

RESEARCH ARTICLE



Unintended Effects of Forestry Fiscal Transfers on Deforestation in Indonesia

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ABSTRACT

The largest source of emissions (63%) in Indonesia comes from land use activities as well as forest and land fires. Deforestation is affected by several factors, such as population growth, forest fires, expansion of agricultural land, farming, drought, timber harvesting, and the lack of government attention. As part of its efforts to suppress deforestation, the Indonesian Government has allocated several types of funding for the forestry industry. However, there are disagreements over the most effective funding and implementation difficulties. This research aims to analyze the impact of forestry fiscal transfer on deforestation using spatial autoregressive in Indonesia. The results show that the forestry significantly affects deforestation in Indonesia is Forest Revenue-Sharing Fund with a positive coefficient value (0.65). Other factors that significantly affect deforestation in Indonesia are the Regional Budget for Environment (0.77), population size (−2.21), Gross Regional Domestic Product in the mining sector (0.83), area (0.99), and income per capita (−2.39). The research findings conclude that forestry fiscal transfers contribute to deforestation, instead of mitigating deforestation. The Central Government should refine ecological fiscal transfer (EFT) schemes by adopting innovative, performance-based models and collaborating with Regional Governments to implement detail-earmarked budgeting, ensuring alignment with conservation goals.

Introduction

One of the objectives of sustainable development is to reduce greenhouse gas (GHG) emissions. The Ministry of Environment and Forestry [1] stated that the largest emission source (63%) originated from land-use change activities as well as forest and land fires. Indonesia has implemented economic incentive mechanisms that reflect Indonesia's commitment to sustainable forest management, particularly to reducing carbon emissions. This aligns with the vision of Reducing Emissions from Deforestation and Forest Degradation (REDD+) [2]. Two of these four scopes emphasize reducing emissions from deforestation and degradation, which aligns with one of the priority policy goals outlined in National Forestry Plan (*Rencana Kehutanan Tingkat Nasional/RKTN*) 2011–2030, namely increasing land cover [3].

Improving sustainable land use requires a comprehensive mapping of natural resource potential, effective land planning, and improved fiscal management. Land use decisions have significantly impacted government revenue. Conversely, fiscal decisions substantially affect land use [4]. Land-use change activities result from economic and massive population growth. The primary factors that influence land cover reduction are increasing population, leading to heightened population density and economic growth, which significantly impact land use/land cover (LULC) [5–8]. The Indonesian Land Cover Quality Index (LCQI) has shown a declining trend since 2017, highlighting the need to pay attention to the conditions of land cover, including forest cover. In addition to the declining LCQI, forest area consistently decreased from 2014 to 2018. This aligns with the increased release of forested areas from 1985 to 2014, reaching 773,384 ha [9].

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In economics, goods are classified based on two characteristics, excludability (the ability to restrict access) and rivalry (reduced availability when consumed by others). This classification results in four types of goods, namely private goods, public goods, common-pool resources, and club goods [10]. Forests classified as common goods often face a "tragedy of the commons" due to unclear property rights [11]. In Indonesia, forests serve as both conservation zones and areas for economic activity, creating a trade-off between their uses. Decentralization, emphasized by Law Number 23 of 2014 concerning Regional Government, highlights the critical role of local governments in forest management. Land use competition arises between the local and central governments. Decisions on conservation or economic activities affect neighboring regions and result in spillover effects. To address these challenges, government intervention is essential to regulate forests as public goods. Fiscal transfers can improve the efficiency of managing these areas and reduce free-rider problems.

According to the OECD [12,13], economic instruments influence the behavior of producers and consumers by altering the costs associated with their activities through changes in pricing. Fiscal policies influence local governments' behavior, which can be positive (mimicking the successful practices of neighboring regions) or negative (free-riding by avoiding contributions). Efforts must be made to reduce the rate of deforestation, such as rehabilitation and reforestation, provide policies and regulations, increase public awareness of forest functions, and increase the participation of parties in maintaining the function of forest areas [3]. The government provides various types of funding; however, there is debate over which funding mechanisms are most effective in achieving the stated success indicators. Therefore, research is needed on the influence of fiscal funding and transfers on Indonesia's forestry sector and GHG emissions. However, the implementation of fiscal transfers faces several common challenges including data availability, budget sustainability, and coordination difficulties between ministries [14].

The mechanism of ecological fiscal transfer (EFT) was first implemented in Brazil. Brazil and Indonesia face shared challenges such as deforestation and the need to balance economic development with environmental conservation. Brazil's ICMS-E provides valuable insights for Indonesia to formulate effective ecological fiscal policies. The EFT involves the addition of a tax value called *Imposto sobre Circulação de Mercadorias e Serviços* (ICMS-E). Several state laws redistribute a portion of the revenue from ICMS-E at the state level to municipal governments based on ecological indicators [15,16]. Ecological fiscal transfers, particularly in the forestry sector, have been shown to positively influence the expansion of forest cover or conservation area [17–22]. However, ICMS-E implementation faces several challenges ranging from regulations, communication mechanisms between mayors and city-level civil servants as actors, to challenges in managing centralized and integrated ICMS-E value and criteria data sets [16].

Furthermore, the challenges encountered in the implementation of fiscal transfers in the forestry sector are related to inadequate funding allocation. One type of forestry fiscal transfer in Indonesia, Forest Special Allocation Fund (*Dana Alokasi Khusus Kehutanan/DAK*) aims for sustainable forest management, but some observers argue that the Forest Special Allocation Fund can potentially stimulate increased deforestation and degradation [23]. Budget sustainability poses a challenge for fiscal transfers in the forestry sector [24]. This study aims to analyze the impact of fiscal transfers in the forestry sector and other factors on the extent of land cover in Indonesia. This study focuses on the forestry sector, specifically the extent of land cover in the form of deforestation figures, which is influenced by fiscal transfers in the forestry sector, agricultural land area, mining land area, population density, and GHG emissions. Fiscal transfer in the forestry sector in this research consists of Forest Special Allocation Fund, Forest Revenue-Sharing Fund (*Dana Bagi Hasil Sumber Daya Alam Kehutanan/DBH*), and Reforestation Fund (*Dana Reboisasi/DR*) across Indonesia by province.

Materials and Methods

Location and Time of Research

The data used in this study consisted of secondary data spanning a ten-year period from 2011 to 2020. The secondary data included land cover extent by province, fiscal transfer (Forest Special Allocation Fund, Forest Revenue-Sharing Fund, and Reforestation Fund) by province, agricultural land area by province, mining land area by province, and GHG emissions in the forestry sector by province. List of detailed variables are shown in Table 1. The data sources in this research are the Indonesian Central Bureau of Statistics (*Badan Pusat Statistik/BPS*), the Directorate General of Fiscal Balance under the Ministry of Finance (MoF), and the Ministry of Environment and Forestry (MoEF). The panel data were analyzed quantitatively and qualitatively then processed using Microsoft Office Excel 2019 and STATA.

Table 1. Variable description.

No.	Data	Abbreviation	Unit
1	Forest deforestation area	Deforestation	Hectare (ha)
2	Forest Special Allocation Fund	DAK	Rupiah (IDR)
3	Forest Revenue-Sharing Fund	DBH	Rupiah (IDR)
4	Reforestation Fund	DR	Rupiah (IDR)
5	Environmental Budget for Local Revenue and Expenditure	APBD LH	Rupiah (IDR)
6	Population	Pop	Individual
7	Agricultural land area	Agric	Hectare (ha)
8	Plantation land area	Plant	Hectare (ha)
9	Gross Regional Domestic Product (GRDP) of agriculture, forestry, and fisheries sector	GRDP Agric	Rupiah (IDR)
10	Gross Regional Domestic Product (GRDP) of mining and quarrying sector	GRDP Mining	Rupiah (IDR)
11	Income per capita	Inc	Rupiah (IDR)

Note: The data used were panel data for 33 provinces in Indonesia over a ten-year period (2011–2020). The total observations to be analysed amount to 330 observations.

In this study, missing data were minimal because the data were provided in full by the relevant ministries and agencies. However, missing data were handled using interpolation techniques and by comparing their projections with those of related variables. Data heterogeneity was addressed by incorporating a spatial weighting matrix, which accounts for regional differences and interactions, and by employing fixed effects models (FEM) or random effects models (REM) to control for unobserved heterogeneity across units. These steps ensured the robustness of the model and minimized potential biases in the analysis.

Data Analysis Method

The effects of fiscal transfers in the forestry sector and other influencing factors on the extent of forest areas in Indonesia were analyzed using a spatial panel data model with a spatial lag or spatial autoregressive (SAR) model that considers the endogenous interaction effects among dependent variables. The SAR model offers significant advantages by explicitly accounting for spatial dependencies, making it particularly effective for analyzing regional data. It captures the spatial spillover effects between regions, allowing for a more accurate understanding of how outcomes in one region are influenced by neighboring areas. The SAR model simplifies the complexity of spatial relationships into a single framework, whereas its flexibility enables the incorporation of spatial weight matrices. Mathematically, the SAR model is expressed in Equation 1.

$$y_{it} = \rho \sum_{j=1}^n w_{ij} y_{jt} + x_{it} \beta + \mu_i + \varepsilon_{it} \quad (1)$$

Notes:

- y : Forest deforestation (ha)
- x_1 : DAK (rupiah)
- x_2 : DBH (rupiah)
- x_3 : DR (rupiah)
- x_4 : APBD LH (rupiah)
- x_5 : Population (individuals)
- x_6 : Agricultural land area (ha)
- x_7 : Plantation land area (ha)
- x_8 : GRDP of agricultural (rupiah)
- x_9 : GRDP of mining (rupiah)
- x_{10} : Income per capita (rupiah)
- ρ : SAR coefficient
- w_{ij} : Element of weighting matrix W

N : 33 provinces
 μ : Fixed one-way error component
 ε : Error vector
i : Cross section data (33 provinces)
t : Time series data (2011 to 2020)

The spatial weighting matrix is one of the simplest ways to explain spatial relationships in a model. The distance-weighting matrix, w_{ij} , indicates the spatial weights between spatial units i and j . Weighting using the inverse distance method can utilize the actual distances, and vice versa. The calculation of the distance between locations can involve the latitude and longitude coordinates of the analyzed regions. Mathematically, the inverse distance matrix is expressed in Equation 2 and 3.

$$w_{ij} = \frac{w_{ij}^*}{\sum_j w_{ij}^*} \quad (2)$$

$$w_{ij}^* = \frac{1}{d_{ij}^\alpha} \quad (3)$$

Notes:

w_{ij}^* : The inverse value of d_{ij}

d_{ij} : Distance from spatial unit i to spatial unit j (distance between provinces i and j)

Matrix W normalization was performed to facilitate interpretation. Matrix W is a nonnegative matrix; therefore, all weights range between zero and one. The advantage of using panel data is its ability to combine cross-sectional and time-series data, resulting in a larger number of observations and fewer identification issues [25]. This study employs the commonly used approach of the REM because there is no correlation between the individual effects and regressors.

Results and Discussion

Results

General Description of Deforestation in Indonesia

Indonesia is the third-largest tropical forest nation globally and a key beneficiary of global agreements regarding climate change mitigation through sustainable forest management [26]. In contrast, Indonesia has the highest deforestation rate, reaching 1,000 km² per year [27]. Excessive exploitation of forest resources negatively affects biodiversity, leading to forest degradation [28].

Wood harvesting activities and other forest management practices affect the structure and function of forest ecosystems [29]. Furthermore, poverty poses the greatest challenge for long-term sustainable forest management [30]. Changes in forest cover, the extent of protected areas, conservation units, and environmental quality are influenced by several factors, such as Intergovernmental Fiscal Transfer (IFT), EFT, economic growth (industry/manufacturing, agriculture, and mining sectors), and population [11,20–22,31,32]. The extent of forest cover is important because land use composition affects the level of carbon emissions [33]. Previous studies have demonstrated that an increase in deforestation contributes to the acceleration of carbon emissions [34–37].

In 2015 and 2019, deforestation in Indonesia increased compared with that in the preceding years. This phenomenon resulted from the forest and land fire crisis in Indonesia, particularly in Riau, Jambi, South Sumatra, West Kalimantan, Central Kalimantan, and South Kalimantan. Forest fires in 2015 resulted in losses worth 220 trillion IDR, encompassing social, health, and environmental losses as well as losses due to halted economic activities [38].

The panel data period used in this study spans 2011 to 2020 which the general data are shown in Figure 1. During 2019–2020, the COVID-19 pandemic had the potential to impact forests in Indonesia negatively. COVID-19 accelerated the enactment of the Job Creation Law, aimed at promoting job creation and economic growth by relaxing environmental regulations that could harm forests [39]. Additionally, the government launched a food estate program to address potential food crises resulting from the pandemic. This program was excluded from the forest moratorium and posed a threat to peatlands and protected forests in Central Kalimantan because it established new agricultural land for rice and other staple crops.

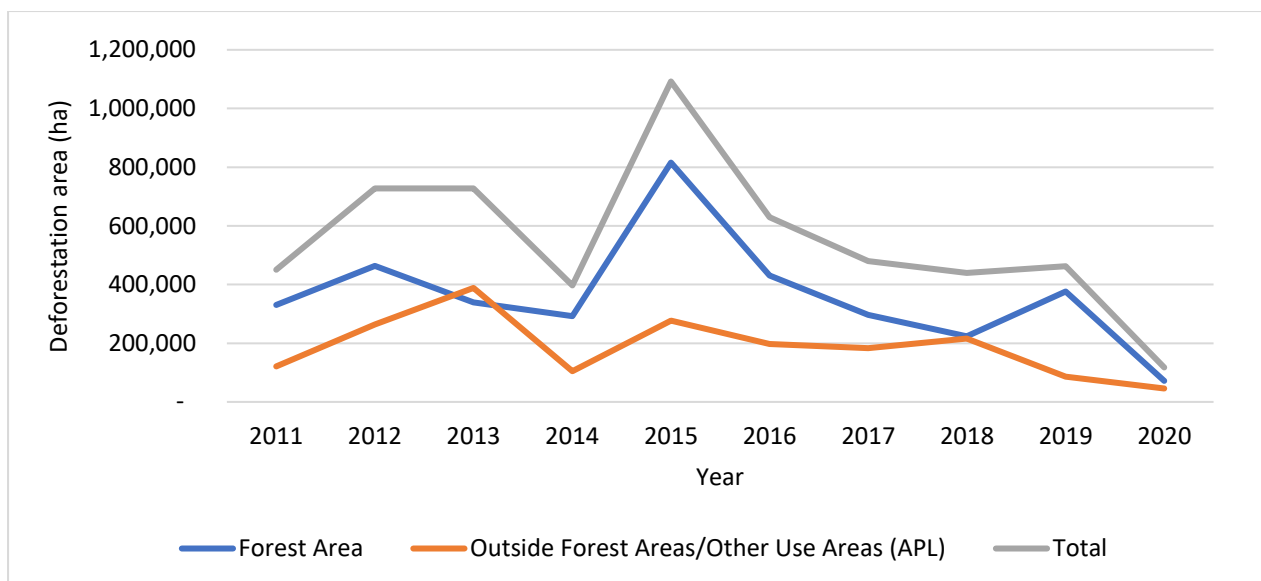


Figure 1. Deforestation area in Indonesia year 2011–2020 (ha).

The COVID-19 pandemic represents an external variable not included in the model used in this study, although it could potentially influence deforestation. However, this study focused on specific variables identified through an in-depth systematic literature review. Nevertheless, forestry fiscal transfer variables during the same period (COVID-19) exhibit a trend like deforestation rates. This finding further highlights the increasing influence of fiscal transfers on deforestation. Figure 2 shows the average distribution of deforestation from 2011 to 2020. The provinces with the highest forest area deforestation rates were Riau and Central Kalimantan. The average forest area deforestation in Riau Province reached 75,275.71 hectares per year, while that in Central Kalimantan Province reached 65,292.62 hectares per year.

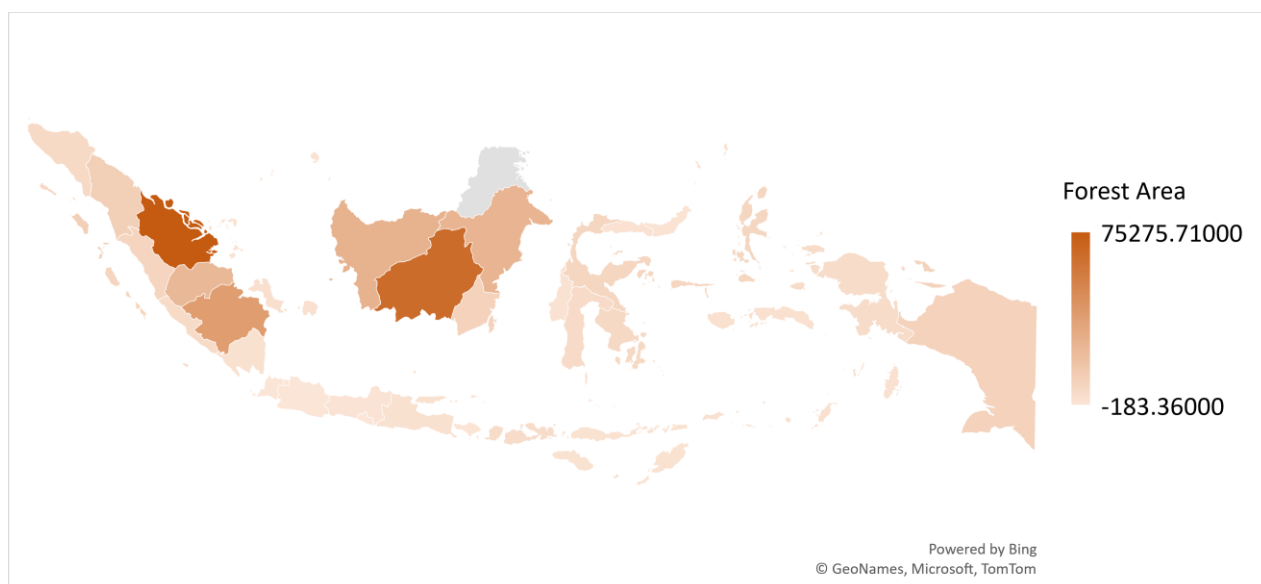


Figure 2. Average distribution of deforestation in Indonesian forest areas in 2011–2020 (ha).

Estimation of Spatial Autoregressive Analysis

The findings of this study indicate that the extent of deforestation is influenced by several factors, such as the Forest Special Allocation Fund (DAK), the Regional Budget for Environmental Affairs (*Anggaran Pendapatan dan Belanja Daerah Fungsi Lingkungan Hidup/APBD LH*), population size, GRDP in the mining sector, plantation land area, and income per capita. The spatial autoregressive analysis results for all variables are shown in Table 2.

Table 2. The results of SAR estimation on deforestation in Indonesia.

Variables (Dependent: deforestation)	Spatial autoregressive			
	Coef.	Std. Err.	z	P>z
DAK	0.174	0.155	1.120	0.262
DBH	0.648	0.286	2.270	0.023***
DR	−0.452	0.276	−1.640	0.102
APBDLH	0.766	0.373	2.050	0.040***
Pop	−2.209	0.383	−5.770	0.000***
Agric	−0.018	0.292	−0.060	0.950
Plant	0.843	0.145	5.830	0.000***
GRDPAgric	0.198	0.302	0.650	0.513
GRDPMining	0.995	0.193	5.150	0.000***
Inc	−2.392	0.488	−4.900	0.000***
Constant	35.372	5.655	6.260	0.000

*** = significant at the 5% level; Pseudo R squared = 0.5 or 50%.

Discussion

Special Allocation Funds for Forestry

Over the past 15 years, the province with the highest average realization of the Forest Special Allocation Fund was Papua, amounting to IDR 25,125.52 million per year. The average absorption percentage of the Forest Special Allocation Fund during this period was 82.96%. One of the targets of the Forest Special Allocation Fund is to reduce critical land, but the results of this study do not align with the achievement targets of implementing the Forest Special Allocation Fund [40]. However, based on the analysis results, this study indicates that the Forest Special Allocation Fund has a positive and significant effect on deforestation. These results suggest that the Forest Special Allocation Fund has contributed to an increase in deforestation.

The analysis results regarding the influence of fiscal transfers on the extent of forest area align with several previous research results [11,32]. The positive impact of the Forest Special Allocation Fund on deforestation may be attributed to regulatory gaps and contradictions between regulations as well as the absence of regulations for financing forest environmental services, including emission reduction, due to funding policies that still adhere to the BaU principle [11]. Rajaraman and Gupta [32] stated that the allocation of funding is too low to prevent the conversion of forest land into more commercially profitable uses. Consequently, funding from conventional management is insufficient to preserve forested lands.

Revenue Sharing Fund for Forestry

In the last 15 years, the Revenue Sharing Fund for Forestry (*DBH Kehutanan*) has exhibited fluctuations, reaching its highest allocation and realization in 2021. The average absorption of the Forest Revenue-Sharing Fund budget from 2008 to 2022 is 95%. Throughout this period, both the average allocation and realization of the Forest Revenue-Sharing Fund budget were highest in the provinces of East and South Kalimantan. The realized budget for the Forest Revenue-Sharing Fund in East Kalimantan reached IDR 445,669.49 million, while in Central Kalimantan it amounted to IDR 337,516.98 million.

The results of this study indicate that Forest Revenue-Sharing Fund have a significantly positive impact on deforestation. This could be due to the low state revenues from fines for the delayed payment of Forest Utilization Business Permits (*Izin Usaha Pemanfaatan Hutan/IIUPH*), Forest Resource Provision (*Provisi Sumber Daya Hutan/PSDH*), and Reforestation Fund (*Dana Reboisasi/DR*) [11]. The proportion of the Forest Revenue-Sharing Fund has not been comprehensively evaluated at the national level, but there is an interest at the Regional Government level to enhance the allocation of the regional Forest Revenue-Sharing Fund.

Reforestation Fund

East Kalimantan and Central Kalimantan received the highest average allocation and realization of the Reforestation Fund in the period 2008–2022. The allocation of the Reforestation Fund over the last 15 years has fluctuated. Budget allocations tended to increase until 2016 but have shown a declining trend since 2017.

The Reforestation Fund does not significantly influence deforestation, but it has the potential to reduce deforestation. Its impact is not maximized owing to the nonsignificant results. This aligns with research findings from previous studies that demonstrate the very low utilization of the Reforestation Fund.

Government Regulation is considered very strict by regional forestry, which leads them to choose not to use the Reforestation Fund to avoid legal issues [41]. Regional forestry offices also state that they lack sufficient funds to perform forest-area enhancement functions. The results of previous research prove that Reforestation Fund cannot be used because of disagreements between the regional and central governments regarding Reforestation Fund usage regulations [11].

Related studies have reviewed regulatory gaps and found contradictions among regulations as well as the absence of regulations for financing forestry environmental services, including emission reduction. This is due to the funding policies that adhere to the BaU principle. Contradictions among regulations arise in Government Regulation, which stipulates that districts must use the Reforestation Fund for forest rehabilitation activities, whereas the Central Government stipulates that the Reforestation Fund can be used to finance supporting activities, such as research, development, and infrastructure development [11].

Regional Budget for Environmental Affairs

One of the variables related to environmental funding but not part of fiscal transfers is the Regional Budget for Environmental Affairs. This study shows that the Regional Budget for Environmental Affairs has a positive and significant impact on deforestation. This could be attributed to the fund allocation of the Regional Budget, which is mostly used to finance operational needs, including employee salaries.

Population Size

During the period 2010–2020, the population of Indonesia consistently increased. The population of Indonesia reached 272.28 million in 2002 and had already reached 275.77 million in 2022. This study estimates the impact of Indonesia's population on the deforestation rate across all provinces during the period 2011–2022. The results of the SAR analysis indicated that population size had a significant and negative impact on the deforestation rate. This could be attributed to the fact that the deforestation variable used in this study includes deforestation in conservation forest areas that are not designated for production purposes, such as production forests.

Economy Activities

This study analyzed the influence of economic activities on deforestation. Economic activities were examined using variables such as the extent of agricultural land, extent of plantation land, GRDP in the agricultural sector, and GRDP in the mining sector. In this study, agricultural land area was assessed based on the area of irrigated rice fields. During the period 2008–2020, the area of irrigated rice fields and the rice harvest area tended to increase until 2018 and started showing a declining trend from 2018 to 2020. East Java, Central Java, and West Java are three provinces with the highest average land area from 2008 to 2020. The provinces with the lowest average areas of irrigated rice fields were the Riau Islands and Jakarta. This study indicated that agricultural land and GRDP from agriculture do not significantly affect deforestation in Indonesia.

The other variable used in the economic activity approach was the extent of plantation land. The total area of plantation land in Indonesia has increased from 2008 to 2022. In 2008, the plantation area was 19,103 thousand ha. Over 15 years, the plantation area has increased by 34.36%, reaching 25,668 thousand hectares. Riau is a province with the highest average area of plantation land, averaging 3,124 thousand hectares. The provinces with the largest average plantation land areas were South Sumatra and North Sumatra. The provinces with the smallest plantation land areas were Jakarta and Yogyakarta.

The findings of this study indicate that plantation land area has a significantly positive impact on deforestation. This suggests that an increase in the area of plantation land will significantly contribute to a reduction in forest area across the average provinces in Indonesia. Furthermore, SAR Analysis also estimated that GRDP in the mining sector significantly influences the increase in deforestation rates.

Implication

Fiscal transfer mechanisms should be optimized to support forest conservation and address deforestation, and Reforestation Fund have the potential to reduce deforestation; however, their impact is not statistically significant. Central and Regional Governments must harmonize regulations to ensure coherent implementation, particularly by integrating the Reforestation Fund into conservation-focused frameworks. The General Allocation Fund (*Dana Alokasi Umum/DAU*) offers significant potential as an alternative fiscal mechanism to support environmental and forestry conservation through the EFT approach. By incorporating environmental and forestry indicators into the DAU allocation formulas, the fund could incentivize local governments to prioritize conservation efforts. Furthermore, the planned establishment of the

Environmental Protection Fund (*Dana Perlindungan Lingkungan/DPL*) aligns with the EFT principles by providing incentives for regions that actively protect forest areas. These measures should be integrated into national policy frameworks to maximize their effectiveness, ensure sustainability, and provide well-coordinated fiscal support for forest conservation and climate mitigation.

Conclusions

The research findings show that fiscal transfers contribute to deforestation, deviating from the intended purpose of fiscal transfers, which is to mitigate deforestation rates. The fiscal transfer in the forestry sector that significantly influences deforestation in Indonesia is the Revenue Sharing Fund for Forestry, with a positive coefficient value (0.65). Other factors that significantly affect deforestation in Indonesia are Environmental Regional Budget (0.77), population size (−2.21), GRDP in the mining sector (0.83), area of plantation land (0.99), and income per capita (−2.39). The central government should refine the ecological fiscal transfer schemes in the forestry sector by moving beyond the traditional *business-as-usual* approach. This entails rethinking current funding mechanisms to incorporate innovative and performance-based models that align with conservation objectives. The Central Government should collaborate with the Regional Government to implement clear earmarked budgeting to minimize mismatches or regulatory contradictions. Further in-depth research is required to analyze EFT and explore its potential.

Author Contributions

RAE: Conceptualization, Methodology, Software, Investigation, Writing - Review & Editing; **EIKP:** Conceptualization, Review, Supervision; **N:** Conceptualization, Review, Supervision.

Conflicts of Interest

There are no conflicts to declare.

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