

## Environmental Fiscal Strategies: The Potential of Timber Excise to Address Deforestation and Increase State Revenues in Indonesia

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### ABSTRACT

This study examines the feasibility of imposing an excise tax on timber products from forest logging activities in Indonesia using a systematic literature review and a quantitative simulation approach. Data from Statistics Indonesia (BPS) on timber production between 2020-2023 are utilized to assess the potential impact of such a policy. The study argues that wood, as a key forest product, meets the criteria for being an Excisable Good (BKC) due to its consumption needing control, its environmental impacts, and the need for state levies. Additionally, it highlights the urgency of introducing this tax to address deforestation and generate additional state revenue. The research also presents various simulated excise rates to estimate the policy's economic effect. This study contributes to the literature on new BKC imposition. It provides fiscal policy recommendations to tackle deforestation, advising the Ministry of Environment and Forestry and the Ministry of Finance on the implementation of timber excise.

### Article Info :

#### Article history :

Received : Agustus 28, 2024

Revised : February 21, 2025

Accepted : March 5, 2025

#### Keywords:

deforestation; excise tax;  
fiscal policy; timber products

### INTRODUCTION

Indonesia is geographically rich in natural resources, including forests. This advantage is certainly not without challenges, especially the real problem Indonesia faces, which is deforestation. Deforestation is the reduction of forest areas due to land use agreements for infrastructure, communities, agriculture, mining, and plantations (Wahyuni & Suranto, 2021). In a study conducted by Giljum et al. (2022), with a large area of deforested area, Indonesia is the country that contributes the most, recording 58.2% of forest damage due to mining in all 26 countries investigated (Greenpeace; 2023a; 2023b). In addition to forest degradation, coal mining activities significantly impact the environment by causing changes in soil structure, decreased soil fertility, threats to biodiversity, reduced water and air quality, and environmental pollution due to waste generation, all of which have detrimental effects on ecosystems (Feng et al., 2019; Gopinathan et al., 2023).

According to [Forest Declaration Assessment \(2024\)](#), Indonesia's deforestation rate is alarmingly high, ranking as the second largest globally, with deforested areas reaching 1.18 million hectares. This figure marks a significant 57% increase from 0.71 million hectares in 2021 and 0.75 million hectares in 2022. The scale of deforestation is staggering, equating to four times the size of the "Ibu Kota Nusantara," which, according to Law No. 21 of 2023, covers only 252,000 hectares. The publication [Forest Declaration Assessment \(2024\)](#) also highlights that mining, plantations, and the pulp and paper industries are the primary contributors to the escalating deforestation rates in Indonesia. This deforestation rate will undoubtedly hinder Indonesia's commitment to achieving net-zero emissions by 2060 and could potentially strip Indonesia of its title as the "lungs of the world" ([Kemenkeu, 2022](#); [Wahyuni & Suranto, 2021](#)).

Deforestation significantly contributes to global warming and has adverse effects on both outdoor worker health and productivity ([Lawrence et al., 2022](#); [Masuda et al., 2020, 2024](#); [Sohngen, 2020](#); [Wigand, 2022](#); [Zeppetello et al., 2020](#); [Feng et al., 2019](#)). According to [Wahyuni & Suranto \(2021\)](#), deforestation is associated with illegal logging activities that endanger all life and are largely caused by forest fires, contributing to global warming. In [Septyan \(2024\)](#), Deforestation is said to contribute to climate change indirectly. Climate change is largely caused by global warming because there are so many greenhouse gases in the atmosphere, hence global warming ([Fawzy et al., 2020](#); [Filonchuk et al., 2024](#); [Shiraiwa, 2023](#); [Trenberth & Cheng, 2022](#); [Sihidi et al., 2024, 2025](#)). According to [Septyan \(2024\)](#), The most common greenhouse gas produced by most human activities is carbon dioxide (CO<sub>2</sub>), where the second major source of CO<sub>2</sub> emissions after fossil fuel combustion is deforestation. At the same time, the largest carbon sink is the forest, which is known to absorb excess carbon dioxide in the atmosphere and use photosynthesis to convert it into oxygen ([Sadjati et al., 2023](#)). The rise of deforestation will lead to climate change and global warming ([Wahyuni & Suranto, 2021](#)). Therefore, forest logging must be restricted because it can hurt society or the environment.

To address the market failure caused by deforestation, the concept of externalities, as discussed by [Batabyal \(2023\)](#), offers a framework for understanding and mitigating these environmental impacts. Negative externalities, such as those resulting from logging, lead to overproduction because the true societal costs—such as climate change and biodiversity loss—are not reflected in market prices. [Pigou \(1932\)](#) suggested that taxation based on the marginal external cost of an activity could efficiently reduce the occurrence of such negative externalities. In this context, a timber excise tax could internalize the environmental costs associated with deforestation, encouraging sustainable forest management. This aligns with the principle that taxes or other regulatory tools can correct market failures and promote societal goals like environmental sustainability ([Batabyal, 2023](#)).

In this light, imposing excise taxes on timber products from logging activities is a promising policy tool to address deforestation in Indonesia. This is because excise is an official levy imposed by the state on goods with specific characteristics intended to regulate and monitor the distribution of these goods effectively ([Handayani, 2024](#)). Despite these substantial negative externalities, Indonesia has yet to implement fiscal mechanisms like excise taxes on timber production to mitigate environmental damage and generate additional state revenue. Considering the negative impacts of deforestation

in Indonesia, along with the rising air temperatures that can deplete global oxygen reserves, and as a concrete measure to achieve net-zero emissions, the imposition of excise taxes could serve as a potential solution (BBC, 2021). According to Law of the Republic of Indonesia Number 39 of 2007 concerning Amendments to Law Number 11 of 1995 concerning Excise (Excise Law), Excise is a state levy imposed on certain goods with properties or characteristics stipulated in the law. The Excise Law states that these characteristics include goods whose consumption needs to be controlled, the circulation of the use of these goods needs to be monitored, their use can hurt society or the environment, and their use requires the imposition of state levies for the sake of justice and balance which are subject to excise. Therefore, the imposition of excise taxes on timber products resulting from logging in forest areas has the potential to control the high rate of deforestation.

In addition, the imposition of excise taxes on timber products resulting from forest logging could enhance Indonesia's fiscal independence. This is because, in 2023, it was reported on the website DJBC Kemenkeu (2024) that revenue from the Directorate General of Customs and Excise (DGCE) itself was not achieved by only reaching 95.4% of the target. With excise revenue worth IDR 221.8 trillion or 97.6 percent of the target of Presidential Regulation 75 of 2023, this is due to controlling cigarette consumption and maintaining the sustainability of the cigarette industry workforce. According to Purwanto et al. (2023) the three categories of goods subject to excise in Indonesia are Tobacco Products (HT), Beverages Containing Ethyl Alcohol (MMEA), and Ethyl Alcohol (EA). This is in contrast to other Southeast Asian countries that sometimes impose excise taxes on more than three categories of commodities or services. For example, it is said that Indonesia has the fewest forms of FSCs when compared to other Southeast Asian countries such as Thailand, which has at least 16 types; the Philippines, which has 13 types; Singapore, which has 33 types; and Malaysia, which has 14 types (Setyawan & Sabrie, 2022). Therefore, the Indonesian government should consider expanding the list of goods and services subject to excise tax, including timber products from deforestation. This approach would help mitigate the negative impacts caused by logging activities but also increase state revenue.

Numerous studies have examined the intersection of forest taxation, timber production, and environmental sustainability, providing critical insights for developing excise policies targeting forest products. Chang (2018) demonstrated how forest property taxes, such as unmodified property and productivity-based taxes, impact land expectation values and optimal harvest age, influencing timber valuation. Sun (2018) analyzed the effects of taxation schemes on forest rotation age, highlighting the potential for taxation to influence timber productivity and economic outcomes. Similarly, Gong & Susaeta (2020) investigated the implications of timber price uncertainty on harvest decisions, showing how unit and value-based taxes can affect forest management strategies. The relationship between taxation and externalities in timber production was explored by Englin & Klan (1990), who derived optimal taxation models for addressing environmental externalities based on tree species and land productivity. Additionally, Dennis (1985) addressed the broader economic implications of capital gains taxation on timber income, revealing significant effects on welfare and supply.

Research has also highlighted the challenges of inefficiencies in timber revenue systems and their connection to deforestation. Mumbunan & Wahyudi (2016) identified

revenue losses in Indonesia's timber royalties, emphasizing improved forest revenue administration to optimize fiscal outcomes. Deacon (1995) explored how policies, such as timber harvest taxes and domestic processing incentives, could mitigate deforestation in developing countries. Meanwhile, Barbier & Rauscher (1994) analyzed the impact of trade policies on tropical deforestation, advocating trade interventions as a potential second-best policy option. Chaudhary et al. (2016) studied the biodiversity implications of forest management, who compared species richness under various management systems, highlighting the trade-offs between economic profitability and conservation outcomes. Gallon & Busch (2014) conducted a meta-analysis identifying key factors that reduce deforestation, such as road expansion controls, protected areas, and enforcement of forest protection laws. However, Brandt et al. (2016) noted that even sustainability policies could paradoxically drive higher deforestation rates due to increased timber production in managed concessions. Given these findings, implementing a Forest Products Timber Excise in Indonesia could play a crucial role in addressing the challenges of deforestation, optimizing timber production practices, and enhancing fiscal outcomes by integrating environmental costs into economic models. This fiscal approach would ensure that timber production aligns with both conservation objectives and the need for sustainable development.

Despite numerous studies on forest taxation, timber production, forest products, timber excise, and environmental sustainability, no research has focused specifically on the imposition of timber products excise tax in Indonesia. This gap in research is significant, given the pressing issues of high deforestation rates, global warming, and environmental degradation in the country, which could be mitigated by implementing forest products such as timber excise. Furthermore, the failure to meet excise revenue targets could be addressed by introducing additional revenue streams from applying such a tax.

Therefore, this study aims to analyze the feasibility of imposing an excise tax on timber products derived from forest logging areas. The excise in question includes timber products from forest logging into the list of excise goods under the Excise Law. The timber products subject to this excise would be those derived from forest areas designated by the Ministry of Environment and Forestry. The methodology employed is a systematic literature review to assess the potential feasibility of this exercise. This method is particularly suitable for this research, as it effectively examines the intersection of timber taxation, deforestation, and environmental sustainability. This study is expected to provide valuable insights to policymakers, offering recommendations for implementing forest products timber excise to achieve the target of net-zero emissions by 2060 in Indonesia, control deforestation, and enhance national budget independence.

## METHOD

This research combined a qualitative approach using a systematic literature review and a quantitative approach using a simulation method. This approach was selected for its ability to provide an in-depth analysis of the legality aspect of implementation and illustrate the policy's economic impact. A systematic literature review allows the author to justify timber excise implementation better. Researchers must synthesize, compare research results, and create a literature review to determine objectives and explain the research process (Ridwan et al., 2021). The literature collected

also includes examples of countries that apply excise taxes on trees, timber, etc. Based on the literature collected, the author will propose the feasibility and potential of imposing an excise tax on forest products in the form of wood in Indonesia. In addition, the author also collects data on the extent of forest loss in Indonesia and the projected impact of emissions generated due to forest loss.

To thoroughly understand the pattern and potential for expanding excise tax imposition, the researcher conducted an extensive literature review, analyzing various sources, including books, academic journals, and legal regulations such as laws and ministerial decrees. This qualitative approach aimed to assess the feasibility of intensifying excise taxation on forest products, particularly timber. By identifying patterns and principles within the collected data, the study offers a comprehensive view of the excise system and explores viable strategies for setting and implementing timber excise rates. The literature review provides a solid theoretical foundation for evaluating the potential and practicality of such a policy in Indonesia.

In addition to the literature study, the research employs a simulation method to model various tariff scenarios, offering detailed projections of the economic impact that could result from the timber excise policy. This method allows for an in-depth understanding of revenue generation under different conditions, enhancing the study's analytical depth. By integrating legal analysis with economic simulations, the dual-method approach ensures a balanced assessment of policy feasibility and enforceability. It offers critical insights for policymakers, supporting the design of an effective and sustainable excise framework that aligns with Indonesia's economic and environmental goals.

The qualitative approach was conducted using a systematic literature review to justify imposing excise on timber products. The data utilized originates from the Directorate General of Customs and Excise, Global Forest Watch, Statistics Indonesia (BPS), and national and international journals. National and international journals are collected using the Boolean Operator with the keyword "timber tax" on the Scopus and Google Scholar databases as it has reliable article credibility. The quantitative approach was conducted by utilizing the data on timber production provided by Statistics Indonesia (BPS) between 2020-2023.

The quantitative approach used the simulation method to illustrate the potential revenue from implementing the timber excise. Using several tariff assumptions, the simulation approach is employed to analyze the potential revenue from excise. The analysis of potential excise revenue from junk food utilizes the average growth method (Gautama et al., 2023; Purwanto et al., 2023).

$$G = \sum(P_1 - P_0) / n$$

Where:

G = Average growth

P<sub>1</sub> = Timber production of the year

P<sub>0</sub> = Timber production of one year before

n = data number

The average growth rate obtained is used to estimate timber production for the upcoming years. This production level is then multiplied by the timber price specified in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia, Number P.64/MENLHK/SETJEN/KUM.1/12/2017, to get the production value. The

production value is then multiplied by several tariff assumptions to provide an estimate of the revenue generated from the implementation of this policy.

## RESULTS AND DISCUSSION

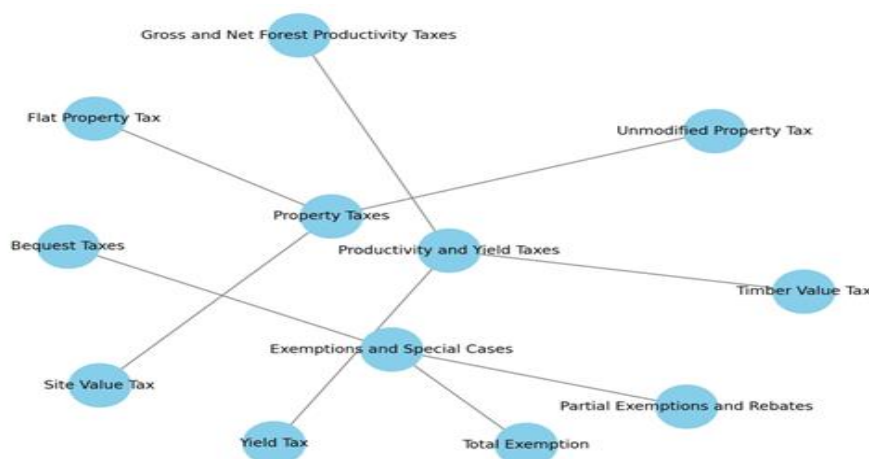
### Types of Timber Tax Objects

Timber taxation encompasses various types of taxes, each with unique characteristics and implications for forest management, land valuation, and timber yields. Property taxes are one of the most common forms of taxation applied to timberlands. The unmodified property tax is levied annually on the full market value of both land and standing timber. This type of tax tends to reduce land expectation values and shorten the optimal harvest age, influencing the economic feasibility of long-term forestry investments (Chang, 2018). In contrast, the site value tax, which is applied only to the value of the land and excludes the timber, is considered neutral in its effects on forest management. It does not alter reservation prices or optimal harvest decisions, making it a preferred option for promoting sustainable practices (Gong et al., 2020; Chang, 2018). A less frequently discussed type is the flat property tax, which imposes a fixed annual charge regardless of the value of the land or timber. Its impact on forest management decisions remains limited in the literature (Chang, 2018).

Productivity and yield taxes focus more directly on timber and forest output. Gross and net forest productivity taxes are based on the productivity of forest land and are known to lower land expectation values. However, they generally do not influence optimal harvest age unless the tax affects standing timber value (Chang, 2018). The timber value tax, applied to the value of harvested timber, encourages earlier harvesting by reducing optimal reservation prices (Gong et al., 2020). Similarly, the yield tax, imposed as a percentage of the stumpage value at the time of harvest, is designed to be neutral concerning harvest timing, provided forest productivity is not taxed. This neutrality makes it a viable tool for balancing fiscal goals and sustainable forest management (Sun, 2018)

Some taxation policies provide exemptions or special cases to promote forestry practices or reduce burdens on landowners. Total exemptions, for instance, eliminate timber-related taxes for a fixed period to encourage forestry activities. States like New York and Pennsylvania have adopted such policies to stimulate reforestation and sustainable land use. Alternatively, partial exemptions and rebates reduce the tax burden on forest landowners, thereby improving the neutrality of tax systems toward forest land use. Examples include New Hampshire's rebate system, which helps offset some of the financial challenges associated with timberland ownership. Lastly, bequest taxes, levied on the transfer of forest property through inheritance, have significant implications for long-term timber supply. These taxes can influence landowners' decisions regarding harvest timing and intergenerational land management strategies

Based on the explanation above, the thematic analysis of the definition of the types of timber tax objects can be described as follows (Figure 1):



**Figure 1.** Thematic Analysis of The Definition of The Types of Timber Tax Objects  
*Source:* Processed by the Author (2024)

The diversity of timber tax objects highlights the complexity of balancing fiscal policy with sustainable forest management. Property taxes like site value promote neutrality and sustainability, while yield taxes maintain fiscal contributions without disrupting optimal harvest decisions. Meanwhile, exemptions and rebates offer targeted support to encourage reforestation and equitable taxation practices. Understanding these variations is crucial for policymakers aiming to design tax systems that optimize economic, environmental, and social outcomes in forestry.

Timber value tax, in this case, we equate with Forest Products. Timber Excise taxes are particularly compelling for elaboration due to their direct link to harvested timber, which aligns taxation with actual economic activity rather than potential or estimated values. This type of tax is applied to the value of timber at the time of harvest, making it a fair and transparent system that ensures landowners only pay taxes when they generate income from their forestry operations (Gong et al., 2020). Unlike property taxes, which can burden landowners even during periods of non-harvest, Forest Products Timber Excise taxes provide flexibility and reduce financial pressure, encouraging better alignment with market conditions. However, their impact on harvest timing—lowering reservation prices and incentivizing earlier harvesting—introduces critical considerations for policymakers balancing fiscal objectives and sustainable management goals. These characteristics make Forest Products Timber Excise taxes a highly relevant area for analysis, especially in discussions about creating tax systems that are both equitable and supportive of long-term forestry investments.

### Forecasting the growth of timber production

The analysis to determine the potential excise revenue from timber was conducted using the ad valorem method. This method offers the advantage of stability against the effects of inflation (Purwanto et al., 2023). This study's calculation of potential excise tax on forest products in the form of timber offers a clustering system. Where the imposition of excise tax is based on the price cluster imposed on a type of tree. This is because the value of each tree in the forest is different from one tree to another. In this case, researchers used data from the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.64 / MENLHK / SETJEN / KUM.1 / 12/2017 concerning Determination of Forest Product Benchmark Prices for Calculation

of Forest Resource Provisions and Stand Compensation. The regulation is mentioned as related to the class and type of trees in the forest. It states the Benchmark Price, which is determined based on the average selling price of forest products at the collection point for timber forest products from natural forests. The production volume and value of timber for 2024-2025 were projected using the average growth rate method based on data from 2020 - 2023 timber production. Timber production data for 2020-2023 is presented in the following table 1.

**Table 1.** Timber production data for the years 2020-2023

Timber Type	2020	2021	2022	2023	Average Growth
Acacia	32.114.477	31.281.653	31.543.729	31.112.758	-1.04%
Mixed Forest Group	20.655.010	23.902.238	26.101.855	30.931.015	14.48%
Meranti Group	4.794.697	5.563.958	5.240.307	4.449.116	-1.62%
Indah Group	492.164	1.692.804	1.111.444	1.080.662	68.95%
Ebony Group	810	775	1.390	1.826	35.47%
Others	2.960.873	1.982.176	653.838	640.347	-34.04%

Source: (Statistics Indonesia, 2022)

Based on the average growth outlined above, the timber production forecast 2024 2025 offers a foundational estimate for determining the excise tax base (Table 2). This projection anticipates future production volumes and plays a pivotal role in fiscal calculations, as the excise tax base is directly tied to these figures. By forecasting production accurately, policymakers can better estimate the potential revenue generated from timber excise, aligning financial expectations with regulatory goals.

**Table 2;** Timber Production Forecast

Timber Type	2024*	2025*
Acacia	30.789.002	30.468.615
Mixed Forest Group	35.408.283	40.533.635
Meranti Group	4.376.876	4.305.808
Indah Group	1.825.738	3.084.514
Ebony Group	2.474	3.351
Others	422.348	278.564

Source: (Statistics Indonesia, 2022)

To determine the excise tax base for timber products, the production volume must be multiplied by the timber price as outlined in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.64/MENLHK/SETJEN/KUM.1/12/2017. This regulation provides the official framework for calculating the taxable value of timber by linking it to standardized pricing, ensuring consistency and transparency in the assessment process. Such an approach ensures that the calculation accurately reflects the economic value of timber production and serves as a reliable basis for excise tax collection (Table 3).

**Table 3.** Excise Tax Base Calculation Details

Timber Type	Price (Rp)	2020 (Rp million)	2021 (Rp million)	2022 (Rp million)	2023 (Rp million)	2024* (Rp million)	2025* (Rp million)
Acacia	140,000	4,496,027	4,379,431	4,416,122	4,355,786	4,310,460	4,265,606
Mixed Forest Group	417,000	8,613,139	9,967,233	10,884,474	12,898,233	14,765,254	16,902,526
Meranti Group	718,000	3,442,592	3,994,922	3,762,540	3,194,465	3,142,597	3,091,570
Indah Group	1,550,000	762,854	2,623,846	1,722,738	1,675,026	2,829,893	4,780,997
Ebony Group	9,200,000	7,452	7,130	12,788	16,799	22,757	30,829
Others	810,000	2,398,307	1,605,563	529,609	518,681	342,102	225,637
<b>Total Production Value</b>		<b>19,720,372</b>	<b>22,578,125</b>	<b>21,328,271</b>	<b>22,658,991</b>	<b>25,413,063</b>	<b>29,297,165</b>

Source: Data Processed by the Author (2024) (\*Forecasted)

Using tariff assumptions of 5%, 10%, and 15% applied to the timber production values mentioned above, the potential excise revenue from timber is calculated as follows. The tariff assumption is based on previous research on imposing excise for a new object, such as those of [Gautama et al. \(2023\)](#) and [Purwanto et al. \(2023\)](#) in Table 4.

**Table 4.** Potential Excise Tax Revenues from Forest Timber Production

Year	Production Value (Rp million)	5% Rate (Rp million)	10% Rate (Rp million)	15% Rate (Rp million)
2020	19,720,372	986,019	1,972,037	2,958,056
2021	22,578,125	1,128,906	2,257,813	3,386,719
2022	21,328,271	1,066,414	2,132,827	3,199,241
2023	22,658,991	1,132,950	2,265,899	3,398,849
2024*	25,413,063	1,270,653	2,541,306	3,811,959
2025*	29,297,165	1,464,858	2,929,716	4,394,575

Source: ([Gautama et al., 2023](#); [Purwanto et al., 2023](#))

The table 4 illustrates the potential excise tax revenues from forest timber production at varying rates of 5%, 10%, and 15% for 2020 to 2025, with the data for 2024 and 2025 being projections. Timber production value shows a consistent upward trend, beginning at IDR 19,720,372 million in 2020 and increasing to a projected IDR 29,297,165 million in 2025. This growth reflects either a potential rise in timber production volume or an increase in valuation. At a 5% excise rate, the estimated excise revenue increases from IDR 986,019 million in 2020 to IDR 1,464,858 million in 2025. Similarly, at a 10% excise rate, the potential revenue grows from IDR 1,972,037 million in 2020 to IDR 2,929,716 million in 2025.

Meanwhile, at a 15% excise rate, the revenue expands significantly from IDR 2,958,056 million in 2020 to IDR 4,394,575 million in 2025. Although it is only a rough calculation with many shortcomings, it can even be further expanded in determining both tariffs and basic prices and how to calculate excise. In addition to aiming for state

revenue, it is important to regulate excise on timber to reduce the negative impacts generated by logging in the forest.

**Discussion**

**The Increasing Needs of Excise Revenue Data in Indonesia**

DGCE is an agency under the Ministry of Finance that collects state revenue (revenue collector). The main sources of DGCE revenue are Import Duty, Export Duty, and Excise (Setyawan & Sabrie, 2022). The DGCE performance report for the last five years shows that Excise Revenue is the largest revenue source. The Performance Report of Excise Revenue, Import Duty, and Exit Duty can be seen in the following table.

**Table 5.** Realization of DJBC Revenue (rillion rupiah)

Types of Tax Revenue	2018	2019	2020	2021	2022	2023
Import Duties	39,09	37,53	32,35	28,89	51,08	50,89
Excise Taxes	159,58	172,42	176,31	195,52	226,88	221,85
Export Duties	6,76	3,53	4,28	34,57	39,82	13,60
Total	205,44	213,48	212,94	268,98	317,78	286,33
Growth	6,70%	3,90%	-0,25%	26,32%	18,04%	-0,90%

Source: (DGDE, 2024)

In Table 5, it can be seen that Excise Revenue has the highest realization compared to other DGDE revenue sources. This is due to the receipt of high cigarette excise tax; the simple reason is that there are still many smokers in Indonesia. On the page Simanjuntak (2021) it is stated that Indonesia is the third most smoker behind China and India.

From Table 5, it can be seen that the excise revenue target in the last three years has always increased every year, while the excise revenue against the target in the last three years has decreased. However, nominally, the excise revenue has an upward trend but not significantly. This is due to the government regulation of cigarette restrictions, which impacts reducing excise revenue from cigarettes. With the decrease in excise revenue, it is necessary to extend or expand the imposition of excise in Indonesia so that the extensification of excise will impact state revenue.

**The Increasing Rate of Deforestation**

Table 6 shows that Global Forest Watch (2024) revealed that in 2021-2022, there was an increase in primary forest loss in Indonesia. According to Global Forest Watch data related to primary forest loss in Indonesia as follows:

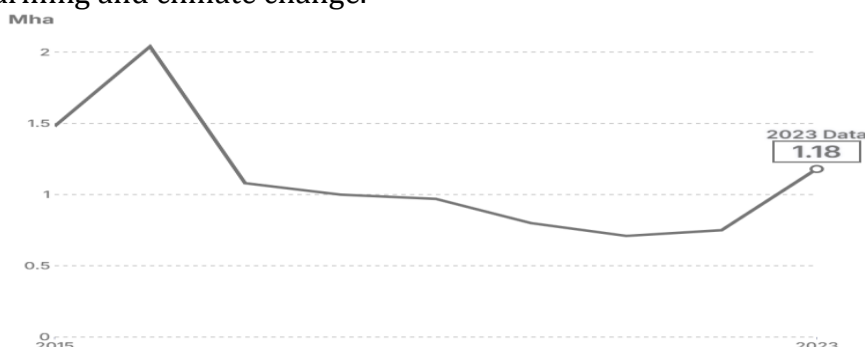
**Table 6.** Primary Forest Loss and Remaining Primary Forest Area in Indonesia

Year	Forest Loss	Remaining Primary Forest Area
2019	324 kha	89.9%
2020	270 kha	89.6%
2021	203 kha	89.4%
2022	230 kha	89.1%
2023	292 kha	88.8%

Source: (Global Forest Watch, 2024)

In the 2024 Global Forest Watch Report, it is stated that in 2023 Indonesia will lose 1.03 Mha of primary forest (Figure 2). When compared with the developing carbon

issue, Global Forest Watch (2024) states that forest loss due to deforestation will cause an increase in the amount of carbon in the air. If forest loss data is converted into carbon emissions, a total of 842 Mt of CO<sub>2</sub> emissions will be produced, which can have an impact on global warming and climate change.



**Figure 2.** Deforestation (Including Areas of Tree Cover Loss Cleared by Fires) in Indonesia

Source: (Forest Declaration Assessment, 2024)

According to a survey by Forest Declaration Assessment (2024), Indonesia's deforestation rates are alarmingly high, with total deforestation in 2023 reaching 1.18 million hectares (Mha), accounting for 18.4% of global deforestation. This positions Indonesia as the second-highest contributor to deforestation worldwide. Notably, even when excluding forest fires, Indonesia's deforestation rate in 2023 remains substantial at 1.14 Mha. This suggests that deforestation in the country is primarily driven by economic and social activities, including agriculture, mining, industry, housing development, and raw material production (Forest Declaration Assessment, 2024). Furthermore, the deforestation trend has shown a sharp increase, rising from 0.71 Mha in 2021 to 0.75 Mha in 2022, representing a significant 57.3% growth over this period.

### Excise on Forest Product as an Alternative Solution

It cannot be denied that the actions of an economic actor are interrelated with the actions of other economic actors in society, regardless of the actions of other economic participants (Aprilianti & Herianingrum, 2021). Certainly, every action involving one economic actor with another will have positive and negative impacts created or received by other parties. So that the impact caused is known as externality (Aprilianti & Herianingrum, 2021). According to Hanifiyah & Subari (2020), externality is one event that arises due to environmental economic activities. Positive and negative externalities can result from economic actions (Hubah, 2023). However, in the circumstances of economic activity, negative externalities often occur, as is the case in logging in forest areas in Indonesia.

Wood production due to logging in forest areas in Indonesia hurts the environment. This is because Indonesia is one of the countries with the nickname of the lungs of the world so that with deforestation will eliminate the possibility of existing oxygen storage and instead increase the possibility of CO<sub>2</sub> in the air cannot be minimized. In the long term, this will increase the earth's temperature, which will have many negative impacts on an ongoing basis, such as triggering forest fires that will increase the risk of oxygen loss and gas emissions. Cutting down trees will create a deterrent effect that will have a global impact.

Aggressive deforestation will hurt Indonesia, not only Indonesia but the whole world will feel the impact. With the negative externalities generated by deforestation behavior, a regulation that can control deforestation behavior is needed. The fiscal policy that can be taken is the imposition of excise tax on timber, this is because it is in accordance with the conditions that the timber resulting from the felling of trees needs to be controlled, the felling of these trees needs to be monitored, the felling can have a negative impact on society or the environment, and its use needs the imposition of state levies for the sake of justice and balance subject to excise tax.

### **Potential for excise revenue from forest products in the form of wood**

Excise is one of the sources of state revenue, which is the duty and authority of DGCE. Reported on the job. cemented.go.id page that in 2022, excise revenue amounted to 220 trillion Rupiah while the total state revenue amounted to 1784 trillion Rupiah, so excise's contribution to state revenue was 12.3%. If you look at the trend, the excise target always increases yearly, but excise revenue has decreased in the last three years. According to [Setyawan & Sabrie \(2022\)](#), excise revenue still relies on the imposition of cigarette excise alone, so to achieve the set excise target, it is necessary to add new excisable objects, one of which is the imposition of excise on logging in forest areas.

Excise functions as a regulated, meaning that excise is a mechanism used by the government to regulate the consumption pattern of BKC ([Setyawan & Sabrie, 2022](#)). Excise has several other purposes beyond increasing state revenue, including regulating the environment, public health, social impacts, etc. The production of timber from logging trees in forest areas can be seen as a new excisable item because it impacts increasing global warming, loss of oxygen supply, and potentially disrupt the balance of the ecosystem. The imposition of excise on timber resulting from logging can be done because it meets several conditions, among others:

Fulfill the basic characteristics of excise taxation. In the book [Surono \(2005\)](#), based on the Excise Law, the selection of objects of excisable goods is limited to certain goods that have the nature or characteristics of goods whose consumption needs to be controlled, the circulation of the use of these goods needs to be monitored, their use can have a negative impact on society or the environment, and their use requires the imposition of state levies for the sake of justice and balance subject to excise. If it is related to the context of cutting down trees in forest areas, it is more likely that it will cause negative externalities for the environment. In the long term, cutting down trees in forest areas will cause global issues such as global warming, increased carbon emissions due to forest fires, and large amounts of CO<sub>2</sub>, which will certainly damage the ecosystem.

Does not overlap with other consumption tax systems. In this case, imposing excise taxes on timber from logging aims to regulate and control logging activities, reduce negative environmental impacts, and encourage more sustainable logging practices. On the other hand, consumption taxes aim to collect revenue from the consumption of goods and services by end consumers. According to the Value-added Tax (VAT) Law, Taxable Goods (BKP) are tangible goods that, by nature or law, can be in the form of movable or immovable goods and intangible goods, which are taxed under the VAT Law. According to [Sudjarwadi et al. \(2017\)](#), the value-added tax in Indonesia is consumption type VAT. Meanwhile, according to the Excise Law, certain goods that have properties or characteristics that are determined to be subject to excise under the Excise Law, such as

their consumption, need to be controlled, the circulation of the use of these goods needs to be monitored, their use can have a negative impact on society or the environment, and their use needs the imposition of state levies for the sake of justice and balance are subject to excise.

Consumption taxes, such as Value Added Tax (VAT) and other sales taxes, are usually implemented at the retail level or the end of the goods distribution chain. Meanwhile, excise taxes on timber forest products are proposed to be applied at the beginning of the supply chain, i.e., when timber is extracted from natural sources or when it is first processed by industry. This aims to ensure that the environmental impacts of natural resource exploration and exploitation activities can be addressed early. In the VAT Law, no reason relates to environmental issues; it can be concluded that there are differences in the definition of goods according to the VAT Law and the Excise Law, so there is no overlap between excise and VAT imposition.

It's not an essential item. According to Rahardja & Manurung (2010), in research by [Herdiana \(2016\)](#), essential goods are goods that are very important in people's daily lives. In research ([Maslow, 1943](#)), Maslow's Basic Needs Theory reveals that after fulfilling basic physiological needs, security, and social needs, people's needs will increase to get appreciation from their social environment. If answered again, basic physiological needs are important for humans. In line with this, in the findings of [Sutono \(2021\)](#), most people do not use Maslow's theory but rather fulfill primary needs, which are physiological (physical needs, such as eating, drinking, clothing, and shelter). Wood, as a forest product, cannot be categorized as essential in the context of daily life and human survival in this modern era. Various substitute materials are available and can fulfill the same needs without relying on wood.

Fulfilling the principle of efficiency. An efficient control tool to ensure that the felling of trees in forests to fulfill timber production is done sustainably and responsibly is the imposition of excise taxes. This will prevent excessive use of timber and encourage more judicious and effective use of timber. State excise taxes can fund forest conservation and rehabilitation programs. Materials obtained from logging operations are recycled to preserve and improve forest conditions and preserve the ecological functions of the forest. When the money generated from the forest is used to preserve the forest itself, it is an efficient use of resources.

From a revenue perspective, the imposition of an excise tax on timber has the potential to become a significant and sustainable source of state income. The funds collected through this tax can be strategically allocated to support priority development sectors such as infrastructure, education, and public health, thereby contributing to broader efforts in improving community welfare. Simultaneously, from a regulatory standpoint, excise on timber serves as a fiscal tool to control logging activities and mitigate environmental degradation. Thus, the dual function of timber excise—as a revenue-generating and regulatory instrument—positions it as a strategic policy in achieving both economic and ecological goals.

On the other hand, regulation through excise also aims to control forest exploitation and ensure that timber utilization is carried out sustainably. With the imposition of excise, the timber industry is encouraged to implement more efficient and environmentally friendly practices. This control is particularly important given that

forests are one of the largest assets owned by the country, offering tremendous economic, ecological, and social benefits. The focus of the excise tax on timber from logging in forests is for regulatory purposes because the negative externalities generated by excessive logging affect not only Indonesia, but also the world, and the affected are not only humans but also ecosystems.

Consider best practices in excise tax collection. The imposition of an excise tax on timber from logging in forest areas is applied in several countries. The imposition of timber excise tax in Myanmar is imposed on resources in the country in the form of tree-felling products, namely teak wood and logs. Brazil does the same thing by imposing excise taxes on wood and goods from wood and wood charcoal. Indeed, Indonesia and Brazil have abundant forests, so both are the world's hope for supplying world oxygen (Table 7).

This excise tax also serves as an efficient policy instrument for internalizing environmental costs. Logging has negative environmental impacts like habitat loss, air quality degradation, and climate change. By imposing an excise tax, these external costs become part of the economic calculation of logging, requiring industry players to consider environmental impacts in their business decisions.

**Table 7.** Imposition of Excise Tax on Forest Products in the World

No	Country	The type worn
1	Brazil	Wood and wood products, wood charcoal, products from other forest trees (rubber and paper)
2	Myanmar	Teak wood, logs, and wood pulp
3	India	Paper Raw Materials
4	Vietnam	Patterned Paper

Source: (Kristiaji & Yustisi, 2019)

The imposition of an excise tax on timber resulting from logging activities in Indonesia necessitates a well-structured and carefully designed scheme. A robust excise framework ensures that the policy targets the reduction of negative externalities—such as deforestation and environmental degradation—without hindering legitimate economic activities in the forestry sector. Therefore, the introduction of timber as a new Excisable Good (BKC) should be approached with a balance between environmental objectives and sustainable economic growth.

The imposition of this excise tax will have various positive and negative impacts. The positive impact of the imposition of excise tax on logging timber will increase the cost of companies that carry out logging to cover land. In short, the cost of logging will increase, which is expected to reduce the incentive to conduct illegal logging. In addition, excise revenue can be used to fund forest conservation and rehabilitation programs, including reforestation and protection of threatened flora and fauna or even creating new sustainable environments. Indirectly, the imposition of excise can encourage the forestry industry to be more responsible and pay attention to aspects of environmental sustainability in its business processes.

## CONCLUSION

An in-depth analysis of implementing a forest products timber excise tax in Indonesia reveals the sector's strong potential to generate state revenue while

addressing urgent environmental challenges. The diversity of current timber taxes reflects the complexity of aligning fiscal objectives with sustainable forest management. With significant timber production forecasted, the sector presents a promising opportunity for revenue generation. Moreover, given Indonesia's high deforestation rates and its commitment to becoming a net-zero emission country by 2060, imposing an excise tax on timber is a fiscal and environmental necessity. Timber meets key criteria for Excisable Goods (BKC), including regulating consumption, monitoring distribution, and reducing negative environmental impacts such as deforestation and climate change.

The excise tax on timber could strengthen Indonesia's environmental governance by discouraging overexploitation and supporting climate mitigation efforts while creating a sustainable revenue stream. However, effective implementation will require careful consideration of product classification, tariff design, and collection mechanisms. Additional attention must be given to revenue sharing, earmarking, and understanding economic impacts, including substitution effects. This study contributes to the broader discourse on new BKC policies and offers practical recommendations for the Ministry of Environment and Forestry and Finance. By adopting a balanced and informed approach, Indonesia can align environmental protection with economic development, ensuring long-term forest sustainability and fiscal stability. This study is limited to simulation and literature review approaches without involving primary data from industry actors or relevant government institutions. Future research is recommended to explore stakeholder perceptions and the practical impacts of timber excise policy through comprehensive field studies.

## REFERENCES

- Aprilianti, L., & Herianingrum, S. (2021). Dampak eksternalitas PT. Eratex djaja probolinggo dalam perspektif ekonomi Islam. *Jurnal Ekonomi Syariah Teori Dan Terapan*, 8(1), 85-97. <https://doi.org/10.20473/vol8iss20211pp85-96>
- Barbier, E. B., & Rauscher, M. (1994). Trade, tropical deforestation and policy interventions. *Environmental & Resource Economics*, 4(1), 75-90. <https://doi.org/10.1007/BF00691933>
- Batabyal, A. A. (2023). The Theory of Externalities. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.4643096>
- BBC. (2021). *Deforestasi: Negara mana saja yang paling banyak membatat hutan?* BBC.Com. <https://www.bbc.com/indonesia/majalah-59357389>
- Brandt, J. S., Nolte, C., & Agrawal, A. (2016). Deforestation and timber production in Congo after implementation of sustainable forest management policy. *Land Use Policy*, 52, 15-22. <https://doi.org/10.1016/j.landusepol.2015.11.028>
- Sudjarwadi, S., Karamoy, H., & Budiarmo, N. (2017). Analysis calculation and reporting of value added tax (VAT) at PT. Manado jaya lestari. *Jurnal EMBA*, 5(2), 1060-1069. <https://doi.org/10.35794/emba.5.2.2017.16067>
- Chang, S. J. (2018). Forest valuation under the generalized Faustmann formula with taxation. *Forest Policy and Economics*, 88, 46-51. <https://doi.org/10.1016/j.forpol.2017.12.007>
- Chaudhary, A., Burivalova, Z., Koh, L. P., & Hellweg, S. (2016). Impact of Forest Management on Species Richness: Global Meta-Analysis and Economic Trade-Offs. *Scientific Reports*, 6(1), 23954. <https://doi.org/10.1038/srep23954>

- Deacon, R. T. (1995). Assessing the Relationship between Government Policy and Deforestation. *Journal of Environmental Economics and Management*, 28(1), 1–18. <https://doi.org/10.1006/jeem.1995.1001>
- Dennis, D. F. (1985). *Capital Gains Treatment of Timber Income: An Economic Assessment*. <https://www.govinfo.gov/content/pkg/GOVPUB-A13-PURL-gpo38788/pdf/GOVPUB-A13-PURL-gpo38788.pdf>
- DGDE. (2024). *Statistik DJBC*. Direktorat Jenderal Bea Dan Cukai Kementerian Keuangan. <https://www.beacukai.go.id/statistik.html>
- DJBC Kemenkeu. (2024, January 5). *Tutup Tahun, Capaian Penerimaan Bea Cukai 2023 Tembus Rp286,2 Triliun*. Direktorat Jenderal Bea Dan Cukai. <https://www.beacukai.go.id/berita/-tutup-tahun-capaian-penerimaan-bea-cukai-2023-tembus-rp286-2-triliun.html>
- Englin, J. E., & Klan, M. S. (1990). Optimal taxation: Timber and externalities. *Journal of Environmental Economics and Management*, 18(3), 263–275. [https://doi.org/10.1016/0095-0696\(90\)90006-K](https://doi.org/10.1016/0095-0696(90)90006-K)
- Feng, Y., Wang, J., Bai, Z., & Reading, L. (2019). Effects of surface coal mining and land reclamation on soil properties: A review. *Earth-Science Reviews*, 191, 12–25. <https://doi.org/10.1016/j.earscirev.2019.02.015>
- Forest Declaration Assessment. (2024). *Deforestation*. Forest Declaration Assessment. [https://dashboard.forestdeclaration.org/indicator-search/?\\_sft\\_country=indonesia](https://dashboard.forestdeclaration.org/indicator-search/?_sft_country=indonesia)
- Gallon, K. F., & Busch, J. (2014). What Drives Deforestation and What Stops it? A Meta-Analysis of Spatially Explicit Econometric Studies. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2458040>
- Gautama, B., Maretianiandini, S. T., & Purwanto, D. (2023). Trade-off ekstensifikasi cukai atas gula: Analisis dampak perekonomian. *TAXPEDIA: Journal of Tax Policy, Economics, and Accounting*, 1(2), 107–124. <https://doi.org/https://doi.org/10.61261/muctj.v1i2.42>
- Giljum, S., Maus, V., Kuschnig, N., Luckeneder, S., Tost, M., Sontner, L. J., & Bebbington, A. J. (2022). A pantropical assessment of deforestation caused by industrial mining. *Proceedings of the National Academy of Sciences*, 119(38). <https://doi.org/10.1073/pnas.2118273119>
- Global Forest Watch. (2024). *KEHILANGAN HUTAN PRIMER DI INDONESIA*. <https://www.globalforestwatch.org/Dashboards/Country/IDN/>
- Gong, P., & Susaeta, A. (2020). Impacts of forest tax under timber price uncertainty. *Forest Policy and Economics*, 111, 102030. <https://doi.org/10.1016/j.forpol.2019.102030>
- Gopinathan, P., Subramani, T., Barbosa, S., & Yuvaraj, D. (2023). Environmental impact and health risk assessment due to coal mining and utilization. *Environmental Geochemistry and Health*, 45(10), 6915–6922. <https://doi.org/10.1007/s10653-023-01744-z>
- Greenpeace. (2023a, December 8). *Deforestation: Playing With Fire | An analysis of Indonesia's FOLU Net Sink 2030 policy*. Greenpeace Southeast Asia. <https://www.greenpeace.org/southeastasia/publication/64023/indonesias-folu-net-sink-2030-policy/>
- Greenpeace. (2023b, December 8). *Main Api dengan Deforestasi: Basa-Basi Komitmen Iklim Lewat FOLU Net Sink 2030*. Greenpeace Indonesia.

- <https://www.greenpeace.org/indonesia/publikasi/57737/main-api-dengan-deforestasi-basa-basi-komitmen-iklim-lewat-folu-net-sink-2030/>
- Handayani, R. (2024, April). *Apa itu Cukai, Karakteristik dan Perbedaan Cukai dengan Pajak*. Pajak.Com. <https://www.pajak.com/pajak/apa-itu-cukai-karakteristik-dan-perbedaan-cukai-dengan-pajak/>
- Hanifiyah, M., & Subari, S. (2020). Eksternalitas pabrik gula PT. Kebun tebu mas desa lamongrejo kecamatan ngimbang kabupaten lamongan. *Agriscience*, 1(1), 324–338. <https://doi.org/10.21107/agriscience.v1i1.8013>
- Herdiana, A. F. (2016). *Analisis Faktor-Faktor yang Mempengaruhi Permintaan Sepeda Motor di Kota Malang*. Skripsi: Universitas Brawijaya.
- Hubah, S. V. (2023). Eksternalitas penetapan kebijakan pajak karbon di Indonesia. *Media Riset Ekonomi [MR.EKO]*, 2(3), 131–145. <https://doi.org/10.36277/mreko.v2i3.287>
- Kemenkeu. (2022, November 24). *Ini Komitmen Indonesia Mencapai Net Zero Emission*. Kementerian Keuangan. <https://kemenkeu.go.id/informasi-publik/publikasi/berita-utama/Ini-Komitmen-Indonesia-Mencapai-Net-Zero-Emission>
- Kristiaji, B. B., & Yustisi, D. (2019). Komparasi Objek Cukai secara Global dan Pelajaran bagi Indonesia. *Working Paper DDTC*. [https://ddtc.co.id/id/publikasi/komparasi-objek-cukai-secara-global-dan-pelajaran-bagi-indonesia\\_63](https://ddtc.co.id/id/publikasi/komparasi-objek-cukai-secara-global-dan-pelajaran-bagi-indonesia_63)
- Mumbunan, S., & Wahyudi, R. (2016). Revenue loss from legal timber in Indonesia. *Forest Policy and Economics*, 71, 115–123. <https://doi.org/10.1016/j.forpol.2016.06.025>
- Pigou, A. C. (1932). *The economics of welfare* (4th ed.). Macmillan.
- Purwanto, D., Gautama, B. H., Prastyono, A., & Nasutra, N. (2023). Ekstensifikasi cukai kertas: Potensi dan dampak perekonomian di Indonesia. *Jurnal Perspektif Bea Dan Cukai*, 7(1), 76–100. <https://doi.org/https://doi.org/10.31092/jpbc.v7i1.2111>
- Ridwan, M., AM, S., Ulum, B., & Muhammad, F. (2021). Pentingnya Penerapan Literature Review pada Penelitian Ilmiah. *Jurnal Masohi*, 2(1), 42. <https://doi.org/10.36339/jmas.v2i1.427>
- Sadjati, E., Sulisty, J., & Azwin, A. (2023). Potensi Karbon Pada Tegakan Hutan Adat Imbo Putui Desa Petapahan Kabupaten Kampar. *Jurnal Karya Ilmiah Multidisiplin (JURKIM)*, 3(1), 90–94. <https://doi.org/10.31849/jurkim.v3i1.12658>
- Septyan, A. R. (2024). *Deforestasi: Pengertian, Penyebab, Dampak, dan Pencegahan*. Forester Act. <https://foresteract.com/deforestasi/>
- Setyawan, B., & Sabrie, G. M. (2022). Kajian potensi kendaraan bermotor menjadi barang kena cukai. *Jurnal Prespektif Bea Dan Cukai*, 6(2), 365–385. <https://doi.org/10.31092/jpbc.v6i2.1778>
- Simanjuntak, J. (2021, June 2). *Indonesia Peringkat ke-3 dan Jepang ke-7 Terbanyak Perokok di Dunia*. Tribunnewa. <https://www.tribunnews.com/internasional/2021/06/02/indonesia-peringkat-ke-3-dan-jepang-ke-7-terbanyak-perokok-di-dunia>
- Statistics Indonesia. (2022). *statistics of forestry production 2023* (Vol. 12). Statistics Indonesia. <https://www.bps.go.id/en/publication/2024/07/26/3a38028576970e086c1cf32f/statistik-produksi-kehutanan-2023.html>

- Sun, J. C. (2018). An Economic Analysis of Forest Taxation's Impact on Optimal Rotation Age. In *Economics of Forestry* (pp. 131–144). Routledge. <https://doi.org/10.4324/9781315182681-7>
- Surono. (2005). *Bahan ajar teknis cukai II* (1st ed., Vol. 1). Sekolah Tinggi Akuntansi Negara.
- Sutono. (2021). Guarantee of social needs in islamic economic perspective. *Jurnal Inovasi Penelitian*, 1(8), 1647–1661. <https://doi.org/10.47492/jip.v1i8.286>
- Fawzy, S., Osman, A. I., Doran, J., & Rooney, D. (2020). Strategies for mitigation of climate change: a review. *Environmental Chemistry Letters*, 18(6), 2069–2094. <https://doi.org/10.1007/S10311-020-01059-W>
- Filonchyk, M., Peterson, M. P., Zhang, L., Hurynovich, V., & He, Y. (2024). Greenhouse gases emissions and global climate change: Examining the influence of CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O. *Science of The Total Environment*, 173359. <https://doi.org/10.1016/j.scitotenv.2024.173359>
- Lawrence, D., Coe, M. T., Walker, W. S., Verchot, L. V., & Vandecar, K. L. (2022). The Unseen Effects of Deforestation: Biophysical Effects on Climate. *Frontiers in Forests and Global Change*, 5. <https://doi.org/10.3389/ffgc.2022.756115>
- Masuda, Y. J., Garg, T., Anggraeni, I., Wolff, N. H., Ebi, K. L., Game, E. T., Krenz, J., & Spector, J. T. (2020). Heat exposure from tropical deforestation decreases cognitive performance of rural workers: an experimental study. *Environmental Research Letters*, 15(12), 124015. <https://doi.org/10.1088/1748-9326/ABB96C>
- Maslow, A. H. (1943). A theory of human motivation. *Psychological Review*, 50(4), 370–396. <https://doi.org/10.1037/h0054346>
- Masuda, Y. J., Parsons, L. A., Spector, J. T., Battisti, D. S., Castro, B., Erbaugh, J. T., Game, E. T., Garg, T., Kalmus, P., Kroeger, T., Mishra, V., Shindell, D., Tigchelaar, M., Wolff, N. H., & Zeppetello, L. R. V. (2024). Impacts of warming on outdoor worker well-being in the tropics and adaptation options. *One Earth*. <https://doi.org/10.1016/j.oneear.2024.02.001>
- Shiraiwa, M. (2023). Facing Global Climate and Environmental Change. *ACS Environmental Au*, 3(3), 121–122. <https://doi.org/10.1021/acsenvironau.3c00014>
- Sihidi, I. T., Romadhan, A. A., Kamil, M., & Febriana, N. N. (2024). Green Politics in the Political Agenda and Village Development Policies in Batu City. *Journal of Ecohumanism*, 4(1). <https://doi.org/10.62754/joe.v4i1.5169>
- Sihidi, I. T., Romadhan, A. A., Kamil, M., & Salahudin. (2025). A Bibliometrics Analysis of Green Politics: Insights and Implications. *International Journal of Environmental Impacts*, 8(1), 71–79. <https://doi.org/10.18280/ijei.080108>
- Sohnngen, B. (2020). Climate Change and Forests. *Annual Review of Resource Economics*, 12(1), 23–43. <https://doi.org/10.1146/ANNUREV-RESOURCE-110419-010208>
- Trenberth, K. E., & Cheng, L. (2022). A perspective on climate change from Earth's energy imbalance. *Environmental Research*, 1(1), 13001. <https://doi.org/10.1088/2752-5295/ac6f74>
- Wahyuni, H., & Suranto, S. (2021). Dampak Deforestasi Hutan Skala Besar terhadap Pemanasan Global di Indonesia. *JlIP: Jurnal Ilmiah Ilmu Pemerintahan*, 6(1), 148–162. <https://doi.org/10.14710/jiip.v6i1.10083>

- Wigand, M. E. (2022). Climate Change, Pollution, Deforestation, and Mental Health: Research Trends, Gaps, and Ethical Considerations. *Geohealth*, 6(11). <https://doi.org/10.1029/2022gh000632>
- Zeppetello, L. R., Parsons, L. A., Spector, J. T., Naylor, R. L., Battisti, D. S., Masuda, Y. J., & Wolff, N. H. (2020). Large scale tropical deforestation drives extreme warming. *Environmental Research Letters*, 15(8), 84012. <https://doi.org/10.1088/1748-9326/AB96D2>