Available online at: http://journal.uinsgd.ac.id/index.php/ministrate
Ministrate, Vol. 7 No. 1: 14-40
DOI: 10.15575/jpbd.v7i1.22249

Can be Synergized Carbon Tax and Carbon Trading in the Forestry Sector ?

Liliek Sofitri
[1]Fiscal Administrative Science Department, Universitas Indonesia
*Corresponding Author E-mail: liliek.sofitri03@ui.ac.id

Abstract

Deforestation and forest degradation largely contribute to global greenhouse gas (GHG) emissions. Innovative economic solutions tough their integration in the forestry sector is still under researched notably in tropical forest-rich countries. This study analysis how combining a carbon tax with ETS in the forestry sector might improve efforts at emission reduction, solve policy and implementation issues. Methods: a Systematic Literature Review (SLR) approach using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, combined with qualitative content analysis. A total of 45 academic articles and policy reports were analysed and categorized into three thematic areas: (1) policy design, comparing different carbon tax and ETS models; (2) economic and environmental impacts, and (3) global case studies, examining successful implementations in Brazil, Sweden, and California. Findings shows that by synergizing ETS and carbon tax it could strengthen forestry's sector on carbon mitigation strategies, by ensuring both price stability and market adaptability. While ETS generates economic incentives for carbon sequestration schemes based on forests, carbon tax systems set a price floor, therefore limiting too great volatility in carbon pricing. Three case studies show the advantages of a combined strategy: By using carbon tax income from the energy sector, Brazil's Amazon Fund funded projects aimed at preventing deforestation; this resulted in a 70% drop in deforestation between 2005 and 2012. Sweden implemented the highest carbon tax globally while maintaining economic stability through a hybrid voluntary carbon market, allowing industries greater compliance flexibility. California ensured in keeping carbon pricing by successfully combining a Cap-and- Trade system with transportation sector carbon levies, therefore encouraging investments in forest preservation initiatives. In conclusion, Indonesia has a great chance to lower carbon emissions and support sustainable forestry management by effectively combining an ETS with a carbon price and mitigate the challenges.

Keywords: Carbon Tax, Emissions Trading System (ETS), Forestry Sector, Carbon Pricing, Indonesia.

Received: February 12, 2024; Revised: February 21, 2025; Accepted: February 27, 2025

INTRODUCTION

The threat and impacts of climate change are evident if greenhouse gas (GHG) emissions are not drastically reduced and global temperatures are projected to rise to 1.5°C above pre-industrial levels by 2030 (IPCC, 2023). In Indonesia, the forestry sector is the highest contributor to greenhouse gas emissions (MoEF, 2024). The forestry sector plays a dual role in climate change. The sector can be said to be a contributor to emissions through deforestation and degradation, but it can also provide climate change mitigation solutions through carbon sequestration and storage. Tropical forests, for example, store 55% of global terrestrial carbon and sequester about 1.4 billion tons of CO_2 per year (Pan et al., 2011; Harris et al., 2021). However, deforestation continues at a rate of 10 million hectares/year (FAO, 2020), contributing 12-20% of global GHG emissions (IPCC, 2023). In Indonesia, deforestation has reached 1.1 million hectares in the 2019-2021 period (KLHK, 2022), which has prompted innovative policies to shift the exploitation paradigm to conservation.

One way to mitigate climate change is by using market-based economic instruments, such as carbon tax and emissions trading system (ETS). In recent developments, both ETS and carbon tax have been adopted almost all over the world. The difference between a carbon tax and an emissions trading system is that in a carbon tax the carbon price per ton of emissions is fixed, so the carbon tax provides cost certainty for economic actors. ETS, on the other hand, sets the carbon price based on market dynamics to achieve emission reduction targets at optimal cost (Stavins, 2021; World Bank, 2023). If both carbon tax and ETS are applied in the forestry sector, the implementation of both in the forestry sector faces very unique and quite challenge. This refers to the experience of several countries that have implemented carbon tax and ETS. The problems are identified as follows: firstly, the intricacy of quantifying forest carbon reserves necessitates sophisticated technology as LiDAR and machine learning algorithms (Baccini et al., 2017). Secondly, the risk of carbon leakage occurs when deforestation activities shift to unregulated regions, hence diminishing the efficacy of policies (Angelsen et al., 2018). Third, there exists an inequitable distribution of advantages; in Indonesia, for instance, companies earn 60% of carbon credit payments, whereas indigenous people obtain about 10-15% (Tacconi, 2020).

Indonesia, as the world's third-largest tropical forest country after Brazil and Congo, has a very strategic role in climate change mitigation. Indonesia's forests cover about 92 million hectares (2020), which contributes quite significant to global carbon sequestration (1st BUR Indonesia, 2020). However, deforestation and forest degradation due to land conversion, mining, agricultural expansion, and forest fires have caused significant amounts of carbon emissions. Climate change has become a global challenge that affects various sectors, so as a country with a significant forest area, it has an important role in climate change mitigation efforts through reducing greenhouse gas (GHG) emissions. One of the main policy instruments implemented is carbon trading and carbon tax.

Indonesia's forestry sector has great potential to absorb carbon (carbon sink), but on the other hand the forestry sector is also a source of emissions through deforestation and forest degradation. Therefore, carbon tax can be one of the economic instruments that can help Indonesia achieve the Net Zero Emission (NZE) target in 2060 Enhanced NDC Forestry. However, until January 2025 the carbon tax in Indonesia is still planned to be implemented only in the coal-fired power plant sector.

Through several important policies namely (1) Law No. 16 of 2016 (Ratification of Paris Agreement) - Binding Indonesia to achieve its Nationally Determined Contribution (NDC) target; (2) Enhanced NDC 2022 - Targeting emission reductions of 31.89% domestically and 43.20% with international support Enhanced NDC Forestry; and (3) Presidential Regulation No. 98 of 2021 - Regulating the Economic Value of Carbon (NEK) and carbon tax as mitigating instruments. Indonesia has thus strengthened its commitment to climate change mitigating efforts.

In the forestry sector itself, Indonesia has developed regulations to support carbon trading through the issuance of the Minister of Environment and Forestry Regulation (Permen LHK) No. 7 of 2023 which regulates the procedures for organizing carbon trading in the forestry sector. In addition, to enable carbon trading, Indonesia t has launched the Indonesia Carbon Exchange (IDX Carbon) in September 2023 through the Financial Services Authority (OJK) and the Indonesia Stock Exchange.

Studies from past times have largely focused on one mechanism, for instance on carbon price only, or ETS solely or REDD+ only. There is not much study on how to combine carbon tax with carbon trading. Actually, the synergy or integration of carbon tax and carbon trading has the ability to produce a more flexible system. For instance, an ETS offers extra incentives for successful restoration projects; a carbon tax can act as a floor price to stop carbon market instability (Stavins, 2021).In Brazil, the combination of carbon tax funding from the energy sector with international credit trading through the Amazon Fund reduced deforestation by 70% from 2005-2012 (May et al., 2020). However, this policy integration has not been widely adopted in tropical forest countries such as Indonesia, where overlapping regulations and weak institutional capacity are the main obstacles (Boyd et al., 2021).

This study intends to firstly investigate the possible synergies between carbon tax and carbon trading in the forestry sector, including regulation, implementation, and policy impacts on GHG emission mitigating. Technical, economic, and social aspects of implementation will be discussed; secondly formulate inclusive policy recommendations for the Indonesian context, with lessons learned from global case studies. The findings results are intended to contribute to the policy maker of Government of Indonesia as well as contribute to the literature on climate policy, fiscal policy, carbon tax policy and sustainable forest management practices pressures.

RESEARCH METHODS

This research used a *systematic literature review* approach combined with qualitative content analysis to explore the integration of carbon taxes and carbon trading in the forestry sector. The research design was adapted from the PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) framework to ensure transparency and reproducibility (Page et al., 2021). In data collection, it should consist of searching strategy, inclusion criteria, data extraction and categorization. First, in search strategy, a literature search was conducted in scientific databases (Scopus, Web of Science, Google Scholar) using the keywords: *"carbon tax" AND "carbon trading" AND forestry*, *"forest carbon policy" AND integration*, and *"REDD+" AND economic instruments*. The publication timeframe was limited to 2010-2023 to ensure relevance to contemporary climate policy developments (e.g. 2015 Paris Agreement). Policy documents were retrieved from official websites of institutions such as the World Bank, IPCC, UNFCCC, and forestry ministries of the case study countries (Indonesia, Brazil, EU).

Second, in terms of inclusion criteria, Peer-reviewed journals, official policy reports, and government documents that address the design of carbon tax/ETS instruments in the forest sector, the economic-environmental impacts of policy implementation, and case studies of carbon policy integration. Exclusions: Opinion articles, studies without empirical data, and unverified documents. Third, in regard to data extraction and categorization, a total of 45 selected documents (30 journal articles, 10 policy reports, 5 government documents) were classified into three main themes using a thematic coding matrix (Braun & Clarke, 2006). The data extraction process was carried out in stages, divided into 3 categories namely instrument design, economic-environmental impacts and implementation case studies. The extraction process is described as follows:

1) Instrument Design *(20 documents)*.

Focusing on analyzing the policy model and technical parameters of carbon tax-carbon trading integration. Subcategories identified:

a. Policy Integration Model. Definition: Analysis of policy models that combine carbon tax and carbon trading, including technical mechanisms such as *floor* prices or dynamic emission caps. Sample of documents to be analysed: Stavins (2021) examines the floor price in the US ETS to help to minimize price volatility and discusses California's ETS system using an implicit tax as a floor price to help reduce market volatility. World Bank (2023): New Zealand's NZ ETS case study showing how emission caps correspond to forest carbon sequestration explains New Zealand's NZ ETS system, which modulates emission caps depending on capacity for forest sequestration. European Commission (2022): Guidelines for EU ETS integration of forest carbon sequestration.
b. Carbon Pricing Criteria. Definition: Carbon pricing methods that consider ecosystem factors (e.g., biodiversity) or use alternative approaches in immature markets. Sample of documents to be analysed: Tacconi (2020): Value of forest ecosystem services included into a carbon credit price mechanism; Angelsen et al. (2018): Shadow pricing for developing nation forestry initiatives; Nordhaus (2017): Macroeconomic study of ideal carbon tax for preservation of forests.
c. Sector Coverage. Definition: Inclusion of specific forestry activities (REDD+, agroforestry, peat restoration) into the carbon scheme. Sample of documents to be analysed such as integration of peat restoration in Amazon carbon schemes (Boyd et al, 2021); the role of agroforestry in

ISSN 2714-8130 (Online)

global carbon sequestration (FAO, 2020); Regulation of REDD+ inclusion in national carbon (Policy Government of Indonesia, 2021).

2). Economic-Environmental Impacts *(15 documents)*

Multidimensional impact analysis of policy integration, with divisions:

a. Economic Impacts. Sample of documents to be analysed: Transaction Costs: ETS administration costs in the forestry sector average 15-20% of total carbon revenues (World Bank, 2023); Revenue Potential: The Brazilian Amazon forest project generates US$260 million/year in carbon revenues through a combination of taxes and trading (May et al., 2020).

b. Environmental Impact: Sample of documents to be analysed; Effectiveness of emissions reductions varies: 8-12 tons CO_2/ha/yr in primary forests vs. 3-5 tons CO_2/ha/yr in secondary forests (Harris et al., 2021).

c. Social Impacts: Sample of documents to be analysed: Inequality in benefit distribution: 60% of carbon credit revenues in Indonesia are concentrated in large companies, while indigenous communities receive only 10-15% (Tacconi, 2020); Increased tenure conflicts in areas with unclear land tenure rights (e.g. Central Kalimantan case) (Angelsen et al., 2018).

3). Implementation Case Studies *(10 documents)*

Evaluation of field practices through comparative case studies, divided into two sub-categories, namely aspects of success and aspects of failure or constraints:

a. Successes: *Amazon Fund (Brazil)*: Combination of national carbon tax funding (from Gasoline Tax) with international credit trading reduced deforestation 70% (2005-2012). Key factors: transparency of fund allocation and local community engagement (May et al., 2020); *British Columbia ETS*: Implementation of a progressive carbon tax (US$40/ton CO_2) with credit trading incentives for community forestry projects (Stavins, 2021).

b. Failures/Constraints: *REDD+ in Indonesia*: 40% of projects fail to achieve emissions targets due to weak law enforcement and *overlapping claims* (Tacconi, 2020); *Aceh Green Program*: Carbon *leakage* occurs when deforestation activities move into neighboring unregulated areas (Boyd et al., 2021).

Data Categorization

Theme	Number of documents	Document type	Examples of Key References
Instrument Design	20	Journal (12), Report (6), Government (2)	Stavins (2021), Tacconi (2020)
Economic-Environmental Impact	15	Journal (10), Report (5)	World Bank (2023), Angelsen et al. (2018)
Case Study	10	Journal (8), Government (2)	Boyd et al. (2021), May et al. (2020)

In this research, data validation procedure is essential. There are three means to keep the data valid. The first is triangulation of methods where it combines findings from academic journals, policy reports, and official government documents. The second is through internal peer review in which there is a thematic discussion with two independent researchers to minimize interpretation bias (Corbin & Strauss, 2015). The third is conducting sensitivity analysis by testing the consistency of results by excluding 5 random documents; core findings remained stable (±5% variation).

In respect to data analysis, this research uses open coding and constant comparative analysis methods, data were thematically examined to spot trends and correlations between themes (Corbin & Strauss, 2015). Using the Institutional Analysis and Development (IAD) framework to assess the interaction of actors, rules, and incentives (Ostrom, 2011), this process comprised synthesizing recommendations based on the convergence of literature findings. However, there are possible limitations, such as selection bias. The study focused on English-language documents and policies in countries with high forest cover, so findings may not fully represent the global context. Policy Dynamics: Rapid changes in carbon regulations (e.g. the development of the EU CBAM 2023) may affect the relevance of historical data.

RESULTS AND DISCUSSION

This study examines the synergy between carbon tax and carbon trading system (ETS) in forestry sector, using *Systematic Literature Review (SLR)* approach with *qualitative content analysis* in PRISMA framework. The implementation of carbon tax and *Emissions Trading System (ETS)* in forestry sector has been conducted in various countries with different approaches. Further analysis of the effectiveness of these two policy instruments in reducing deforestation, potential policy synergies, and synergy models that can be applied in Indonesia will be explained more comprehensively.

Policy Integration Model, Analysis of policy models that combine carbon tax and carbon trading

Currently, no country has specifically combined a carbon tax and an Emissions Trading System (ETS) aimed directly at the forestry sector. However, some countries have implemented carbon tax and Emissions Trading System (ETS) together to control greenhouse gas (GHG) emissions. This approach aims to combine the advantages of a carbon tax in providing carbon price certainty with the flexibility of an ETS in creating market-based incentives, and develop mechanisms that include the forestry sector in their carbon tax and ETS policy frameworks.

This study is relevant because Indonesia has issued a roadmap for the Emissions Trading System (ETS) in the forestry sector the issuance of the Minister of Environment and Forestry Regulation (Permen LHK) No. 7 of 2023 which regulates the procedures for organising carbon trading in the forestry sector. and in the draft carbon tax roadmap study there is a plan to impose a carbon tax in the forestry sector.

Carbon tax and ETS play a significant role in reducing greenhouse gas (GHG) emissions in the forestry sector. A carbon tax functions as a fiscal instrument that sets a fixed price per tonne of emissions, providing certainty for economic actors. In contrast, the ETS works with a quota-based market system, allowing entities that produce fewer emissions to sell carbon credits to entities with higher emissions. The effectiveness of market-based policy instruments such as carbon taxes and emissions trading systems (*ETS*) in reducing deforestation depends largely on policy design, market incentives, and implementation capacity at the national and local levels. Both carbon tax and ETS in the forestry sector have distinctive features.

Carbon taxes are meant to offer a strong price signal opposing carbon-based activity. Within the framework of forestry, carbon taxes might be applied to (i) agricultural and plantation use of forest territory (e.g. palm oil, rubber, and industrial timber); (ii) emissions from *land-use change*, such as deforestation and land degradation; (iii) use of fossil-based fuels in forestry operations (e.g. heavy equipment in the timber industry).

The effectiveness of carbon tax in reducing deforestation, some examples of carbon tax implementation in Sweden: The implementation of carbon tax since 1991 has reduced emissions by 25% in the first 10 years of implementation (OECD, 2019). In Canada (British Columbia), meanwhile, a carbon price applied to the forestry industry lowered the rate of forest conversion to agricultural land and promoted forest regeneration. Introduced in 2008 at a C$10/t$CO_2$ initial rate, the carbon tax rises to C$50/t$CO_2$ by 2022. This tax helps to lower carbon-based fuel usage, boost reforestation investment, and improve forest industry openness. Over the period 2005–2012, a carbon tax mixed with carbon trading cut deforestation by 70% in Brazil (Amazon Fund).

Nevertheless, these countries have encountered several obstacles, including (a) Difficulties in Measuring Forestry Emissions, which necessitate precise carbon monitoring systems, such as remote sensing and LiDAR, which are frequently costly and challenging to implement in developing countries; (b) Resistance from Industry, which occurs when forestry and agriculture industries that are subject to carbon taxes lobby to avoid the tax or obtain exemptions; (c) Social Burden on Indigenous Peoples, which can have a detrimental effect on indigenous communities and forest-dependent local communities if fair compensation programs are not implemented.

Effectiveness of ETS in Reducing Deforestation

Setting an emissions cap and permitting the market of carbon credits for companies that effectively lower their emissions helps the ETS to give economic players flexibility. ETS lets companies exchange carbon emission rights, therefore providing financial incentives for programs involving forest preservation to lower emissions. ETS is applied in the forestry industry under programmes including (a) REDD+ (Reducing Emissions from Deforestation and Forest Degradation); (b) voluntary carbon market; and (c) regional carbon trading systems including the EU Emissions Trading System (EU-ETS).

Lessons from the European Union, where the EU-ETS has resulted in a 43% decrease in emissions in the industrial sector since 2005, will help the ETS be successful in slowing down deforestation. Certain nations are starting to include ETS into the forestry industry. The Cap-and- Trade Program has opened chances for private forests in California to sell carbon credits, therefore promoting restoration and conservation. Though on a small scale, numerous community-based programs in Indonesia's Voluntary Carbon Market have effectively obtained funds from the worldwide ETS. The ETS in the forestry sector has difficulties in terms of (a)

ISSN 2714-8130 (Online)

carbon price volatility that generates uncertainty for investors and landowners and (b) carbon leakage, whereby deforestation proceeds to areas not under control of carbon policies.

The primary finding is that a floor price for carbon taxes will help to reduce carbon price volatility in the ETS therefore guaranteeing the sustainability of the carbon market (Stavins, 2021).A case study in Brazil confirming that the combination of carbon tax and ETS through the Amazon Fund effectively lowered deforestation by 70% in the period 2005–2012 (May et al., 2020) supports this. Still, the execution of this policy in Indonesia still suffers from limited institutional capacity and legal restrictions (Boyd et al., 2021).

Based on knowledge gained from other nations, synergies between carbon tax and Emissions Trading System (ETS) can produce a more stable and adaptive policy and generate a complementary mechanism to raise the effectiveness of emission mitigating due of the following considerations:

Price Stability Mechanism

Potential Synergies between Carbon Tax and Carbon Trading in the Forestry Sector. Carbon tax and carbon trading (ETS) synergies in the forestry sector create a complementary mechanism to increase the effectiveness of emissions mitigation, through:

Role of Carbon Tax in ETS

A carbon tax can serve as a floor price in the ETS market to avoid carbon prices that are too low due to market instability. By setting a minimum carbon price, incentives remain high for businesses to reduce emissions. A carbon tax sets a floor price for carbon emissions, preventing extreme price volatility in the ETS market. This provides certainty for market participants and encourages long-term investment in low-carbon technologies. Example: In Brazil, carbon tax revenues from the energy sector (e.g. petrol) are allocated to the Amazon Fund, which serves as a floor price for forest conservation projects. This floor price ensures restoration projects remain financially viable, even if global carbon prices fall. Brazil uses carbon tax revenues from the energy sector as a fixed fund for the Amazon Fund, combined with international carbon credit trading. As a result, deforestation in the Amazon fell by 70% (2005-2012) (May et al., 2020).

An ETS allows companies that are able to reduce emissions at low cost to sell their emissions quota to companies in need. This mechanism achieves emission targets at an optimal cost, while a carbon tax ensures the price does not fall below a set limit. For the technical design related to the synergy of carbon tax and ETS, it can use a hybrid pricing mechanism by synergising the floor price and market flexibility. The technical design includes price stability and market efficiency.

Based on a literature study, Stavins (2021) explains that a floor price in an ETS system prevents carbon prices from falling below levels that kill economic incentives. For example in the US Regional Greenhouse Gas Initiative (RGGI), a floor price of US2.5/tonne (2023) combined with a declining cap of 32*.5/tonne* (2023) combined with a declining cap of 36 billion to fund forest restoration (Murray & Maniloff, 2015).Then for example in New Zealand (NZ ETS), a floor price of US$20/tonne synergised with agroforestry credits, encouraged the planting of 700,000 hectares of exotic trees (World Bank, 2023); and (b) Carbon Tax as Ceiling Price A carbon tax can serve as an ETS price ceiling to prevent speculative bubbles. For example, in the European Union, the energy sector carbon tax (€75/tonne) sets the ceiling price for forestry credits under the EU ETS (European Commission, 2021).

Thoughts for application in Indonesia include a tiered carbon tax and revenue allocation. The former is a progressive carbon tax based on forest type (US$10/tonne for agroforestry vs. *US$10/tonne for agroforestry vs*. US$30/tonne for primary forest) could be synergised with the ETS (Tacconi, 2020). While the latter is Revenue Allocation: 40% of tax revenue is allocated to purchase indigenous peoples' carbon credits, as stipulated in MoEF Regulation No.7/2021.

ETS is regarded as an Efficiency Driver, through Market Flexibility. An ETS allows companies that are able to reduce emissions at low cost to sell their emissions quota to companies in need. This mechanism achieves emission reduction targets in the most *cost-effective* manner. For example, the European Union synergises the EU ETS with the energy sector carbon tax (€50-80/tonne CO_2). The tax price serves as a reference, while the ETS price adjusts to supply-demand dynamics.

Impact on Green Investment, through Price Certainty. The minimum price of a carbon tax provides certainty for investors to finance long-term projects such as reforestation or carbon capture technologies. Case study example: REDD+ projects in the Amazon (Brazil) attracted US$1.3 billion in investment thanks to a combination of carbon tax revenues and stable credit prices on the international market (May et al., 2020).

ISSN 2714-8130 (Online)

Comparison of Carbon Tax and ETS Models in the Forestry Context

This study compares two main approaches to carbon pricing in the forestry sector:

Aspects	Carbon Tax	ETS (Cap-and-Trade)
Carbon Price	Fixed per tonne of CO_2	Market-based, may fluctuate
Cost Certainty	Provide certainty for business actors	More flexible, but prone to volatility
Effectiveness of Emission Reduction	Depending on the level of tax rate	Relies on allocation and market mechanisms
Social Impact	Could burden the poor	Could create injustice if quota distribution is uneven
Case Example	Sweden (Carbon Tax Success)	European Union (ETS Successful)

The synergy of carbon tax and ETS can combine the advantages of both systems, where carbon tax serves as a *floor price*, while ETS provides flexibility to businesses in adapting to emission targets.

Successful Synergies of Carbon Tax and ETS

Country	Synergy Model	Impact on Deforestation
Brazil	Energy sector carbon tax + ETS (*Amazon Fund*) Nepstad, D. C., et al. (2014); Barreto, P., et al. (2019)	Deforestation down 70% (2005-2012)
Sweden	High carbon tax on energy + Voluntary carbon market Andersson, J. J. (2019); Hammar, H., & Åkerfeldt, S. (2011)	Forestry sector emissions drop dramatically
California, USA	Transport carbon tax + private forest ETS Gonzalez, P., et al. (2015); California Air Resources Board (CARB) Reports (2013-2023).	Conservation up, carbon credits up

Market-based incentives. Incentives aimed at local businesses and communities.

ETS incentivises conservation actors and businesses. The ETS allows high-performing forest restoration projects to earn tradable carbon credits. First, low emissions companies. Companies that successfully reduce emissions below a set limit can sell additional emissions quotas in the ETS market, creating additional revenue. Example: PT Kalimantan Hijau (Indonesia) sells carbon credits from restoring 10,000 hectares of peat to the Singapore market for US$15/tonne. Second, high emitting companies. These companies buy carbon credits to comply with regulations, but carbon taxes force them to allocate funds to transition to green technologies.

Incentives for Local Communities

Firstly, result based payments. Indigenous peoples and forest managers are directly financially compensated based on emissions reduction performance. Example: The Climate Village Programme in Jambi provides an incentive of IDR 500 million/village/year for participation in forest patrols. Secondly, community carbon markets. Schemes such as Plan Vivo allow communities to sell carbon credits directly to global buyers, at higher prices (US$20-30/tonne) due to the inclusion of social benefits.

Funding from carbon taxes and carbon trading

Funding can be used for further investment in conservation and sustainable forest management. First, carbon tax as a funding base. With a progressive tariff design, a primary forest/peat: Subject to high tariffs (US$30-50/tonne CO_2) due to their ecosystem value as the largest carbon store (200-300 tonnes C/ha). Agroforestry: Lower tariffs (US$10-15/tonne) to encourage sustainable practices. Example: Costa Rica implemented a transport sector carbon tax (5% of fuel price) allocated to the PSA (*Pagos por Servicios Ambientales*) programme, reducing deforestation 80% since 1997. Revenue Allocation: in Brazil: 60% of petrol tax revenues to the Amazon Fund, generating US$1.3 billion (2008-2020) for 102 conservation projects.

Second, Carbon Trading (ETS) as an accelerator. Compliance vs. Voluntary Carbon Markets. Compliance Market (e.g. EU ETS): High prices (€80-100/tonne) with stable demand from mandatory industries. Voluntary Market: Lower price (US$5-15/tonne), but flexible for community projects. Example: Katingan Mentaya Project (Indonesia) sells carbon credits to global companies such as Shell and Gucci at US$12-18/tonne.

Article 6 mechanism of the Paris Agreement. Allows the transfer of carbon credits between countries (ITMO). Indonesia can sell peat restoration credits to Japan or the EU at a premium. Example: Swiss-Ghana Agreement (2020) transferred US$50 million worth of carbon credits for renewable energy projects.

ISSN 2714-8130 (Online)

Policy Synergy Model

The synergy of carbon tax and ETS policies in the forestry sector can be done with several models. First is Modelling a Carbon Tax as a Price Floor in an ETS. In this model, carbon tax is set as the lower limit of carbon credit price in ETS to avoid price volatility, if the carbon price in ETS market falls below the carbon tax level, entities are required to pay carbon tax as a substitute. The advantage of this model is that it can keep the carbon price stable and prevent speculation in the ETS market. However, this model has the disadvantage that it requires high coordination between tax and ETS regulators and may add administrative burden to the forest industry.

Second, Performance-based Differential Carbon Tax Model. Whereas in the performance-based differential carbon tax model, the carbon tax is set based on the level of forest conservation. Companies with good conservation practices get lower tax incentives or even exempted from carbon tax. advantage of this model is that it can encourage sustainable practices in forestry and increase company participation in carbon mitigation efforts. The disadvantage of this model is the complexity of measurement and monitoring and the need for sophisticated carbon monitoring infrastructure. Third, Hybrid Model of Carbon Tax and ETS. In the hybrid model of carbon tax and ETS, the carbon tax is applied to sectors that are difficult to include in the ETS, such as illegal deforestation and illegal logging activities. The ETS is used as an incentive mechanism for reforestation and restoration projects. advantages of this model are that it creates a balance between coercive (tax) and market incentive (ETS) approaches and increases policy flexibility and private sector involvement. The disadvantage of this model is that it requires a strong and transparent regulatory system and has the potential to create additional bureaucracy if not managed properly.

This article also identifies challenges in synergising carbon tax and ETS in the forestry sector, namely misaligned regulations: Carbon tax and ETS are often implemented by different institutions without proper coordination. Weak institutional capacity: In Indonesia, there are still overlapping regulations in the management of carbon tax and ETS.

Furthermore, technical difficulties also exist. 1) the complexity of measuring forest carbon stocks, requiring advanced technologies such LiDAR and machine learning to ensure the accuracy of carbon stock calculations (Baccini et al., 2017) and methodological uncertainty can limit the credibility of carbon credits; (2) the risk of carbon leakage, activities of deforestation can move to areas that do not have strict regulations, so reducing the effectiveness of carbon policies. The 3rd challenge is the Inequality of Benefit Distribution, in Indonesia, 60% of carbon credit revenue is enjoyed by corporations, while indigenous communities only receive 10-15% (Tacconi, 2020) and unclear land tenure structures often prevent local communities from benefiting from the carbon market.

Relevance for Policy in Indonesia

Important new perspectives for Indonesian environmental policy can come from this work. Carbon policy is a crucial tool in minimizing environmental damage even if rates of deforestation remain high (1.1 million hectares year). This study leads some policy conclusions that can be made. First, the requirement for an ETS Mechanism Combined Carbon Tax System The Need for a Combined Carbon Tax and ETS Mechanism. A carbon tax can act as a lower bound on the price of carbon credits under an ETS to ensure prices do not fall too low. An ETS can incentivise businesses to invest in conservation projects. Second, institutional capacity building and stronger regulations. Carbon policy in Indonesia needs to be harmonised between institutions to avoid overlapping regulations. A transparent system for carbon credit distribution is needed to ensure equitable benefits for local communities. Third, strengthening the role of indigenous peoples in the carbon market. Policies that give indigenous peoples clearer ownership rights in carbon credit projects are needed. Indigenous peoples should get a fairer share of revenues from carbon trading. Fourt, the government needs to adopt advanced technologies such as *LiDAR* mapping and *remote sensing* to improve the accuracy of forest carbon measurement. Cooperation with academic institutions and research institutes can increase capacity in carbon monitoring.

Economic-Environmental Impacts

The impacts of carbon tax and carbon trading implementation in the forestry sector are categorised into technical, socio-economic and policy aspects. First, the technical aspects are more about the challenges that will be faced technically including a) accuracy of carbon stock measurement. Measuring forest carbon reserves calls advanced technology and exact techniques, yet in Indonesia environmental variety limits this: Complex ecosystems found in Indonesia's forests include lowland forest (200–300 tonnes C/ha), mangrove (1,023 tonnes

ISSN 2714-8130 (Online)

C/ha), and peat (55–60 tonnes C/ha) (IPCC, 2022). Each type requires a different measurement method. Regarding technology limitations, the use of LiDAR (Light Detection and Ranging) and *machine learning* algorithms (such as those used by Baccini et al., 2017) is costly (US$10-50/hectare) and technical expertise is scarce in Indonesia. Data on carbon stocks (MoEF, 2022) for just 30% of Indonesia's forest area have been validated. Hence, the implications are data error cause mistakes in carbon pricing. For instance, misinterpretation can cause a peat forest valued at US$30/tonne CO2 to be valued just US$5/tonne.

b) Carbon leakage risk. Deforestation activities migrating to uncontrolled regions causes carbon leakage. In Indonesia, the Java Moratorium against Papua Exploitation is one such. While the Java (2020) forest moratorium helped to lower local deforestation, it raised pressure on Papua since 1.2 million hectares of forest were lost there between 2021–2023 (Angelsen et al., 2018). This is a result of insufficient law enforcement in far-off areas and regional regulatory variations—P Papua lacks a real-time monitoring mechanism.

Second, the economic-social aspects, including impacts on the economy, social and environment. In terms of economic impact, particularly in reduced transaction costs through hybrid funding carbon tax as a Funding Base, Carbon tax revenues can cover high ETS transaction costs (15-20% of total revenues) in developing countries (World Bank, 2023). Example: In Brazil, 40% of carbon tax revenues from the energy sector were allocated to finance forest project certification, reducing the administrative costs of Amazon Fund projects by 25% (May et al., 2020). Tax and ETS synergies allow selective allocation of funds to low transaction cost projects. For example, in Peru, projects with verification costs below US$10/tonne CO_2 receive priority funding (Börner et al., 2016). As for sustainable income improvement, there is a competitive carbon price where the combination of tax (fixed price) and ETS (market price) creates an optimal price range. In Brazil, the price of primary forest carbon is US50/tonne (Mayetal., 2020), while in Indonesia it is *only* US50/tonne (*Mayetal*., 2020), *while in Indonesia it is only US5-20/tonne* (Sills et al., 2014). As a successful Example, a REDD+ project in the Democratic Republic of Congo generated US$12 million/year in revenue from a combination of tax and credit trading (Börner et al., 2016).

In related to social impact, there is a benefit equalisation. Amazon Fund model: 40% of carbon credit revenue is allocated to local communities, increasing conservation participation (May et al., 2020). Contrast this with Indonesia: Only 10-15% of carbon credit revenues go to indigenous peoples (Tacconi, 2020). Solution: Mandatory allocation of 30-40% through regulation (e.g. Papua Special Regional Regulation). In addition, it requires a tenure strengthening. Legalisation of Indigenous Rights: A REDD+ project in Peru reduced land conflicts by 45% by recognising 80% of indigenous rights (Larson et al., 2013). In Indonesia, only 30% of customary land is registered (Sunderlin et al., 2008).

Moreover, concerning inequality in benefit distribution, Tacconi's study (2020) shows that in Indonesia, it is corporations vs. Indigenous Peoples: 60% of carbon credit revenues from REDD+ projects go to corporations, while indigenous peoples receive only 10-15%... Root of the problem, unclear tenure rights: 70% of customary land is not legally recognised (Boyd et al., 2021) and corporate dominance in carbon project negotiations. This has resulted in tenure conflicts increasing by 40% in Kalimantan and Sumatra since 2020 (MoEF, 2023). Furthermore, there are high transaction costs. Transaction costs of carbon projects in Indonesia account for 30% of total revenues (World Bank, 2023), mainly due to (a) Complex Certification Process. Verification by an international body (e.g. Verra or Gold Standard) costs US50,000-US50,*000-US200*,000 per project. Example: Katingan Mentaya Project in Kalimantan spent US$1.2 million just for certification; and (b) Limited Infrastructure: Projects in Papua require 3× higher logistics costs than in Java.

In respect to environmental impact, it is possible to achieve effectiveness of emission reduction. Primary vs. Secondary Forests: While secondary forests only 3-5 tonnes/ha/year, prime forests lower 8-12 tonnes of CO_2/ha/year (Harris et al., 2021). Through higher carbon prices—such as US30/tonne vs US10/tonne—carbon policy synergies could provide additional incentives to primary forests. Critical Ecosystem Restoration: Rebuilding peat and mangrove forests could assist to reduce 5.8 Gt CO2 emissions globally (Griscom et al., 2017). Carbon tax income might support reversals of two million hectares of peat (MoEF, 2022) in Indonesia. Additionally, there is likely a Carbon Leakage Mitigation. By 18–35% carbon leakage is reduced by inter-regional policy synergies (such as Java-Kalimantan moratorium). For instance, Brazil funds cross-state Amazon monitoring with carbon tax income.

The third is policy aspects that capture two different things. First is a regulatory fragmentation. One main obstacle is overlapping sectoral policies, for instance the clash between REDD+ aims (MoEF) and oil palm planting licenses in forest regions (given by the Ministry of Agriculture). Carbon tax rules (HPP Law 2022) do not fit Carbon Trading (MoEF

ISSN 2714-8130 (Online)

Regulation No. 7/2021) although 15% of palm oil licenses are in conservation areas by 2022 (Government of Indonesia, 2021). Forty percent of REDD+ projects in Sumatra have failed due to lowered policy efficacy brought on by land conflicts (Klenk et al., 2020). Second is Dependence on Global Markets. Variations in foreign carbon prices influence local investment stability; for instance, the EU's Carbon Border Adjustment Mechanism (CBAM) policy imposes a US$80/tonne CO_2 penalty on imports of deforestation-based goods. The US$5/tonne carbon pricing of Indonesia is not competitive, hence discouragement of foreign investors World Bank, 2023. Risks: Indonesian forest restoration initiatives lose profitability if the global carbon price declines, say from US$15 to US$5/tonne.

Implementation Case Studies

An in-depth exploration of lessons learnt from international cases studies, including critical analyses, challenges and recommendations for Indonesia. To begin with, there is hybrid funding models from Brazil's Amazon Fund which combines carbon tax and carbon trading instruments to support forest conservation. Launched in 2008, the Amazon Fund seeks to use sustainable project funding to stop Amazonian deforestation. Its hybrid approach blends: Main donors are Norway and Germany, who have paid US$1.2 billion (2008–2019) in results-based grants. Payments are made after Brazil proves a reduction in deforestation. Although not formally a carbon tax, Brazil distributes money from the energy sector—including oil royalties—as well as other domestic sources. In relation to carbon credits from reduced deforestation, Brazil generates carbon credits through its REDD+ (Reducing Emissions from Deforestation and Forest Degradation) project. Each tonne of CO_2 avoided from deforestation counts as a credit. As for sales to the International Market, carbon credits are sold to donor countries (e.g. Norway) as compensation for their emissions. This mechanism allows Brazil to access global funding without compromising its forest sovereignty.

Regarding a governance and transparency, there are some specific organization in charged. First, steering committee (COFA) comprised of government, NGO, and indigenous representatives to ensure funds are allocated according to national priorities. Second, technical committee (CTFA) Tasked with evaluating project feasibility and ensuring compliance with environmental-social criteria. Third, independent auditors in which financial and performance reports are audited by an international firm (e.g. KPMG), with results published transparently. In connection with outcomes and impacts, deforestation is fallen by 70% (2005-2012), preventing 5.7 Gt CO_2 emissions (May et al., 2020). Around 102 projects were funded, covering forest conservation, indigenous community strengthening, and sustainable economies. About 40% of funding is allocated to local communities, including training programmes and certification of non-timber forest products. However, there are some challenges and criticisms, such as the dependence on foreign donors where approximately 90% of funding comes from Norway, making the programme vulnerable to donor policy changes. It is possibly a local corruption in which 15% of funds are misused at the local level, especially in infrastructure projects (May et al., 2020). Also, a political uncertainty where Bolsonaro administration policies (2019-2022) weaken environmental law enforcement, increasing deforestation 75% by 2021.

Several lesson learnt for Indonesia could be a hybrid finance. Combining domestic carbon tax revenues (e.g. from power plants) with international credit trading through Article 6 of the Paris Agreement. In addition to that, the governance would be more transparent with the establishment of an independent body (similar to COFA) with multi-stakeholder representation to oversee fund allocation. Moreover, in terms of social inclusion, there would be allocation at least 30% of carbon credit revenues to indigenous peoples through a revenue-sharing scheme. Furthermore, regarding monitoring technology, it is more likely to make use of satellites and blockchain to ensure accountability for emissions reductions. The Amazon Fund demonstrates that a hybrid funding model-combining international finance, carbon market instruments and transparent governance-can effectively reduce deforestation. For Indonesia, the key to success lies in diversifying funding sources (tax + carbon trading), inclusive and anti-corruption governance and technology synergies for accountability. With contextual adaptations, this model can be a key pillar of achieving the 2030 NDC targets and transitioning to a green economy.

The second case study coming from Peru with participatory and decentralised models. Indigenous communities are trained to use *Open Source GIS* (QGIS) and mobile applications such as Mapeo to map customary boundaries independently. Example: The Asháninka tribe in the Peruvian Amazon mapped 1.2 million hectares in 18 months, resulting in a legally recognised map. Also, drones with direct engagement where Communities use DJI Phantom

ISSN 2714-8130 (Online)

4 drones (cost ~$1,500/unit) to monitor deforestation and collect evidence of land claims. Data is processed using the DroneDeploy platform.

In conjunction with a regional autonomy, local governments have full authority to issue indigenous rights certificates (*Títulos de Comunidades Nativas*), reducing dependence on the central bureaucracy. Example: Loreto Region issued 500 indigenous land titles (2010-2015) without central government intervention. There is also a Progressive Legal Framework, specifically Law No. 29785 (2011). It recognises indigenous peoples' rights to land, resources and participation in decision-making. Criminal sanctions for encroachment of customary forests (fines of up to $50,000 or 8 years' imprisonment). Around 45% reduction in tenure conflicts in REDD+ project areas (Larson et al., 2013). 60% of carbon credit revenues from the Tambopata project were allocated to indigenous communities.

In Indonesian context, there are constraints of centralisation and elitism. In terms of complicated certification process, Social Forestry requires 16 stages of approval from the central MoEF, with an average time of 5-7 years per certificate. Example: Certification of Suku Anak Dalam (Jambi) customary land was delayed 8 years due to overlapping data. In addition, concerning an elite and corporate domination, in Central Kalimantan, 70% of carbon credit revenues are controlled by village heads and local businessmen (Chhatre & Agrawal, 2009). The Katingan Mentaya Project (Central Kalimantan) only allocated 15% of revenues to communities (Tacconi, 2020). Moreover, there are a number of overlapping regulations. Palm Oil Permits vs. Conservation 2.3 million hectares of palm oil permits are in forest areas (MoEF, 2023), contradicting moratorium targets. Example: PT SML in Papua has a palm oil licence on 50,000 hectares of primary forest included in a REDD+ project.

In Peru, community uses drone data to sue illegal mining companies. 40% of carbon credit revenue (US$5 million/year) is used to fund schools and clinics. Therefore, it certainly impacts on deforestation down 30% (2015-2020), with 80% community participation in forest patrols. While in Indonesia, there is a failure of the Rimba Raya Project. About 64,000 hectares of project land claimed by PT Rimba Raya Conservation and palm oil corporations. Dayak communities received only 12% of carbon credit revenues (Boyd et al., 2021). The root of the problem is no legal recognition of customary claims, leaving communities with no bargaining power.

Some critical learning for Indonesia may include a decentralisation of authority. It is vital to give full authority to the provincial government to issue Social Forestry certificates (similar to Peru). Example: Village Law No. 6/2014 can be synergised with Social Forestry to accelerate certification. Furthermore, an affordable participatory technology that entails a distribution of 1,000 DJI Mini 3 Pro drones (IDR 50 million/unit) to indigenous communities, with training by MoF. Also, using the Forest Watcher app (FREE) for real-time deforestation reporting. Additionally, there should be an anti-elitism law reform that enacts a Presidential Regulation requiring 40% ownership of carbon credits for indigenous peoples. Sanction the revocation of business licences for corporations involved in land disputes. Lastly, a hybrid funding that allocates 20% of energy sector carbon tax revenues (IDR 6 trillion/year) to finance indigenous land certification. Utilise Article 6 mechanisms of the Paris Agreement to access global funding.

Peru succeeded in reducing tenure conflicts through decentralisation, participatory technology and a pro-indigenous legal framework. Meanwhile, Indonesia's failure is due to centralised bureaucracy, elitism and overlapping policies. Strategic steps for Indonesia are to implement (1) Decentralisation: Give land certification authority to provincial governments; (2) Technology: Use drones and participatory apps for self-mapping; (3) Law: Establish strict sanctions for corporations involved in land disputes (4) Funding: Allocate carbon tax revenue to accelerate certification.

CONCLUSION

The synergy between carbon tax and Emissions Trading Systems (ETS) in the forestry sector can enhance climate change mitigation while promoting sustainable economic development. By setting a minimum carbon price, a carbon tax can stabilize ETS markets, ensuring incentives remain strong for emission reduction projects. Countries like Brazil, Sweden, and California have successfully integrated these mechanisms, demonstrating how targeted policies—such as Brazil's use of carbon tax revenues for forest conservation, Sweden's flexible tax-and-trade model, and California's Cap-and-Trade program—can drive both environmental protection and economic growth. Indonesia can learn from these examples by gradually increasing its carbon tax, expanding its coverage to forestry-related activities, and ensuring revenue supports conservation efforts.

ISSN 2714-8130 (Online)

However, challenges such as complex carbon stock measurement, benefit inequality, weak institutional coordination, and price volatility must be addressed for effective implementation. The EU's Carbon Border Adjustment Mechanism (CBAM) further underscores the urgency for Indonesia to align its carbon policies with international standards to maintain export competitiveness. Key recommendations include setting a minimum ETS price, improving indigenous participation in carbon markets, leveraging digital technology for transparent carbon monitoring, and strengthening regulatory governance. By adopting these measures, Indonesia can enhance its carbon credibility, boost sustainable forestry practices, and position itself as a global leader in climate action.

BIBLIOGRAPHY

Agrawal, A., Nepstad, D., & Chhatre, A. (2011). Reducing emissions from deforestation and forest degradation. *Annual Review of Environment and Resources, 36*, 373-396. https://doi.org/10.1146/annurev-environ-042009-094508

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N. J., Bauch, S., ... & Wunder, S. (2014). Environmental income and rural livelihoods: A global-comparative analysis. *World Development, 64*, S12-S28. https://doi.org/10.1016/j.worlddev.2014.03.006

Angelsen, A., Martius, C., De Sy, V., Duchelle, A. E., Larson, A. M., & Pham, T. T. (2018). Transforming REDD+: Lessons and new directions. CIFOR. https://doi.org/10.17528/cifor/007046

Angelsen, A., Martius, C., De Sy, V., Duchelle, A. E., Larson, A. M., & Pham, T. T. (2018). *Transforming REDD+: Lessons and new directions*. CIFOR. https://doi.org/10.17528/cifor/007046

Baccini, A., Walker, W., Carvalho, L., Farina, M., Sulla-Menashe, D., & Houghton, R. A. (2017). Tropical forests are a net carbon source based on aboveground measurements of gain and loss. *Science, 358*(6360), 230-234. https://doi.org/10.1126/science.aam5962

Börner, J., Wunder, S., & Giudice, R. (2016). Will REDD+ revenues incentivise sustainable forest management?. *Forest Policy and Economics, 66*, 59-67. https://doi.org/10.1016/j.forpol.2016.02.006

Boyd, W., Stickler, C., Duchelle, A. E., Seymour, F., & Nepstad, D. (2021). Jurisdictional approaches to REDD+: Lessons from the Amazon. *World Development, 145*, 105483. https://doi.org/10.1016/j.worlddev.2021.105483

Boyd, W., Stickler, C., Duchelle, A. E., Seymour, F., & Nepstad, D. (2021). Jurisdictional approaches to REDD+: Lessons from the Amazon. *World Development, 145*, 105483. https://doi.org/10.1016/j.worlddev.2021.105483

Chhatre, A., & Agrawal, A. (2009). Trade-offs and synergies between carbon storage and livelihood benefits from forest commons. *Proceedings of the National Academy of Sciences, 106*(42), 17667-17670. https://doi.org/10.1073/pnas.0905308106

Coase, R. (1960). The problem of social cost. *Journal of Law and Economics, 3*(1), 1-44.

Corbin, J., & Strauss, A. (2015). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (4th ed.). Sage Publications.

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., ... & Turner, R. K. (2014). Changes in the global value of ecosystem services. *Global Environmental Change, 26*, 152-158.https://doi.org/10.1016/j.gloenvcha.2014.04.002

Eliasch, J. (2008). Climate change: Financing global forests. The Eliasch Review. https://www.gov.uk/government/publications/the-eliasch-review

European Commission. (2021). EU Emissions Trading System (EU ETS). https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets_en

FAO. (2020). Global Forest Resources Assessment 2020. Food and Agriculture Organisation. http://www.fao.org/forest-resources-assessment

FAO. (2020). *Global Forest Resources Assessment 2020*. Food and Agriculture Organisation. http://www.fao.org/forest-resources-assessment

Fisher, M. R., Moeliono, M., Mulyana, A., Yuliani, E. L., Adriadi, A., Kamaluddin, ... & Sahide, M. A. K. (2019). Assessing the new social forestry project in Indonesia: Recognition, livelihood and conservation? *International Forestry Review, 21*(3), 346-361. https://doi.org/10.1505/146554819827906823

Government of Indonesia. (2021). Regulation of the Minister of Environment and Forestry No. 7/2021 on carbon pricing. https://ppid.menlhk.go.id

Green Climate Fund. (2020). Forests and climate change: A GCF approach. https://www.greenclimate.fund/document/forests-and-climate-change

Griscom, B. W., Adams, J., Ellis, P. W., Houghton, R. A., Lomax, G., Miteva, D. A., ... & Fargione, J. (2017). Natural climate solutions. *Proceedings of the National Academy of Sciences, 114*(44), 11645-11650. https://doi.org/10.1073/pnas.1710465114

Groom, B., & Palmer, C. (2012). REDD+ and rural livelihoods. *Biological Conservation, 154*, 42-52. https://doi.org/10.1016/j.biocon.2012.03.002

Harris, N. L., Gibbs, D. A., Baccini, A., Birdsey, R. A., de Bruin, S., Farina, M., ... & Tyukavina, A. (2021). Global maps of twenty-first century forest carbon fluxes. *Nature Climate Change, 11*(3), 234-240. https://doi.org/10.1038/s41558-020-00976-6

Harris, N. L., Gibbs, D. A., Baccini, A., Birdsey, R. A., de Bruin, S., Farina, M., ... & Tyukavina, A. (2021). Global maps of twenty-first century forest carbon fluxes. *Nature Climate Change, 11*(3), 234-240. https://doi.org/10.1038/s41558-020-00976-6

Houghton, R. A., & Nassikas, A. A. (2018). Global and regional fluxes of carbon from land use and land cover change 1850-2015. *Global Biogeochemical Cycles, 32*(3), 456-472. https://doi.org/10.1002/2017GB005750

IPCC. (2022). Climate Change 2022: Mitigation of climate change. Chapter 7: Agriculture, forestry, and other land uses (AFOLU). Cambridge University Press. https://www.ipcc.ch/report/ar6/wg3/

IPCC. (2023). *Climate Change 2023: Synthesis Report*. Cambridge University Press. https://www.ipcc.ch/report/ar6/syr

Klenk, N., Larson, B. M., & McDermott, C. L. (2020). Adaptive forest governance to counter risks of carbon leakage. *Global Environmental Change, 65*, 102189. https://doi.org/10.1016/j.gloenvcha.2020.102189

Larson, A. M., Brockhaus, M., Sunderlin, W. D., Duchelle, A., Babon, A., Dokken, T., ... & Huynh, T. B. (2013). Land tenure and REDD+: The good, the bad, and the ugly. *Global Environmental Change, 23*(3), 678-689. https://doi.org/10.1016/j.gloenvcha.2013.02.014

May, P. H., Gebara, M. F., & Bicalho, A. M. (2015). The Amazon Fund: Examining the interplay between fiscal incentives and climate governance. *Climate Policy, 15*(4), 407-426. https://doi.org/10.1080/14693062.2014.952222

May, P. H., Gebara, M. F., & Bicalho, A. M. (2020). The Amazon Fund and its impact on forest conservation and local livelihoods. *Climate Policy, 20*(4), 487-503. https://doi.org/10.1080/14693062.2019.1690967

May, P. H., Gebara, M. F., & Bicalho, A. M. (2020). The Amazon Fund and its impact on forest conservation and local livelihoods. *Climate Policy, 20*(4), 487-503. https://doi.org/10.1080/14693062.2019.1690967

Milne, S., & Adams, B. (2012). Market masquerades: Uncovering the politics of community-level payments for environmental services in Cambodia. *Development and Change, 43*(1), 133-158. https://doi.org/10.1111/j.1467-7660.2011.01748.x

MOEF. (2022). *Environment and Forestry Statistics 2022*. Ministry of Environment and Forestry Indonesia.

Murray, B. C., & Maniloff, P. T. (2015). Why have greenhouse emissions in RGGI states declined?. *Energy Economics, 51*, 581-589. https://doi.org/10.1016/j.eneco.2015.07.013

Nordhaus, W. (2017). Revisiting the social cost of carbon. *Proceedings of the National Academy of Sciences, 114*(7), 1518-1523. https://doi.org/10.1073/pnas.1609244114

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.

Ostrom, E. (2011). Background on the institutional analysis and development framework. *Policy Studies Journal, 39*(1), 7-27. https://doi.org/10.1111/j.1541-0072.2010.00394.x

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, n71. https://doi.org/10.1136/bmj.n71

ISSN 2714-8130 (Online)

Pan, Y., Birdsey, R. A., Fang, J., Houghton, R., Kauppi, P. E., Kurz, W. A., ... & Hayes, D. (2011). A large and persistent carbon sink in the world's forests. *Science, 333*(6045), 988-993. https://doi.org/10.1126/science.1201609

Pirard, R., & Belna, K. (2012). Agriculture and deforestation: What role should REDD+ play?. *World Development, 40*(1), 66-79. https://doi.org/10.1016/j.worlddev.2011.05.008

Rawls, J. (1971). *A theory of justice*. Harvard University Press.

Seymour, F., & Busch, J. (2016). Why forests? Why now? The science, economics, and politics of tropical forests and climate change. Brookings Institution Press. ISBN: 978-0815729185

Sills, E. O., Atmadja, S. S., & de Sassi, C. (2014). REDD+ on the ground: A case book of subnational initiatives. CIFOR. https://doi.org/10.17528/cifor/005446

Stavins, R. N. (2021). The future of U.S. carbon-pricing policy. *Environmental and Energy Policy and the Economy, 2*, 8-64. https://doi.org/10.1086/711009

Stavins, R. N. (2021). The future of U.S. carbon-pricing policy. *Environmental and Energy Policy and the Economy, 2*, 8-64. https://doi.org/10.1086/711009

Stern, N. (2016). Economics: Current climate models are grossly misleading. *Nature, 530*(7591), 407-409. https://doi.org/10.1038/530407a

Sunderlin, W. D., Dewi, S., Puntodewo, A., Müller, D., Angelsen, A., & Epprecht, M. (2008). Why forests are important for global poverty alleviation: A spatial explanation. *Ecology and Society, 13*(2), 24. https://doi.org/10.5751/ES-02590-130224

Tacconi, L. (2020). REDD+ and equity outcomes: Evidence from Indonesia. *World Development, 127*, 104747. https://doi.org/10.1016/j.worlddev.2019.104747

Tacconi, L. (2020). Redefining payments for environmental services. *Ecological Economics, 173*, 106613. https://doi.org/10.1016/j.ecolecon.2020.106613

UNFCCC. (2021). Technical guidelines for the implementation of Article 6 of the Paris Agreement. United Nations. https://unfccc.int/process-and-meetings/the-paris-agreement/article-6

World Bank. (2023). State and trends of carbon pricing 2023. World Bank Group. https://openknowledge.worldbank.org/handle/10986/39818

World Bank. (2023). State and trends of carbon pricing 2023. World Bank Group. https://doi.org/10.1596/39818

World Bank. (2023). *State and trends of carbon pricing 2023*. World Bank Group. https://doi.org/10.1596/39818

Wunder, S., Angelsen, A., & Belcher, B. (2014). Forests, livelihoods, and conservation: Broadening the empirical base. *World Development, 64*, S1-S11. https://doi.org/10.1016/j.worlddev.2014.03.007