natural wealth and social welfare outcomes.

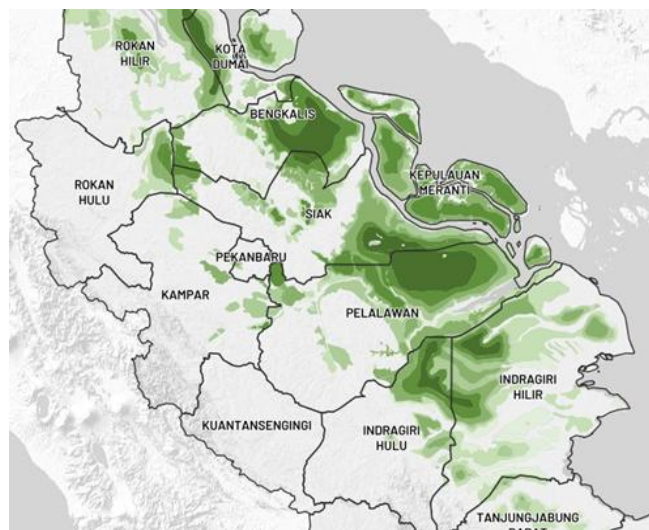
Commercial agricultural expansion, particularly in the oil palm sector, has exerted mounting pressure on peatland ecosystems across the region (Sabiham & Sukarman, 2012). Riau holds the distinction of being Indonesia's second-largest peatland province, with a total peat coverage of approximately 4,360,740.2 hectares equivalent to 60.1 percent of Sumatra's total peatland area. Of this area, approximately 61.17 percent consists of peat with depth not exceeding 300 cm, while the remaining 38.83 percent exceeds this threshold (Mubekti, 2013). Presidential Decree No. 32 of 1990 classifies peatlands with depth of three meters or more as protected zones where commercial economic activities are prohibited (Zamaya, 2023), creating fundamental tensions for communities whose livelihoods depend on these very ecosystems.

Peatland dependent communities in Riau engage in a wide range of economic activities, including smallholder agriculture, plantation farming, fisheries, and the harvesting of non-timber forest products (Zamaya et al., 2021). This livelihood dependency renders these communities highly sensitive to both ecological degradation and shifts in land-use governance. Environmental deterioration resulting from deforestation, drainage, and recurrent fires can amplify the socioeconomic vulnerabilities faced by such populations (Fatkhullah et al., 2021).

In response to escalating deforestation rates and growing international pressure on climate commitments, the Government of Indonesia introduced a moratorium on new peatland permits through Presidential Instruction (Inpres) No. 10/2011. This policy sought to curb further conversion of primary forests and peatlands, reduce greenhouse gas emissions, and strengthen governance frameworks for land management. The moratorium was extended through a series of subsequent presidential instructions Nos. 6/2013, 8/2015, 6/2017, and 5/2019 reflecting the government's sustained commitment to peatland protection.

The central motivation of Inpres No. 10/2011 was to decelerate deforestation and forest degradation, curtail emissions particularly from the land and forestry sectors, and improve institutional management of natural forests and peatlands (Yusuf, 2014). While the environmental rationale for the moratorium is well-established, its socioeconomic consequences particularly for poor communities that derive their livelihoods from peatland resources remain insufficiently understood. The moratorium's effectiveness in reconciling ecological protection with economic welfare is actively debated in the literature (Flood et al., 2025; Januar et al., 2023; Maulana et al., 2019; Widyatmanti et al., 2022).

This study seeks to fill that gap by providing systematic empirical evidence on the relationship between the peatland moratorium and poverty outcomes in Riau Province. The analysis employs a temporal comparative framework contrasting pre- and post-moratorium poverty trajectories alongside a spatial dimension that distinguishes between areas directly falling under moratorium coverage and those that do not. This dual-axis design enables a more credible causal assessment of the policy's welfare effects, isolating them from concurrent economic and developmental trends.



**Figure 1.** Map of Peatland Distribution in Riau Province

Source: [prims.brg.go.id](http://prims.brg.go.id) (2025)

**Table 1.** Peatland Area in Riau Province based on Depth (Ha)

No	Regency	Peat Depth (cm)				Total
		<100	100 - 200	200 - 300	>300	
1	Indragiri Hilir	377,714.2	5,356.1	433,675.7	181,864.4	998,610.4
2	Indragiri Hulu	12,247.8	4,788.9	133,191.1	71,976.3	222,204.1
3	Pelalawan	41,559.9	21,636.4	418,308.7	275,428.1	756,933.1
4	Kuantan Singingi	4,820.6	0.0	0.0	0.0	4,820.6
5	Kepulauan Meranti	137,888.0	0.0	114,245.3	84,114.9	336,248.2
6	Siak & Pekanbaru	62,781.3	20,222.7	158,247.4	258,231.9	499,483.3
7	Kampar	40,185.5	11,976.6	19,750.4	18,419.7	90,332.2
8	Bengkalis & Dumai	132,166.6	42,442.8	158,296.2	470,985.5	803,891.1
9	Rokan Hilir	140,635.3	21,336.0	127,119.9	303,639.0	592,730.2
10	Rokan Hulu	4,657.0	2,904.7	19,426.0	28,499.3	55,487.0
	Riau Province	954,656.2	130,664.1	1,582,260.7	1,693,159.0	4,360,740.2

Source: Mubekti (2013)

The distribution data presented in Table 1 illustrate notable spatial heterogeneity in peat coverage across Riau's ten administrative regencies. Indragiri Hilir records the largest peatland extent at 998,610.4 Ha, whereas Rokan Hulu accounts for the smallest share at 55,487.0 Ha. At the provincial level, peat coverage totals 4,360,740.2 Ha, with the deepest categories (>300 cm and 200–300 cm) accounting for the majority of the area proportions that underscore the ecological significance of these zones for carbon storage, hydrological regulation, and biodiversity conservation.

**Table 2.** Poverty Level or Percentage (%) per Regency/City in Riau Province in 2020 – 2024

No	Regency/City	Year				
		2020	2021	2022	2023	2024
1	Kuantan Singingi	8.91	8.97	8.24	8.07	7.89
2	Indragiri Hulu	5.96	6.18	6.14	6.06	6.02
3	Indragiri Hilir	5.93	6.18	5.98	5.64	5.66
4	Pelalawan	9.16	9.63	8.97	8.15	8.49
5	Siak	5.09	5.18	5.07	5.23	5.08

6	Kampar	7.38	7.82	7.12	7.04	6.92
7	Rokan Hulu	10.31	10.40	9.95	9.72	9.62
8	Bengkalis	6.40	6.64	6.32	6.31	6.36
9	Rokan Hilir	6.72	7.18	6.73	7.07	7.01
10	Kepulauan Meranti	25.28	25.68	23.84	22.98	23.15
11	Pekanbaru City	2.62	2.83	3.06	3.16	3.15
12	Dumai City	3.16	3.42	3.20	3.21	3.14
	Riau Province	6.82	7.12	6.78	6.68	6.67

Source: Central Statistics Agency of Riau Province (2025)

Poverty data from BPS (2025) reveal pronounced regional disparities across Riau Province. Urban centers such as Pekanbaru City and Dumai City consistently recorded the lowest poverty incidence remaining below 3.5 percent throughout the observation period, whereas geographically remote and predominantly rural regencies like Kepulauan Meranti sustained poverty rates exceeding 22 percent. This urban-rural divide reflects structural differences in infrastructure access, economic diversification, and market connectivity.

At the provincial aggregate, the poverty rate exhibited modest fluctuation, rising to a peak of 7.12 percent in 2021 before declining gradually to 6.67 percent by 2024. Several regencies including Kuantan Singingi and Kampar recorded consistent year-on-year reductions, potentially attributable to local development initiatives or improved access to education and services. Nevertheless, the persistence of elevated poverty in peatland-intensive areas such as Kepulauan Meranti and Rokan Hulu raises important questions about the interaction between environmental governance policies and socioeconomic welfare in these communities.

## METHOD

This study employs a quantitative approach grounded in quasi-experimental design, using the Difference-in-Differences (DiD) estimator to identify the causal effect of the peatland moratorium on poverty outcomes. The treatment group comprises districts and cities within Riau Province that hold peatland coverage in excess of 100,000 hectares and are therefore prioritized under the restoration and protection mandates of Presidential Regulations (Perpres) No. 1/2016 and No. 120/2020. The control group consists of districts with peatland areas below this threshold, which are generally outside the primary scope of moratorium enforcement.

Treatment group members include: Indragiri Hilir (998,610.4 Ha), Pelalawan (756,933.1 Ha), Bengkalis & Dumai (803,891.1 Ha), Rokan Hilir (592,730.2 Ha), Siak & Pekanbaru (499,483.3 Ha), Kepulauan Meranti (336,248.2 Ha), and Indragiri Hulu (222,204.1 Ha). Control group members include Kampar (90,332.2 Ha), Rokan Hulu (55,487.0 Ha), and Kuantan Singingi (4,820.6 Ha). The temporal dimension spans the pre-moratorium baseline period (2009–2011) and the post-moratorium period (2012–2024).

Secondary data were sourced from the Central Statistics Agency (BPS) of Riau Province, the Peat and Mangrove Restoration Agency (BRGM), and the Environment and Forestry Service of Riau Province.

### Hypothesis

H<sub>0</sub> : The peatland moratorium does not affect poverty levels

H<sub>1</sub> : The peatland moratorium affects the poverty levels

### Difference-in-Differences (DID) Estimator

The basic DiD specification is expressed as:

$$y_{it} = \beta_0 + \beta_1 Post_t + \beta_2 Treat_i + \beta_3 (Treat_i \cdot Post_t) + u_{it}$$

The expanded model including control variables is:

$$Poverty_{it} = \beta_0 + \beta_1.Post_t + \beta_2.Treat_t + \beta_3.(Treat_t.Post_t) + \beta_4.Ecogrowth_{it} + \beta_5.Unemploy_{it} + \beta_6.School_{it} + \beta_7.PDRB_{it} + \epsilon$$

Information:

- Poverty<sub>it</sub> = Poverty rate in district I at time t (%)
- β<sub>0</sub> = Baseline poverty for the control group in the pre-moratorium period
- β<sub>1</sub> = General time trend effect
- Post<sub>it</sub> = Time dummy (= 1 for post-moratorium; = 0 for pre-moratorium)
- β<sub>2</sub> = Pre-existing between-group difference
- Treat<sub>t</sub> = Treatment dummy (= 1 for treatment group; = 0 for control)
- β<sub>3</sub> = DiD coefficient (causal effect of the moratorium)
- Treat<sub>t</sub>.Post<sub>t</sub> = DiD interaction term (policy effect indicator)
- β<sub>4</sub> to β<sub>7</sub> = Coefficients on control variables
- Ecogrowth<sub>it</sub> = Regional economic growth rate (%)
- Unemploy<sub>it</sub> = Unemployment rate (%)
- School<sub>it</sub> = Average years of schooling
- PDRB<sub>it</sub> = GDP per capita (million Rp)
- ε<sub>it</sub> = Error term

## RESULTS AND DISCUSSION

### Research Results

This The main finding of this study reveals that the peatland moratorium policy did not have a statistically significant impact on poverty reduction. While the negative coefficient of -2.407 suggests a trend toward poverty reduction in treatment areas relative to control areas, this effect is not statistically distinguishable from zero at conventional significance levels. This finding indicates that we fail to reject the null hypothesis (H0), meaning there is no evidence of a significant moratorium effect on poverty levels in the affected districts.

**Table 3.** Regression Results (DiD Estimation with Robust Standard Errors)

Poverty	Coef.	Robust Std. Err.	t	P> t
Post	3.618	1.548	2.34	0.021
Treat	1.853	1.872	0.99	0.324
Treat_Post	-2.407	1.988	-1.21	0.228
Ecogrowth	-0.079	0.151	-0.53	0.599
Unemploy	0.444	0.228	1.94	0.053
School	-2.468	0.447	-5.51	0.000
PDRB	-0.0001	0.000	-4.83	0.000
_cons	29.877	3.168	9.43	0.000

Source: STATA Processed Data (2025)

The complete estimated equation derived from the regression output is:

$$Poverty = 29.877 + 3.618Post + 1.853Treat - 2.407Treat\_Post - 0.079Ecogrowth + 0.444Unemploy - 2.468School - 0.00001PDRB$$

The implications of this finding are substantial for policy evaluation. First, it demonstrates that environmental restrictions imposed by the moratorium did not translate into measurable poverty changes in peatland-dependent communities. Second, the parallel movement of poverty trends in both treatment and control areas post-policy suggests that broader economic forces dominated local poverty dynamics, overwhelming any specific effects of the moratorium. This

result challenges the assumption that environmental conservation policies necessarily harm or benefit local communities economically, instead revealing a more complex reality where direct policy impacts may be minimal.

Several possible explanations emerge for why the moratorium did not significantly affect poverty levels. Weak policy enforcement may have limited the actual impact on economic activities, as the moratorium's on-paper restrictions might not have translated into substantial on-the-ground changes due to limited monitoring capacity, grandfathered exemptions for existing permits, and enforcement challenges in remote peatland areas. Communities may have demonstrated remarkable resilience through adaptation strategies, including livelihood diversification, intensification of production on allowed land, labor migration to non-peatland sectors, and informal coping mechanisms that continued subsistence activities below the regulatory radar.

Time lag effects present another plausible explanation, as poverty impacts from environmental policies may manifest over longer timeframes than captured in this study period. The structural adjustment process through which communities adapt to new environmental regulations and develop alternative livelihoods may require decades rather than years. Additionally, confounding factors such as concurrent national economic policies, commodity price fluctuations, infrastructure development programs, and other regional initiatives may have obscured the specific effect of the moratorium, making it difficult to isolate the policy's direct impact on poverty.

The most significant finding of this study is that education emerges as the strongest poverty determinant among all variables examined. The coefficient of -2.468 with a p-value less than 0.001 indicates that each additional year of average schooling in a district is associated with a reduction in poverty rate of approximately 2.47 percentage points. This robust and highly significant relationship holds even after controlling for economic growth, unemployment, GDP per capita, and the moratorium policy effect, demonstrating education's fundamental role in poverty alleviation.

The policy implications of this finding are profound and far-reaching. Human capital development through education appears to be considerably more effective than land-use restrictions alone in addressing poverty in peatland areas. While environmental regulations like the moratorium focus on constraining certain economic activities, education expands the set of economic opportunities available to individuals and communities, enabling them to participate in higher-value economic activities beyond resource extraction. The substantial poverty reduction returns from education suggest that investments in educational infrastructure, teacher quality, and access in peatland areas would generate significant social and economic benefits.

For peatland communities specifically, prioritizing educational access and quality becomes a critical policy imperative (Winarno, 2020). These often remote and isolated areas face particular challenges in education delivery, including difficulties in recruiting and retaining qualified teachers, inadequate school infrastructure, limited access to educational materials and technology, and opportunity costs that discourage school attendance among poor families. Addressing these barriers through targeted interventions such as scholarship programs, boarding school facilities, distance learning technologies, and teacher incentive schemes could unlock the transformative potential of education for poverty reduction in these vulnerable communities.

Unemployment demonstrates a positive relationship with poverty that approaches statistical significance, with a coefficient of 0.444 and a p-value of 0.053. This finding indicates that each percentage point increase in the unemployment rate is associated with an increase in

poverty rate of approximately 0.44 percentage points. While marginally missing the conventional 5% significance threshold, this relationship is substantively important and aligns with theoretical expectations about labor market dynamics and poverty.

The near-significant positive effect of unemployment underscores the critical need for job creation programs alongside conservation policies. In peatland contexts, where the moratorium restricts certain traditional economic activities, the absence of alternative employment opportunities can trap communities in poverty even if environmental conditions improve. The relationship between unemployment and poverty operates through multiple channels, including direct income loss from joblessness, reduced household consumption and investment capacity, erosion of human capital through prolonged unemployment, psychological and social costs that affect productivity, and intergenerational transmission of disadvantage as unemployed parents struggle to invest in children's education and health.

The labor market dimension of poverty in peatland areas reveals particular vulnerabilities. Agriculture-based economies experience pronounced seasonal unemployment during non-planting and harvesting periods, creating predictable income volatility. Low agricultural productivity on peatlands generates limited labor demand per hectare, constraining employment opportunities. Skill mismatches between workers trained for resource extraction and opportunities in alternative sectors create structural unemployment. Geographic isolation prevents commuting to employment centers in non-peatland areas, trapping workers in local low-productivity activities. Youth unemployment presents acute challenges as young people lack both traditional agricultural opportunities and skills for modern sector employment, driving out-migration and social problems.

Economic growth shows the expected negative relationship with poverty, with a coefficient of -0.079, but this effect lacks statistical significance ( $p = 0.599$ ). This non-significant result is particularly revealing about the nature of economic development in Riau Province, suggesting that aggregate economic expansion has not effectively translated into poverty reduction for large segments of the population. The finding points to fundamental issues with the inclusiveness of Riau's growth model and raises important questions about how economic benefits are distributed across society.

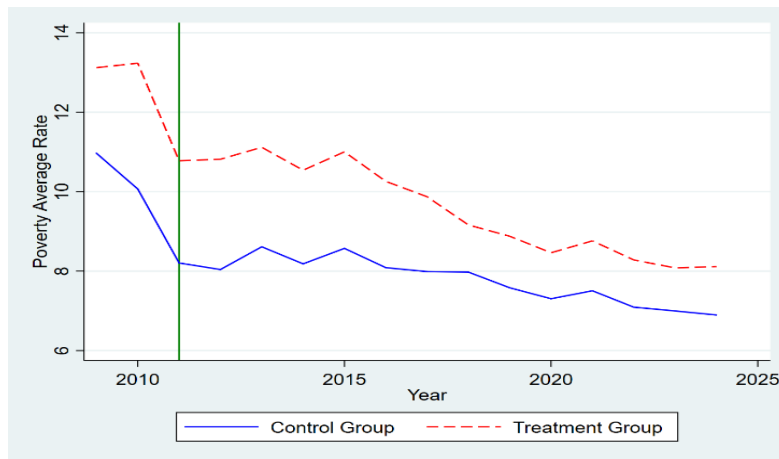
The limited poverty impact of economic growth reflects what development economists term non-inclusive growth, where GDP expansion occurs but benefits accrue disproportionately to already advantaged groups rather than reaching poor populations. In Riau's context, this pattern likely stems from the province's heavy dependence on plantation agriculture, particularly oil palm, which generates substantial economic output but creates relatively few employment opportunities per unit of capital invested. Large-scale plantations and processing industries are capital-intensive rather than labor-intensive, meaning that substantial increases in production and revenue require minimal increases in employment.

Several structural features of Riau's economy contribute to the weak growth-poverty linkage. Land concentration means that benefits from agricultural expansion flow primarily to large landowners and plantation companies rather than smallholders and landless laborers who make up the poor. Enclave development patterns create spatial and economic disconnection between growth centers such as plantation estates, processing facilities, and urban areas and the communities where poverty is concentrated. Limited economic linkages characterize resource extraction sectors, as inputs are often imported and profits flow to external shareholders, weakening the multiplier effects that could benefit local economies. Environmental degradation

accompanying unsustainable growth actually undermines the natural capital that poor communities depend on for subsistence and supplementary income.

Figure 2 provides visual evidence for the parallel trends assumption that underlies the validity of the Difference-in-Difference estimation approach. The graph plots average poverty rates for treatment and control groups over the period from 2009 to 2024, with the vertical line marking the implementation of the peatland moratorium in 2011. The pattern revealed in this graph is crucial for interpreting the causal claims of this study.

In the pre-moratorium period from 2009 to 2011, the treatment and control groups exhibit remarkably parallel trends in poverty rates. Both groups show similar trajectories over time, with poverty declining at comparable rates despite the treatment group having consistently higher poverty levels. This parallel movement before the intervention provides strong support for the DiD identification assumption, which requires that in the absence of the treatment, the two groups would have continued to follow similar trends. The existence of parallel pre-trends validates using the control group as a counterfactual for what would have happened to the treatment group without the moratorium.



**Figure 2.** Parallel Trend Graph of Average Poverty Rates in Treatment and Control Groups before and after Peatland Moratorium Policy Implementation

Source: STATA Processed Data (2025)

After moratorium implementation in 2012, both treatment and control groups continue to exhibit declining poverty trends. Importantly, the trends remain roughly parallel in the post-intervention period, with no sharp discontinuity or structural break visible at the point of intervention. The gap between the two groups narrows gradually over time, reflecting a slight convergence in poverty rates, but this convergence is not statistically significant as confirmed by the DiD regression results. The absence of a visible divergence in trends after 2012 provides visual confirmation of the regression finding that the moratorium did not create differential poverty impacts between high-peatland and low-peatland districts.

The gradual convergence observed in the post-moratorium period, while not statistically significant, merits attention for understanding poverty dynamics in Riau Province. This pattern suggests that various factors beyond the moratorium are contributing to poverty reduction in treatment areas, possibly including general provincial development programs, infrastructure improvements, educational expansion, and economic diversification initiatives. The fact that convergence is gradual rather than sharp supports the interpretation that structural factors and long-term development processes, rather than the specific policy intervention, are driving poverty reduction across the province.

## Discussion

Understanding why the peatland moratorium failed to produce significant poverty impacts requires examining the complex interaction between environmental policy, economic structures, and community responses. The absence of measurable effects does not necessarily indicate policy failure in environmental terms, but rather reveals the limitations of single sector interventions in addressing multidimensional poverty. Several interconnected factors explain this outcome, each reflecting broader challenges in designing policies that simultaneously achieve environmental and development objectives (Ritung & Sukarman, 2016).

Implementation gaps represent a primary explanation for the lack of poverty impact. The moratorium's on-paper restrictions may not have translated into substantial on-the-ground changes in economic activities for several reasons. Weak monitoring capacity limits the government's ability to track compliance across vast and often remote peatland areas, where field verification is logistically challenging and costly. Grandfather exemptions for existing permits meant that many ongoing economic activities continued unaffected, particularly large plantation operations that already held legal concessions before the moratorium. The informal economy, which provides crucial livelihoods for many poor communities, operates largely outside the formal permit system that the moratorium targets, meaning that subsistence agriculture, small-scale forestry, and informal gathering activities continued regardless of policy restrictions (Fatkhullah et al, 2021). Enforcement challenges in remote locations, combined with limited resources for forest and peatland monitoring, created gaps between policy intention and actual implementation that diluted the moratorium's economic impact.

Economic adaptation by affected communities demonstrates remarkable resilience and resourcefulness in the face of environmental restrictions (Dharma, et al, 2024). Rather than experiencing dramatic livelihood disruptions, many communities successfully adjusted through various strategies. Livelihood diversification enabled households to shift from restricted activities to permitted alternatives, reducing dependence on any single income source vulnerable to policy changes. Intensification of production on allowed land, through improved techniques or increased inputs, partially compensated for reduced access to new areas. Labor migration, both seasonal and permanent, provided opportunities to access employment in non-peatland sectors and urban areas, reducing community vulnerability to local restrictions. Informal coping strategies, including continuation of small-scale subsistence activities that fall below regulatory enforcement thresholds, maintained basic livelihood security even as formal economic opportunities contracted (Adriani et al, 2024).



**Figure 3.** Peatland at Riau Province

Source: Researcher, 2025

Insufficient alternative support programs accompanied the moratorium's restrictions, creating a policy gap between what was prohibited and what was enabled. While the moratorium

effectively restricted certain economic activities, complementary programs to support affected communities remained inadequate in scope and effectiveness. Limited alternative livelihood programs meant that few viable replacement income sources were systematically promoted and supported, leaving communities to identify and develop alternatives on their own (Haryanto et al, 2024). Insufficient compensation mechanisms, with no direct transfers or payments for ecosystem services to offset income losses from restricted activities, placed the full adjustment burden on already-poor communities. Weak extension services provided inadequate technical assistance for transitioning to sustainable practices compatible with peatland conservation, limiting the uptake of alternatives like paludiculture or sustainable agroforestry (Ritung et al, 2016). Infrastructure gaps perpetuated isolation from markets and services, constraining the economic opportunities that might compensate for restricted peatland uses.

The structural nature of poverty in peatland areas means that land-use policies alone cannot address the fundamental drivers of deprivation. Poverty in these regions is deeply rooted in factors that transcend environmental regulation and require comprehensive development interventions (Silvianingsih et al, 2020). Geographic isolation creates physical and economic distance from markets, services, and opportunities, fundamentally limiting the returns to any productive activity whether restricted or permitted. Low human capital, reflecting generations of limited educational access and skills development, constrains the ability of individuals and communities to adapt to changing economic conditions or seize new opportunities. Infrastructure deficits in roads, electricity, water supply, telecommunications, health facilities, and educational institutions create an environment where economic productivity and quality of life remain constrained regardless of specific land-use policies. Power asymmetries in relationships with companies, intermediaries, and government institutions leave communities with weak bargaining positions and limited ability to capture value from local resources (Yuliani et al, 2025). Market failures, including thin markets for outputs, volatile prices, limited access to credit and inputs, and lack of value-addition infrastructure, prevent communities from translating productive efforts into adequate incomes even when activities are permitted.

The study's most robust finding, that education is the strongest poverty determinant, aligns with extensive development literature demonstrating that human capital is the most sustainable pathway out of poverty. This relationship proves particularly crucial for peatland communities facing environmental restrictions and economic transitions, as education provides the foundation for adapting to changing circumstances and accessing opportunities beyond traditional resource extraction. Understanding why and how education matters for these communities illuminates potential pathways for integrated policies that advance both conservation and development objectives.

Entrepreneurship and innovation constitute a fifth pathway through which education drives poverty reduction, particularly important for developing alternative livelihoods compatible with conservation. Education fosters innovation and enterprise development, enabling sustainable businesses aligned with conservation objectives. Educated entrepreneurs identify market opportunities for peat-compatible products like paludiculture crops, sustainable fisheries, and ecotourism services. They develop business plans, access credit, manage finances, and scale operations more effectively than counterparts with limited education. They create certified sustainable brands, access premium markets, and add value through processing and marketing rather than selling raw commodities. They innovate in production techniques, developing and adapting methods that increase productivity while maintaining or restoring peatland ecosystems. This entrepreneurial capacity enables communities to develop economic

activities that provide adequate incomes without requiring peatland degradation (Zamaya & Rizaldi, 2025).

The study's findings point decisively toward integrated approaches that address poverty and environmental conservation together rather than treating them as separate or conflicting objectives. Peatlands can sustainably deliver both ecological services including massive carbon storage, water regulation, flood prevention, and biodiversity habitat and human well-being through appropriate livelihoods, poverty reduction, and community development. Achieving this integrated vision requires moving beyond the false dichotomy between environment and development to design policies and programs that harness synergies and manage trade-offs thoughtfully.

Infrastructure investment unlocks economic opportunities by reducing transaction costs, improving market access, and enabling economic diversification (Zamaya, 2023). Physical infrastructure creates an enabling environment where various livelihood strategies become viable. Road construction and improvement connects remote peatland communities to markets, services, and opportunities, reducing transport costs and time while enabling access to inputs and sale of outputs. Electricity grid extension or off-grid renewable energy systems power processing equipment, refrigeration, communications, and household improvements that enhance productivity and quality of life. Water supply systems providing clean water improve health, reduce time spent collecting water, and enable sanitation improvements with productivity benefits. Communications infrastructure including mobile networks and internet access overcomes geographic isolation, enabling market information access, distance learning, telemedicine, and digital financial services. Health and education facilities located closer to peatland communities reduce the need for long-distance travel, improving access and utilization while retaining human capital locally.

Integrated peatland management should coordinate across sectors rather than pursuing fragmented initiatives. A unified peatland strategy integrating conservation and development should provide coherent guidance replacing contradictory signals. Inter-agency coordination mechanisms should align activities of environmental, agriculture, forestry, social affairs, and economic departments. Community participation in planning should ensure that management approaches reflect local knowledge and priorities. Monitoring and adaptive management systems should track both environmental and social outcomes, enabling course corrections based on evidence. District Governments should prioritize budgets to allocate resources to poverty reduction in peatland areas rather than concentrating spending in more accessible or politically connected areas. Budget allocation to basic needs fulfillment should ensure food security, healthcare access, adequate shelter, and essential services for poor peatland populations. Education and skills development funding should support school operations, teacher salaries, student support, and vocational training. Infrastructure improvement budgets should address critical gaps in roads, electricity, water, and communications. Community development support should enable community organizations, collective enterprises, and participatory planning processes.

MSME support programs should facilitate sustainable small enterprises that can provide livelihoods compatible with conservation. Business development services including training, planning assistance, and mentoring should build entrepreneurial capacity. Access to micro-credit and capital through credit programs, guarantee schemes, and equity financing should overcome the financing constraints that prevent enterprise creation and growth. Marketing assistance should connect producers with buyers, develop brands, and access premium markets.

Cooperative development should enable collective bargaining, economies of scale, and shared risk for small producers.

Monitoring and evaluation systems should track outcomes systematically to enable evidence-based management. Poverty monitoring disaggregated by peatland and non-peatland areas should reveal whether particular populations are being left behind. Livelihood surveys in affected communities should document coping strategies, income sources, and well-being outcomes. Program impact evaluations using rigorous methods should identify what works and what doesn't. Adaptive management based on evidence should adjust programs, scale successes, and discontinue ineffective initiatives.

Traditional knowledge integration should combine indigenous wisdom with modern approaches rather than abandoning practices developed over generations. Documentation of traditional peatland management practices should preserve knowledge at risk of loss as elders pass away and young people migrate. Integration into paludiculture and restoration programs should apply proven traditional methods alongside scientific innovations. Protection of cultural heritage while enabling adaptation should maintain identity while permitting necessary changes. Sharing of knowledge across communities should spread successful practices and build collective capacity.

The empirical results of this study demonstrate that the peatland moratorium policy did not produce a statistically meaningful divergence in poverty outcomes between policy-targeted districts and unaffected areas. The near-identical poverty trajectories observed across both groups throughout the observation window suggest that broad-based land-use restrictions, applied in isolation, are fundamentally insufficient to address the structural and multidimensional character of deprivation in peatland-dependent communities. Rather, the econometric analysis points to three dominant determinants of poverty reduction that operate independently of moratorium status: expanded access to quality education, sustained regional economic expansion, and improvements in labor market absorption. These results carry a critical policy implication, environmental conservation instruments must be embedded within a broader socioeconomic development architecture if policymakers are to simultaneously achieve ecological sustainability and meaningful welfare gains for communities residing in peatland areas.

## **CONCLUSIONS**

This study provides rigorous empirical evidence on the socioeconomic impacts of Indonesia's peatland moratorium policy in Riau Province. The peatland moratorium did not significantly impact poverty levels in affected areas. The Difference-in-Difference coefficient of -2.407 with a p-value of 0.228 indicates that changes in poverty rates in treatment areas were statistically indistinguishable from control areas after policy implementation. This finding demonstrates that the policy successfully addresses environmental objectives but lacks integrated poverty alleviation mechanisms, revealing the limitations of single-sector environmental interventions for achieving broader development goals. Human capital development is considerably more effective than regulatory approaches alone for poverty reduction. The finding highlights education as the most sustainable pathway out of poverty, particularly valuable in contexts where environmental policies restrict traditional livelihoods and require economic transitions to alternative activities demanding new skills and knowledge. Labor market interventions are essential for poverty alleviation, as joblessness directly increases poverty through income loss, reduced consumption capacity, and erosion of human capital. The

relationship is particularly important in peatland contexts where environmental restrictions may reduce employment in traditional sectors, highlighting the need for job creation strategies that provide alternatives compatible with conservation objectives.

Economic growth has a negative coefficient as theoretically expected, the lack of statistical significance indicates that GDP expansion does not effectively translate into poverty reduction for large segments of the population. This finding points to structural issues with benefit distribution in resource extraction economies, where growth accrues disproportionately to capital owners and large companies rather than poor communities dependent on land and labor. Pre-treatment parallel trends between treatment and control groups validate the Difference-in-Difference approach and confirm that the absence of significant effects is not a methodological artifact. The visual and statistical evidence of parallel trends before the intervention supports the causal interpretation of results, demonstrating that treatment and control groups would have followed similar poverty trajectories absent the moratorium. The continuation of roughly parallel trends after intervention confirms that the policy did not create differential impacts between high-peatland and low-peatland districts.

The successful integration of peatland conservation with poverty alleviation in Riau Province requires coordinated engagement from multiple stakeholders across government, community, and private sectors. Central government ministries play critical regulatory and programmatic roles. Provincial and district governments coordinate regional implementation, allocate budgets for infrastructure and economic diversification, and facilitate multi-stakeholder dialogue. Local communities and indigenous groups serve as both primary beneficiaries and conservation actors, participating in Payments for Ecosystem Services schemes, adopting sustainable livelihoods like paludiculture and ecotourism, and ensuring their agency in planning processes through community empowerment mechanisms.

The private sector, civil society, and knowledge institutions provide essential complementary functions for integrated conservation-development approaches. Private companies must comply with moratorium regulations while contributing through corporate social responsibility and sustainable business practices, while green investors and financial institutions provide financing for conservation-compatible enterprises. NGOs conduct policy advocacy, provide technical assistance for alternative livelihoods, and monitor implementation to ensure social justice and accountability. Research institutions generate empirical evidence for evidence-based policymaking, develop technologies for paludiculture and peat restoration, and facilitate knowledge transfer to local communities. International donors and organizations provide funding and technical assistance for integrated programs. This multi-stakeholder approach requires a coordination platform that aligns sectoral policies, ensures resource flows and accountability, establishes participatory monitoring mechanisms, and creates economic incentives that simultaneously benefit conservation and poverty reduction—addressing the study's finding that single-sector environmental interventions are insufficient for achieving broader development goals.

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