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EVALUATING GOVERNMENT SPENDING ON CLIMATE CHANGE MITIGATION: EFFECTS ON DEFORESTATION AND CARBON EMISSIONS IN KALIMANTAN, INDONESIA

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Abstract
This study examines the impact of central and local government spending on deforestation and carbon emissions in Kalimantan, a region where emissions are predominantly driven by forest-related activities and fossil fuel consumption. Utilizing a panel data regression analysis from 2016 to 2022, the research considers central government spending and regional transfers as independent variables, with deforestation and carbon emissions as dependent variables, and controls for regional area, gross regional domestic product, and COVID-19 effects. The findings indicate that increased central government expenditure correlates with reduced deforestation, whereas local government spending shows no significant impact on deforestation. Additionally, central government spending is associated with higher carbon emissions, while regional transfers do not significantly affect carbon emissions. Efficiency analysis reveals that East Kalimantan is the most efficient province in reducing deforestation and carbon emissions, while Central, West, and North Kalimantan are the least efficient. The study suggests that budget refocusing is essential for more precise targeting to effectively reduce deforestation and carbon emissions. Furthermore, it highlights the necessity for enhanced coordination between central and local governments, particularly in Central, West, and North Kalimantan, to address climate change issues comprehensively. This research contributes to our understanding of the fiscal dynamics of environmental policy in Indonesia and provides insights for optimizing government spending to mitigate the impacts of climate change.

Keywords: Climate change mitigation, government spending, regional government, deforestation, carbon emissions, fiscal policy
JEL Classification: Q54, H23, Q23, D61

INTRODUCTION

Indonesia is committed to mitigating climate change under the Nationally Determined Contributions (NDCs) of the Paris Agreement, targeting a 29% reduction in carbon emissions unconditionally and 41% with international support, as outlined in the Long-term Strategy for Low Carbon and Climate Resilience 2050 (LTS-LCCR 2050) (Law No. 16 of 2016). A key policy supporting this commitment is the Reducing Emissions from Deforestation and Forest Degradation (REDD+) program, developed with the United Nations Framework Convention on Climate Change (UNFCCC) to reduce forestry sector emissions through forest conservation incentives (UNFCCC, 2015). The Ministry of Environment and Forestry (MOEF) (2020) reveals that fiscal policies, including carbon taxes, renewable energy subsidies, and forest conservation incentives, are central to these efforts, with the government allocating specific budgets since 2016 for projects like peatland restoration and forest rehabilitation. Despite these measures, effective implementation often depends on the local government's capacity to plan and execute climate programs, underscoring the need for enhanced governance and support (MOEF, 2020).

Kalimantan, covering 46% of Indonesia's forests, is home to significant biodiversity and the indigenous Dayak community (MOEF, 2018; Setiajiati et al., 2019; Rakatama & Pandit, 2020). However, since the late 1990s, activities such as mining, illegal logging, and plantation development have caused extensive deforestation. Between 2006 and 2021, deforestation affected 3.04 million hectares, including 0.56 million hectares of peat forests, accounting for 48.5% of the total forest area (Forest Watch Index, 2018; MOEF, 2021). These trends underscore the environmental pressures from both domestic and foreign exploitation of natural resources.

Kalimantan Island is one of the islands with the highest average level of carbon emissions from 2018 to 2023 at 51.15% (MOEF, 2024), which directly contributes to global carbon emissions. As its geography is characterized by vast tropical rainforests and peat ecosystems, Kalimantan plays a key role in climate change mitigation. Moreover, the Indonesian government has implemented various programs and policies to reduce deforestation in the region, including REDD+ initiatives and funding for forest protection, such as fiscal incentives for forest conservation to reduce greenhouse gas emissions (Sovacool et al., 2016) and climate change mitigation programs in the state budget (Handayani et al., 2017). However, the effectiveness of government spending in reducing deforestation and carbon emissions in Kalimantan remains debatable, and challenges persist, including conflicts between resource exploitation and conservation, limited financial and human resources, and inadequate technical and institutional capacities at the local level (Duchelle et al., 2017; MOEF, 2021). Therefore, Kalimantan was selected as the focus of this study due to its significant environmental challenges, the allocation of financial resources for climate mitigation, and the complexities of governance in addressing deforestation and carbon emissions.

Previous studies have explored the relationship between government spending and climate change, revealing varied impacts on deforestation and carbon emissions (Diniyanti & Halimatussadiah, 2020; Florea et al., 2021; Coelho-Junior et al., 2022; Oh, 2023; Onyinyechi & Olasupo, 2022), but none have specifically highlighted climate change mitigation funding as a primary factor. This research examines the effects of Indonesian government spending on climate change mitigation, focusing on Kalimantan, Indonesia's largest forest region. It evaluates the impact of thematic government expenditures on deforestation and carbon emissions across provinces in Kalimantan, filling a gap in the literature by comparing the outputs of mitigation programs against inputs in provinces with different geographical and economic contexts. Based on the above discussion, this study aims to answer the following research questions:

1. Is there a significant effect of Climate-Change Ministry/Agency Spending (CCMAS) and Environmental Transfer Fund (ETF) on deforestation (DF) in Kalimantan?
2. Is there a significant effect of CCMAS and ETF on carbon emissions (CE) in Kalimantan?
3. Which region in Kalimantan demonstrates the most efficient use of CCMAS and ETF in reducing DF and CE?

LITERATURE REVIEW

Government Spending on Climate Change in Indonesia

Government spending is a critical fiscal policy tool for achieving development goals such as poverty alleviation, infrastructure enhancement, and environmental conservation (Hadi et al., 2014). In addressing climate change, it supports mitigation and adaptation efforts through two main schemes: ministry-agency expenditure and transfer expenditure to regions. Ministry-agency expenditure involves allocating funds within the state budget (APBN) to ministries and agencies for program implementation (Zunaidi et al., 2015). Since 2016, a tagging system under the Fiscal Policy Agency (FPA) has categorized climate-related programs into mitigation, focusing on carbon emission reduction, and adaptation, enhancing resilience in economic, social, and ecosystem sectors (FPA, 2021). The Ministry of Environment and Forestry (MOEF) and other ministries intersecting with climate concerns are key users of these tagged funds (FPA, 2021).

Transfer expenditure supports fiscal decentralization and regional autonomy, with specific funds dedicated to environmental conservation and climate change mitigation, such as the Revenue Sharing Fund (DBH) for Reforestation and the Special Allocation Fund (DAK) for environmental tasks. The DBH for reforestation is allocated from reforestation revenues to support forest rehabilitation and management at the regional level, while the DAK provides grants for programs aligned with national priorities, including local environmental initiatives (Hadi et al., 2014; Ministry of Finance Law 216/PMK.07/2021). These funding mechanisms are essential for addressing

climate change through both national and regional efforts.

Overall, this research raises the possibility that both CCMAS and ETF, as forms of government spending, have a positive impact on reducing deforestation and carbon emissions. CCMAS directly supports government initiatives aimed at mitigating climate change. Additionally, ETF serves as a mechanism to restore funding following deforestation, although DBH is allocated for reforestation efforts, which is directly proportional to the extent of deforestation.

Government Spending and Deforestation

Deforestation disrupts carbon storage, alters regional climate patterns, and exacerbates global warming through increased carbon dioxide emissions (Watanabe, 2024; Noman & Zafar, 2023). Forest conservation enhances carbon sequestration and reduces greenhouse gas emissions, making it vital for climate change mitigation. Fiscal transfers to local governments are crucial for funding forest management, as effective spending on forest protection reduces deforestation, as shown in research by Diniyanti and Halimatussadiah (2020) in Indonesia. Conversely, budget cuts, such as those in Brazil's federal environmental agencies, hinder deforestation control efforts (Coelho-Junior et al., 2022), while agricultural spending often drives deforestation through land-use conversion (Puspitasari, 2018; Pendrill et al., 2022).

Central government policies and governance significantly impact deforestation rates. Conservation policies and financial incentives for sustainable practices reduce deforestation (Assunçao et al., 2015; Nepstad et al., 2014), while governance measures, such as law enforcement and property rights, prove more effective than democratic reforms (Wehkamp et al., 2018). However, local governance and policy adaptation vary, leading to different outcomes in forest protection (Deacon, 2017). These findings highlight the need for well-aligned central policies and robust local governance to mitigate deforestation effectively.

This gap indicates that government spending can have both positive and negative impacts on deforestation rates. Considering the context of climate change, the hypothesis of this study is as follows:

H_{1a}: CCMAS affects deforestation in Kalimantan.

H_{1b}: ETF affects deforestation in Kalimantan.

Government Spending and Carbon Emissions

Paris Agreement emphasizes the importance of reducing greenhouse gas emissions to address these challenges (Huang & Shen, 2017). The role of government expenditure in reducing carbon emissions is a critical area of study, with research showing mixed results. For example, increased fiscal spending can reduce CO_2 emissions, as seen in studies by Halkos and Paizanos (2016), who identified reductions in emissions from production and consumption. In addition, Florea et al. (2021) found that environmental protection spending significantly reduced emissions in Romania. Similarly, Zou et al. (2023) highlighted the positive effects of subsidies for low-carbon R&D, and Liu et al. (2023) emphasized the role

of government incentives for low-emission public buildings in China.

However, other studies reveal the complexities in the relationship between government spending and emissions. Oh (2023) found that local government spending on air quality in South Korea reduces emissions directly but increases them indirectly through economic growth. Wójtowicz et al. (2022) observed that environmental spending in Poland reduces emissions but may be counterproductive in highly developed regions. In Nigeria, Onyinyechi & Olasupo (2022) highlighted varied impacts across government levels: federal spending significantly reduced emissions, while state and local spending were less effective or even detrimental. These findings underscore the need for targeted and context-sensitive fiscal policies to maximize emission reductions while mitigating unintended consequences.

Those studies underscore the varying effects of government spending and delegated funds on carbon emissions across different regions, highlighting the need for comprehensive research to determine how thematic government spending can influence carbon emission reductions. Therefore, the hypotheses for this study are:

H_{2a}: CCMAS affects the amount of CO_2 emissions in Kalimantan.

H_{2b}: ETF affects the amount of CO_2 emissions in Kalimantan.

RESEARCH METHODS

This research used multiple regression analysis to examine the influence of CCMAS and ETF on deforestation and carbon emission. Government expenditures for environmental protection contribute significantly to climate change mitigation in the long term in Romania (Florea et al. (2021). Another study examines both the direct and indirect effects of government spending on environmental outcomes through economic growth (Oh, 2023). Higher government spending on forest protection and ranger patrols will lead to significantly greater mitigation of deforestation (Diniyanti & Halimatussadiah, 2020). Moreover, Onyinyechi & Olasupo (2022) also investigate how government spending (central and local government) influences environmental quality through CO_2 emissions, guiding recommendations for fiscal policy adjustments. Therefore, the panel regression model was used in Model I and Model II to investigate the impact of government spending on deforestation and carbon emission. The model was derived from the research by Onyinyechi & Olasupo (2022), Diniyanti and Halimatussadiah (2020), and Oh (2023).

The data utilized encompasses panel data from 2016 to 2022, covering the five provinces on the island of Kalimantan, resulting in 35 unit-year observation points. This study considered economic development levels and geographic conditions as a control variable. The COVID-19 pandemic in 2020 and 2021 significantly reduced government spending allocations for the climate change sector, as priorities shifted towards pandemic response, including health, social protection, and economic

recovery. Therefore, we also included COVID-19 as a control variable. This shift necessitates a deeper examination of the relationship between CCMAS, ETF, gross regional domestic product (GRDP), total area (TA), and the impact of the COVID-19 pandemic (CV) on deforestation and carbon emission reductions.

This approach enables the study to focus more precisely on CCMAS and ETF as the independent variables. The research model is formulated as follows:

Model I

$$DF = \beta_0 + \beta_1 CCMAS + \beta_2 ETF + \beta_3 TA + \beta_4 GRDP + \beta_5 CV + \varepsilon$$

Model II

$$CE = \beta_0 + \beta_1 CCMAS + \beta_2 ETF + \beta_3 TA + \beta_4 GRDP + \beta_5 CV + \varepsilon$$

DF represents the natural logarithm of the amount of deforestation, calculated from the permanent change in forest function from forested to non-forested areas annually (MOEF, 2018). DF data is obtained from the online forest monitoring site globalforestwatch.org. CE is derived from the natural logarithm of the total greenhouse gas emissions (in gigagrams), consisting of CO_2, N_2O in CO_2 equivalents, CH_4 in CO_2 equivalents, HFC in CO_2 equivalents, PFC in CO_2 equivalents, SF_6 in CO_2 equivalents, and NF_3 in CO_2 equivalents per year (Dębkowska et al., 2022). CE data is obtained from the emission monitoring site of the MOEF, signsmart.menlhk.go.id. The total area is the natural logarithm of the provincial area. GRDP is the natural logarithm of the Gross Regional Domestic Product per year, obtained from the Central Bureau of Statistics. CV is a dummy variable indicating the impact of COVID-19, with 2020-2021 assigned a value of 1 and other years assigned a value of 0.

CCMAS represents the natural logarithm of central government spending on climate change-related activities, including thematic spending on climate change mitigation and adaptation in government agencies. This thematic spending is calculated by the authors based on tagging guidelines from FPA and Directorate General of Budgeting (DGB), outlined in the Krisna Application. There are 18 government agencies categorized under climate change thematic spending, covering both mitigation and adaptation. The central government expenditure entering Kalimantan involves 44 government agencies. Based on FPA (2021) of the 18 agencies, 13 have climate change-related spending in Kalimantan, which includes:

1. Ministry of Agriculture
2. Ministry of Transportation
3. Ministry of Health
4. Ministry of Social Affairs
5. Ministry of Environment and Forestry
6. Ministry of Marine Affairs and Fisheries
7. Ministry of Public Works and Public Housing
8. Ministry of Research and Technology/National Research and Innovation Agency
9. Central Bureau of Statistics
10. Ministry of Agrarian and Spatial Planning/National Land Agency
11. Ministry of Villages, Development of Disadvantaged Regions, and Transmigration
12. Meteorology, Climatology, and Geophysics Agency
13. National Search and Rescue Agency

The above categories require further sorting due to the thousands of government spending programs involved. Therefore, the data were sorted based on FPA (2021) and MOEF (2021), with CCMAS focusing only on spending by government agencies related to "Climate Change Mitigation Expenditure" from these 13 agencies. To sort the data, we used keywords derived by FPA (2021) and MOEF (2021) based on programs related to climate change mitigation: "forestry", "environment", ″sustainability", "water resources", "technology", "conservation", "climate", and "climatology". CCMAS is obtained by summing the budget realizations of programs filtered based on these keywords, consisting of 11 programs:

1. Sustainable Commodity Production Enhancement Program
2. Creation of Sustainable Agricultural Bio-Industry Technology and Innovation Program
3. Support for Management and Technical Task Implementation of the Ministry of Environment and Forestry Program
4. Environmental and Forestry Research and Development Program
5. Sustainable Production Forest Management and Forestry Business Program
6. Watershed and Protected Forest Management Program
7. Natural Resources and Ecosystem Conservation Program
8. Environmental Planning and Management Program
9. Environmental Law Enforcement Program
10. Water Resources Management Program
11. Meteorology, Climatology, and Geophysics Program

ETF represents the natural logarithm of the amount of deforestation Revenue Sharing Fund (DBH) and physical Special Allocation Fund (DAK) obtained from the SIMTRADA Application. The Reforestation Revenue Sharing Fund is included because the Ministry of Finance Law (PMK) No. 216 of 2021 on the Use, Monitoring, and Evaluation of Forestry Revenue Sharing and Reforestation mandates that the funds should be used for reforestation activities. Climate change mitigation-related physical DAK expenditure is obtained by filtering data based on "output" with keywords "environment" and "forestry", resulting in two types of output:

1. Assignment DAK for Environment and Forestry Sector
2. Physical DAK for Agriculture, Marine, Fisheries, Environment, and Forestry Sectors

Additionally, to determine the efficiency of CCMAS and ETF in reducing DF and CE relative to each province in Kalimantan, a comparison between output and input using Data Envelopment Analysis (DEA) is needed. We used a five-year dataset of output and input to assess the relative efficiency across regions in Kalimantan. DEA is used to assess the relative efficiency of Decision-Making Units (DMUs) using non-parametric data. A value of 1 indicates that the DMU is relatively efficient, while values below 1 indicate inefficiency. The DEA equation used in this study is as follows:

$$Efficiency = \frac{output}{input} = \frac{u_1 DF + u_2 EC}{v_1 CGS + v_2 TF}$$

where $U_{1,2}$ represents the weight of each output (DF and EC) with values ≥ 0, and $V_{1,2}$ represents the weight of each output (CCMAS dan TF) with value ≥ 0.

RESULTS AND DISCUSSION

Classical Assumption Test

Based on the results of the Shapiro-Wilk test in Table 1, the value of the residual error of Model I was 0.05, and for Model II it was 0.31. The probability values for both models were greater than 0.05, indicating that both models are normally distributed. The test results shown in Table 1 suggest that the normality assumption is met for both models, ensuring that the data generated is unbiased and efficient, thus allowing for the continuation of regression testing with panel data.

As shown in Table 2, the Variance Inflation Factor (VIF) values for all independent variables were below 10 with an average VIF value of 1.56. This indicates that there is no significant multicollinearity among the independent variables in this model. Therefore, the regression model used in this study is free from multicollinearity problems. The Stata v.17 application standard error was calculated with the Huber-White Sandwich estimator with the "robust" option in the Stata v.17 application.

Autocorrelation in this analysis was ignored because the regression model was run with a random effects model. According to (Ghozali, 2016), the random effects model can overcome autocorrelation problems in panel data or data with a structure that has a relationship between times or between observation units. Thus, conducting additional tests or corrections for autocorrelation is unnecessary. Meanwhile, to overcome potential heteroscedasticity in the model, the standard error was calculated with the Huber-White Sandwich estimator with the "robust" option in STATA v17. The skewness values of all variables were close to zero. This suggests that the data is approximately normally distributed, as evidenced by the kurtosis values of CCMAS, ETF, TA, GRDP, DF, and CE, which are less than three (kurtosis <3),

Table 1 Shapiro-Wilk Test

Model	Score	Prob	Conclusion
I	1.674	0.05	Distributed normally
II	0.374	0.31	Distributed normally

Source: Processed by the authors

Table 2 Multicollinearity Test and Descriptive Statistics of Variables for Models I and II

Variable	VIF	Skewness	Kurtosis
CCMAS	1.73	-0.97	0.46
ETF	1.70	-1.32	1.20
TA	1.58	-0.78	-1.03
GRDP	1.77	0.73	-0.12
CV	1.01	-	-
DF	-	-0.72	1.19
CE	-	-0.96	2.26

Source: Processed by the authors

Table 3 Regression Result of Model I: The Effect on Deforestation

Variabel (DF)	Coefficient	Prob	Hipotesis	Descision
CCMAS	-0.3930***	(0.000)	H_{1a}	Accepted
ETF	-0.1067	(0.338)	H_{1b}	Rejected
TA	1.9349***	(0.000)		
GRDP	-0.1571	(0.352)		
CV	-0.4561***	(0.000)		
Constanta	6.3526	(0.101)		
R^2	0.8349			
Total Provinces	5			
Observations	35			

P-values are indicated by the values in parentheses. ***, **, * denote the significance of the coefficients at 1%, 5%, and 10%, respectively.
Source: Processed by the authors

indicating a near-normal distribution with fewer outliers.

CCMAS Effect to DF and CE

As shown in Table 3, Model I accepts H_{1a}, suggesting that CCMAS has a significant negative effect on the deforestation rate. This result indicates that higher CCMAS related to climate change in Kalimantan correlates with a greater reduction in deforestation. This finding is supported by studies conducted by Diniyanti and Halimatussadiah (2020) and Coelho-Junior et al. (2022), which show that CCMAS related to climate change can reduce deforestation. Increased CCMAS related to climate change can enhance Kalimantan's ability to carry out forest conservation and protection, thereby reducing the rate of deforestation.

Brazil also experienced a reduction in deforestation due to government spending, achieving half of its REDD+ target to reduce emissions from deforestation by 2020, with the target year being 2030 (Boucher et al., 2013). Despite Brazil's unique political landscape, often dominated by elite interests, the country managed to reduce deforestation through government spending (Boucher et al., 2013). Additionally, Brazil received US$670 million in compensation from Norway. Although it did not cover all deforestation reduction costs, it was still effective in reducing deforestation (Boucher et al., 2013)

Central government policies are crucial in supporting deforestation reduction. Conservation policies can reduce deforestation even with fluctuations in agricultural product prices (Assunçao et al., 2015). Assunçao et al. (2015) showed that conservation policies could potentially prevent the loss of about 73,000 km² of the Amazon forest, or 56% of the total deforestation from 2005 to 2009. This result is equivalent to avoiding the loss of 2.7 billion tons of CO_2. Deacon (2017) explains that central government intervention in reducing deforestation can include improvements in transportation, taxes and royalties on timber harvests, controls on log exports, various agricultural policies, and tax

Table 4 Regression Results of Model II: Impact on Carbon Emissions

Variabel (CE)	Coefficient	Prob	Hipotesis	Desc.
CCMAS	0.4179***	(0.000)	H_{2a}	Accepted
TF	0.0323	(0.358)	H_{2b}	Rejected
TA	0.4485***	(0.000)		
GRDP	-0.2890***	(0.002)		
CV	-0.1367	(0.327)		
Constanta	18.1805***	(0.000)		
R^2	0.4678			
Total Provinces	5			
Observations	35			

Note: P-values are indicated by the values in parentheses. ***, **, * denote the significance of the coefficients at 1%, 5%, and 10%, respectively.
Source: Processed by the authors

incentives to promote domestic processing industries.

Furthermore, financial incentive mechanisms, if successful in reducing deforestation rates, have a positive effect on deforestation (Nepstad et al., 2014). These incentives can be provided as financial rewards to forest landowners, indigenous communities, municipal governments, and regional governments (Nepstad et al., 2014). These incentives include financial support for sustainable agricultural practices, forest protection and restoration, and training and outreach for the adoption of environmentally friendly technologies (Nepstad et al., 2014).

Governance aspects are often blamed for handling deforestation but remain a subject of debate. Deacon (2017) suggests that the variability in deforestation outcomes can be due to differing local government governance, monitoring, and policy adaptation. Wehkamp et al. (2018) conducted a meta-analysis of 32 cross-country empirical studies in the field of economics, encompassing 227 estimates of the impact of various governance measures on deforestation. They found that governance choices are a key factor in reducing deforestation. Environmental policies, property rights, the presence of environmental NGOs, and law enforcement are more effective in reducing deforestation. On the other hand, Wehkamp et al. (2018) also explained that the use of democracy and rights as governance measures tends to increase deforestation when governance improves. The study indicates that not all aspects of governance improvement support forest conservation equally across local governments. While governance improvements are generally considered positive, some elements do not directly contribute to forest conservation and may even have the opposite effect.

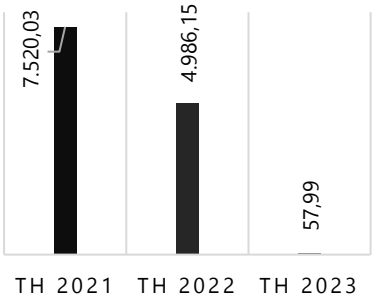
As shown in Table 4, H_{2a} is accepted, indicating that CCMAS has a significant positive effect on CE. This finding reveals a paradox in the relationship between CCMAS related to climate change and CO_2 emissions in the provinces of Kalimantan. The regression results suggest that an increase in CCMAS related to climate change can actually contribute to higher CO_2 emissions. This finding contradicts previous studies, such as those by

Halkos and Paizanos (2016) and Florea et al. (2021), which suggest that government spending can reduce emissions.

However, a study conducted by Oh (2023) supports this result, which also found that government spending can indirectly increase emissions through heightened regional economic activity. Higher economic activity often leads to increased energy consumption, potentially adding to CO_2 emissions. Furthermore, (Wójtowicz et al., 2022) revealed that government environmental spending can be counterproductive in reducing emissions in highly developed regions. (Atyeh & Damrah, 2024) added that the impact of government spending on emissions largely depends on the specific type and context of the expenditure. Therefore, while government spending on environmental issues can play a crucial role in mitigating CO_2 emissions, careful consideration of the type and context of spending is essential to avoid unintended increases in CO_2 emissions. Multisectoral strategies and holistic approaches are needed to address environmental challenges comprehensively, ensuring that government spending not only boosts economic activity but also positively impacts CO_2 emission reduction.

To determine whether this spending is directly related to deforestation and CO_2 emissions, a more detailed investigation of climate spending is necessary. According to the 2021 FPA guidelines on the Use of Budget Marking for Climate Change, there are three direct and indirect

Figure 1 Climate Expenditures in Kalimantan in Billions Rupiah



Source: Author's analysis from Directorate General of Treasury Data (2024)

indicators of climate change mitigation: CO_2 emission reduction, carbon absorption, and prevention of carbon stock depletion. Self-assessments of outputs are conducted by the smallest unit offices responsible for the outputs, as they understand the detailed goals and outputs of their activities. Each unit within a ministry or agency marks the climate change mitigation budget based on Presidential Regulation No. 18 of 2020 on the RPJMN (Midterm Government Plan), prioritizing activities related to sustainable energy development, sustainable land restoration, waste management, green industry development, and low-carbon coastal and marine areas. Despite regulatory standards, self-assessment by units within a ministry or agency often lacks accuracy or does not directly relate to deforestation or carbon emission reduction.

The aggregate from the self-assessments produces a dedicated climate change budget compiled by the DGB. The Directorate General of Treasury (DGTr) then disburses this budget to the working units, and its

realization is reported. Figure 1 shows the realization of climate-related spending in billions of rupiah for the past three years: 2021, 2022, and 2023, based on the data from the DGTr.

From 2022 to 2023, there was a drastic decline in climate spending, with only Rp57.99 billion allocated to Kalimantan. This drop was unusual, representing a decrease of over 90% in one year, indicating a potential inaccuracy in tagging or the absence of tagging for the 2023 budget. Consequently, this data is unreliable and highlights the need for improvements in the budget tagging and government spending systems.

Moreover, in terms of the relevance, programs and outputs of government spending are not specifically linked to deforestation and carbon emissions. Table 5 provides examples of programs that indirectly impact the reduction of deforestation and carbon emissions, such as those created by the Ministry of Public Works and Public Housing (PUPR) that focus on expenditures on road, bridge, housing, and settlement construction. Expenditures on maritime, air connectivity development and maritime transport safety and security in the Ministry of Transportation do not directly affect the reduction of deforestation and carbon emissions either. Therefore, budget tagging for deforestation and carbon emission reduction in line with REDD+ needs to be adjusted to ensure accuracy and focus.

ETF effect to DF and CE

As shown in Table 3, with ETF variable, Model I rejects H_{1b}, which indicates that ETF has no significant effect on deforestation. Similarly, as

Table 5 Examples of Programs Less Relevant to Reducing Deforestation and Carbon Emissions

Year	Ministry of Public Works and Housing's Programs	Ministry of Transportation's Programs
2021	1. Connectivity Infrastructure Program (1 output: implementation of preservation and capacity enhancement of national roads) 2. Housing and Settlement Areas Program (3 outputs: provision of access to decent housing, provision of safe drinking water, and provision of adequate sanitation)	Connectivity Infrastructure Program (2 outputs: facilities in the field of sea connectivity and facilities in the field of sea connectivity)
2022	1. Connectivity Infrastructure Program (2 outputs: infrastructure for land road connectivity and infrastructure for land bridge connectivity) 2. Housing and Settlement Areas Program (2 outputs: OM infrastructure for housing and settlement and infrastructure for housing and settlement)	Connectivity Infrastructure Program (2 outputs: facilities in the field of sea connectivity and infrastructure in the field of air connectivity)
2023	Housing and Settlement Areas Program (1 output: provision of adequate sanitation)	Connectivity Infrastructure Program (1 output: safety and security of sea transportation)

Source: Author's analysis from Directorate General of Treasury Data (2024)

shown in Table 5, Model II rejects H_{2b}, suggesting that ETF has no significant effect on carbon emissions. These results indicate that the climate change-related transfer funds (DBH for reforestation and DAK for environmental task) have no significant influence on deforestation and emissions control in Kalimantan Island. This finding is similar to that of Onyinyechi & Olasupo (2022). They found that the delegation of fiscal expenditure to state governments in Nigeria had no significant impact on emission control. In the context of Kalimantan, programs financed by climate change-related transfer funds, specifically DBH for reforestation and DAK for environmental task, are managed by local governments. Unlike ministry or agency expenditures made by the central government, in the transfer fund scheme, the central government only acts as a distributor of funds. This finding implies the need for improved effectiveness in managing and implementing transfer funds at the regional level.

Moreover, Benzeev et al. (2022) explain that environmental funds in districts or municipalities are important to reduce deforestation in Brazil. Environmental funds support the implementation of conservation projects, enforce environmental laws, and promote sustainable land use practices (Benzeev et al., 2022). The effectiveness of environmental funds in reducing deforestation highlights the importance of financial mechanisms and incentives within local governance frameworks (Fearnside, 2005).

Therefore, the central government should strengthen the capacity of local governments in designing and implementing climate change mitigation programs. The central government can also improve monitoring and evaluation of the use of transfer funds to ensure that the actual usage of the funds is in accordance with the stated objectives. In addition, coordination between central and local governments in planning and implementing environmental programs should be improved. The development of a more integrated and results-based framework can help ensure that any funds allocated have a real and positive impact on the environment.

DEA Analysis

As shown in Table 6, the DEA analysis indicates that East Kalimantan is the most efficient province on the island

Table 6 DEA Analysis

Region	Efficiency Rank (Output-oriented – Deforestation and CO_2eq Emission)		
	Overall	Deforestation	CO_2
Kalimantan Timur	1	2	2
Kalimantan Selatan	2	1	3
Kalimantan Utara	3	3	1
Kalimantan Barat	3	4	4
Kalimantan Tengah	3	4	4

Source: Processed by the authors

of Kalimantan in managing deforestation and carbon emissions relative to climate change-related government spending, including CCMAS and TF. South Kalimantan ranks second, while the remaining provinces, West Kalimantan, Central Kalimantan, and North Kalimantan, are deemed the least efficient with identical scores. Analysis of CCMAS and ETF indicates that South Kalimantan has the highest average of CCMAS allocation, while North Kalimantan has the lowest. Central Kalimantan receives the highest ETF allocation, but this province has the highest deforestation and carbon emissions rates, largely driven by land clearing for agriculture and plantations, coupled with weak law enforcement and limited environmental management. Conversely, East Kalimantan exhibits low deforestation and emissions rates, attributed to its integration of the Forest Carbon Partnership Facility-Carbon Fund (FCPF-CF) program, which gives the province a financial incentive of US$20.9 million from the World Bank for reducing emissions by 22 million tons of CO_2eq (World Bank, 2022; DDPI, 2023).

The success of East Kalimantan in emission reduction is linked to four key factors: strengthened regulations supporting mitigation, integration of the FCPF program into regional plans, stakeholder engagement at all stages, and mainstreaming sustainable practices (Ruhiyat, 2022). These findings highlight the importance of central government support in enhancing regional capacity to combat climate change. Expanding targeted financial and technical assistance to other provinces, particularly Central Kalimantan, West Kalimantan, and North Kalimantan, can promote emission reduction efforts. Benchmarking successful practices from East Kalimantan, such as stakeholder inclusion and regulatory strengthening, can help these provinces improve their efficiency in addressing deforestation and carbon emissions (Nepstad et al., 2014; Assuncão et al., 2015).

CONCLUSION AND IMPLICATION

This study has shown that expenditures made by ministries or agencies have varied effects on the environment in Kalimantan. CCMAS shows a significant negative impact on deforestation rates, indicating that increased CCMAS is associated with reduced deforestation. However, CCMAS also has a significant positive impact on carbon emissions, suggesting that increased CCMAS is linked to higher carbon emissions.

Conversely, the environmental transferred fund doesn't show a significant impact on either deforestation or carbon emissions in Kalimantan. This suggests that the current allocation of ETF has not been effective in influencing the expected environmental changes.

Efficiency analysis indicates that Central Kalimantan, West Kalimantan, and North Kalimantan have the lowest efficiency in using CCMAS and ETF to reduce deforestation and carbon emissions. In contrast, East Kalimantan demonstrates the highest efficiency in reducing deforestation and carbon emissions with the available funds.

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