



# Impacts of land clearing for oil palm on coastal ecosystems: A case study of forest and land fires in Riau Province, Indonesia

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## ABSTRACT

**Background:** Forest and land fires (KARHUTLA) on tropical peatlands in Riau Province, Indonesia, are a recurring environmental crisis linked to the expansion of oil palm plantations. Despite regulatory frameworks, the use of fire for land clearing persists, driven by economic incentives and weak enforcement. This study investigates the environmental, economic, and social impacts of land burning in Riau, focusing on plantation expansion, illegal operations, and regulatory loopholes. **Methods:** A qualitative-descriptive approach was employed, supported by secondary data analysis from governmental and institutional reports. The study utilizes an environmental-economic framework to assess the interdependence between natural resource exploitation and macroeconomic indicators, including the Environmental Kuznets Curve (EKC) and IPAT model. **Findings:** Oil palm plantations in Riau increased by 120,000 hectares, with approximately 1.8 million hectares operated illegally by 190 companies. This expansion significantly contributes to karhutla, resulting in health issues, haze, and transboundary pollution. Although palm oil exports support Riau's economic growth—accounting for half of its total exports in 2021—this comes at the cost of severe environmental degradation and tax losses of up to IDR 150 trillion. Regulatory exceptions permitting traditional burning practices are frequently exploited, undermining enforcement efforts. **Conclusion:** This paper concludes that sustainable solutions require tighter regulation, stronger institutional enforcement, mandatory ISPO/RSPO certification, and a shift toward technological innovations in land clearing. Furthermore, fiscal policies such as commodity taxation can fund environmental restoration efforts. **Novelty/Originality of this Article:** This study lies in its integrated analysis of ecological degradation and economic output through a macroeconomic lens, offering actionable recommendations for balancing palm oil-driven economic growth with environmental sustainability in developing regions.

**KEYWORDS:** environmental economics; forest and land fires; ISPO/RSPO certification; land burning; palm oil; Riau.

## 1. Introduction

Forest and land fires (commonly referred to as karhutla) on tropical peatlands can release substantial amounts of carbon into the atmosphere as CO<sub>2</sub>, while also leading to a wide range of socio-economic issues, human health problems, pollution, and contributing to the climate crisis. The majority of these fires are caused by anthropogenic factors, such as land clearing and land-use conversion for oil palm plantations or other agricultural sectors, as well as slash-and-burn farming practices (Dhandapani & Evers, 2020; Page et al., 2002).

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Indonesia is the largest producer of palm oil in the world, contributing 47 million tons or 59% of global palm oil production, with Riau Province being the country's leading producer, accounting for 20% (USDA, 2023). The high volume of palm oil production in Riau Province has been accompanied by a yearly increase in the total area of oil palm plantations, from 2.74 million hectares in 2019 to 2.86 million hectares in both 2020 and 2021 (BPS, 2022).

This expansion has largely been driven by land clearing and land-use conversion, often involving illegal practices such as the use of fire to open land. Such burning activities have serious environmental and public health consequences, including the production of haze, which can contribute to transboundary air pollution affecting neighboring countries like Malaysia and Singapore (Utami & Primawardani, 2021). The use of fire to clear land for oil palm plantations can trigger extensive forest and peatland fires, especially during the dry season, as Riau Province contains vast peatland areas. Slash-and-burn methods are particularly unsuitable for tropical peatlands, as dried peat is highly flammable (Evers et al., 2017). Between January and July 2023, the area affected by fires in Riau Province reached 1,184.36 hectares, with 1,173 recorded hotspots and 360 confirmed fire spots. According to the Regional Disaster Management Agency (BPBD), these numbers show a decline compared to the previous year. Authorities have arrested an individual suspected of causing the fire—a plantation laborer who used fire to clear land for an oil palm plantation (Republika, 2023).

Efforts to apprehend arsonists are often hampered by the presence of an estimated 1.8 million hectares of illegal oil palm plantations in Riau Province. These plantations operate without plantation business licenses (IUP), forest area release permits, cultivation licenses, or land-use rights (HGU). A total of 190 companies are reportedly involved, resulting in an estimated loss of around IDR 150 trillion in unpaid taxes to the state (DPR RI, 2022).

The Government of the Republic of Indonesia has issued several regulations related to forest and land fires (*karhutla*) and land clearing for oil palm plantations (OPP). Despite these measures, Article 22, point 24 of Law No. 11 of 2020 on Job Creation explicitly prohibits land clearing by burning. However, the law provides an exception for indigenous or local communities, allowing controlled burning of up to two hectares per household in accordance with traditional practices.

In this context, the key issues addressed in this paper concern forest and land fires resulting from the expansion of oil palm plantations in Riau Province. Firstly, there has been a significant increase in the total area of oil palm plantations in the province, from 2.74 million hectares in 2019–2020 to 2.86 million hectares. A substantial portion of this expansion remains uncertified by either the Indonesia Sustainable Palm Oil (ISPO) scheme or the Roundtable on Sustainable Palm Oil (RSPO), and much of it involves land-use conversion and burning. This is particularly hazardous given that large areas of Riau Province consist of highly flammable peatlands.

Secondly, there are 190 oil palm plantation companies operating without official permits, covering a total of 1.8 million hectares. This situation hampers law enforcement efforts against those responsible for illegal land burning and causes substantial financial losses to the state. In addition to causing environmental damage, the presence of these illegal plantations has led to an estimated loss of IDR 150 trillion in unpaid taxes.

Thirdly, although the government permits limited land burning for local communities, the policy is prone to misuse. For instance, between January and July 2023 alone, a total of 1,184.36 hectares of land in Riau Province were burned—far exceeding the legal limits for traditional land-clearing practices. This highlights the inefficiency of current regulations and the weakness of monitoring and enforcement mechanisms on the ground. The purpose of this paper is to analyze the factors and impacts of land-burning activities in Riau Province from environmental, economic, and social perspectives.

## 2. Methods

This study employs a literature review method. The data used are sourced from the Riau Provincial Government, the Ministry of Trade, the Central Bureau of Statistics (BPS), and reputable news portals. The journal literature included in this study is limited to publications from 2013 to 2023, using keywords such as oil palm, tropical peat fire, burnt peatlands, deforestation, and governance.

## 3. Results and Discussion

### 3.1 General description

An overview of the economic-environmental framework related to oil palm plantations (OPP) in Riau Province is illustrated in Figure 1. The main resource focus is the natural resources (NR) of Riau Province—specifically oil palm trees, which are categorized as renewable resources—and the land that is cultivated by oil palm plantations as production firms. These production firms require capital ( $K$ ), which is obtained from capital stock, including the owners and shareholders, who will subsequently receive investment returns ( $I$ ) over time from the plantation operations. Individual consumers (consumption individuals) demand palm oil products from these firms ( $C$ ), and they also serve as the labor force ( $L$ ) involved in the production process.

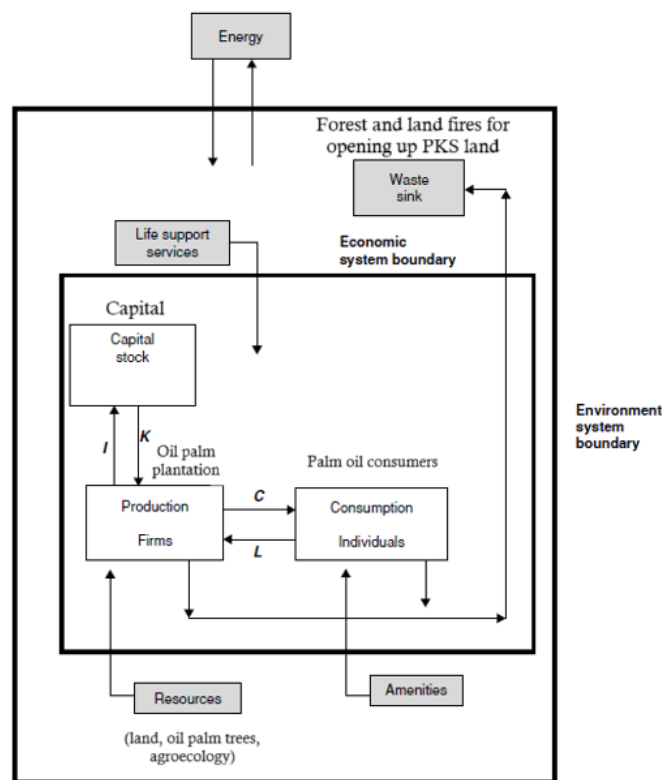


Fig. 1. Economic framework in the environment of PKS in Riau Province

Oil palm is classified as a renewable resource (Susanti & Maryudi, 2016), and the production processes of oil palm plantations (OPP) in Riau Province heavily rely on natural resources, particularly land. This extensive land use generates significant waste, especially through land-clearing activities that lead to forest and land fires (karhutla) and the resulting haze. Based on the framework illustrated in Figure 1, the life support systems provided by the natural environment play a crucial role in economic activities. These environmental services also enable technological innovation (Common & Stagl, 2005). Oil palm companies

in Riau Province can incorporate technological inputs and reduce labor reliance in land-clearing operations, thereby eliminating the need for burning and making land-clearing practices more efficient.

### 3.2 Factors and impacts of land burning for PKS land clearing

#### 3.2.1 Increasing the area of PKS, most of which are not yet ISPO or RSPO certified

Individuals involved in land clearing through burning are still frequently found in Riau Province. Most of them are ordinary community members or laborers working for large plantations who need to clear land quickly and at minimal cost. One recommendation to address this issue—while also improving community welfare—is the implementation of certification. For international trade, support for RSPO (Roundtable on Sustainable Palm Oil) certification is essential to increase the market value of palm oil, as RSPO-certified products are theoretically more appealing to potential consumers. Consequently, market pressure encourages producers, processors, and buyers to obtain RSPO certification, which requires adherence to specific sustainability standards, thereby ensuring environmental sustainability (Oliphant & Simon, 2022).

However, several countries, such as China, do not recognize RSPO as a standard. In such cases, ISPO (Indonesian Sustainable Palm Oil) certification can serve as an alternative standard for domestic trade and markets that do not require RSPO. In fact, there are still 1.8 million hectares of illegal oil palm plantations in Riau Province. Therefore, the central and provincial governments should assist in the formal licensing process and facilitate ISPO certification. Strict penalties, including license revocation and criminal sanctions, should be imposed on companies that continue to use burning methods.

In 2021, the plantation subsector contributed significantly to the Gross Regional Domestic Product (GRDP) of Riau Province, accounting for 17.02%, while the overall agricultural sector contributed 26.83%. According to Figure 2, in 2021 Riau Province exported palm oil products in the following composition: crude palm oil (CPO) 14.88%, other palm oil kernel 4.48%, crude oil of palm kernel 0.22%, and other palm oil 80.43% (BPS, 2021). According to a report from the Ministry of Home Affairs (Kemendagri, 2023), for the period of June 16–30, 2023, the reference export price (HR) of Indonesian CPO was USD 680/MT, with an export duty (BK) of USD 3/MT and an export levy (PE) of USD 65/MT. In comparison, the CPO reference export price in Malaysia was slightly lower at USD 64.65/MT.

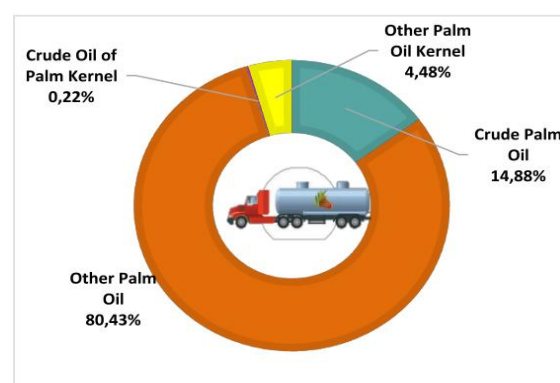


Fig. 2. Comparison of palm oil export volume by type in Riau Province in 2021

Malaysia is the second-largest palm oil producer in the world after Indonesia. According to a study by Ziaei & Ali (2021), a simulated 15% increase in Malaysia's crude palm oil (CPO) reference price (HR) would lead to an increase in foreign assets, national income, capital stock, and the input-output supply and demand of non-palm oil sectors. If the Central Government and the Riau Provincial Government were to implement a higher CPO export reference price, it could contribute to boosting the country's gross domestic

product (GDP) and overall macroeconomic performance. This recommendation regarding the increase in CPO HR is also aligned with the previous suggestion to introduce technological inputs into the production process, aiming to reduce environmental degradation caused by land-burning practices.

### 3.2.2 Illegal palm oil plantations

The arrest of individuals responsible for land burning is difficult, partly because there are 1.8 million hectares of illegal oil palm plantations (OPP) in Riau Province operating without official permits such as Plantation Business Licenses (IUP), forest area release permits, cultivation business licenses, and land use rights (HGU). These illegal operations involve approximately 190 companies and have resulted in an estimated loss of around 150 trillion rupiah in unpaid taxes to the state treasury.

Table 1 presents the foreign trade balance of Riau Province. It can be observed that both export and import figures have been increasing annually, indicating an ongoing exchange between supply and demand within the province. Indonesia's palm oil exports are still primarily in the form of crude palm oil (CPO) and 47 derivative products, whereas Malaysia is able to produce 100 derivative palm oil products (Kemendagri, 2023).

Table 1. Foreign trade balance of Riau Province 2020-2022

	Foreign trade balance (thousand USD)		
	2020	2021	2022
Export	13,810,161.14	19,963,112.16	22,483,115.77
Import	1,317,953.09	1,622,328.05	2,980,188.60
Foreign trade balance	12,492,208.05	18,340,784.11	19,502,927.17

Figure 3 presents the growth in volume and export value of palm oil from Riau Province during 2019–2021, showing a decline in volume but a continuous increase in sales value each year. In 2021, the export value of palm oil from Riau reached 11.17 billion USD. Compared to Table 1, this export value accounts for half of the total export value of Riau Province that year.

Therefore, to reduce forest and land fires caused by oil palm plantation land clearing, it is recommended that the government increase revenue by imposing commodity taxation (Common & Stagl, 2005), especially targeting companies operating illegally. The tax revenues collected can then be reinvested in restoring degraded environments.

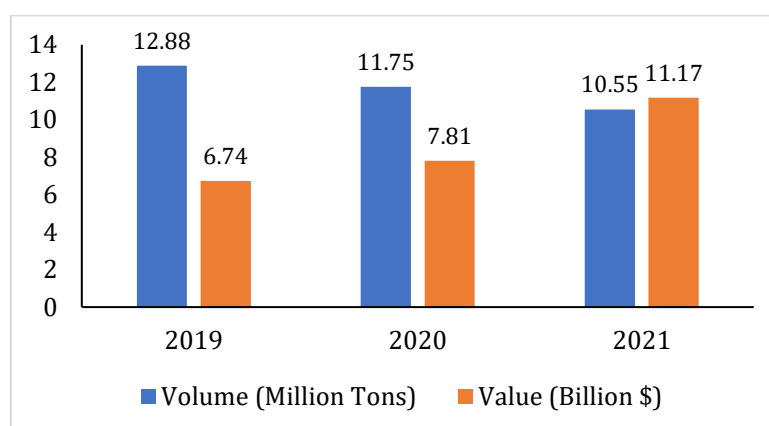


Fig. 3. Development of palm oil export volume and value 2019-2021

### 3.2.3 Regulations that still allow land clearing by burning

The Government of the Republic of Indonesia has issued several regulations related to the clearing of land for oil palm plantations (OPP). These include Law No. 39 of 2014 Article 42, which governs the operation of licensed companies, and importantly, Law No. 32 of 2009

Article 22 Paragraph 1 concerning environmental impact assessments (AMDAL). Additionally, the government has enacted regulations protecting the public from the dangers of forest and land fires, such as Article 28H Paragraph 1 of the 1945 Constitution (UUD 1945), which guarantees the right to a good and healthy environment, and Law No. 32 of 2009 concerning the preservation of environmental sustainability. Furthermore, the government prohibits deliberate land burning punishable under Article 187 of the Criminal Code (KUHP).

All of these regulations clearly address land burning and its sanctions. However, there are certain provisions that can be exploited by individuals who justify land burning. For example, Article 22, Clause 24 of the Job Creation Law (UU Cipta Kerja) No. 11 of 2020 prohibits land clearing by burning but provides an exception for local communities practicing traditional land burning, limited to a maximum of 2 hectares per family head. Similarly, the Ministry of Environment Regulation No. 10 of 2010 on preventing environmental damage related to land fires allows an exemption for customary law communities with a maximum land burning area of 2 hectares.

These two regulations create loopholes that enable individuals and corporations within the oil palm sector to clear land quickly, easily, and cheaply by burning. Therefore, the government needs to enhance supervision and enforcement in implementing these regulations effectively.

### 3.2.4 Impact

The analysis of environmental implications from land burning in Riau Province can be conducted by applying the IPAT identity. In this case, Impact (I) refers to forest and land fires (KARHUTLA) and haze, which are the results of multiplying the population (P) of local communities involved in or affected by these events, affluence (A) as the total output of oil palm plantations (OPP) per capita, and total output (T) representing palm oil production measured in monetary terms as part of the Gross Domestic Product (GDP).

Furthermore, based on the Environmental Kuznets Curve (EKC) hypothesis, illustrated in Figure 3, environmental degradation initially increases with economic development, but after reaching an economic growth equilibrium point, the rate of degradation declines, as indicated by the downward-sloping curve.

Therefore, it can be concluded that the economic growth experienced in Riau Province is likely accompanied by increased community income, which in turn enhances environmental awareness among the population. Additionally, oil palm plantation companies are assumed to allocate sufficient funds to conduct land clearing processes that remain environmentally sustainable.

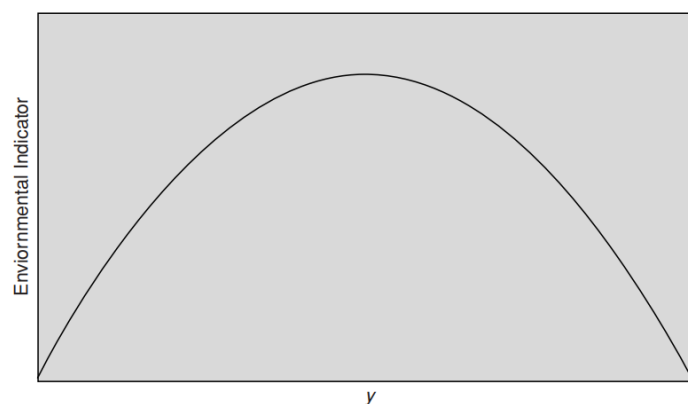


Fig. 3. EKC hypothesis relationship

The impact of forest and land burning is the occurrence of haze, which causes a decline in air quality in the affected areas. The haze from forest fires has widespread effects on

various sectors, including health, education, economy, and tourism, as well as influencing international relations between Indonesia and neighboring countries also affected by the haze.

Air quality in Riau Province has significantly deteriorated due to the haze, reaching levels that are unhealthy and hazardous for many residents. The presence of thick haze and unhealthy air quality has caused concerns among the population about going outdoors, even when staying indoors. The haze has serious health impacts on the residents of Riau Province; for example, in Pekanbaru, thousands of people have experienced acute respiratory infections (ARI) with symptoms such as productive cough, difficulty breathing, dizziness, fever, and nausea.

Palm oil is a product commonly traded in the United States, the European Union, Russia, and several developing countries such as Brazil, Egypt, and Saudi Arabia. Global demand for palm oil is predicted to multiply by 2050, reaching a total of 240 million tons, providing a strong incentive for Indonesian palm oil producers to increase production (Oliphant & Simon, 2022).

The increased volume of Indonesian CPO exports has positively impacted the economy and local communities. However, this growth also poses a threat to Indonesia, as many countries feel intimidated by Indonesian CPO and seek various ways to undermine it. Countries in the European Union have been accused of conducting a black campaign against Indonesian CPO, especially following the implementation of the Renewable Energy Directive (RED) by the European Parliament, which bans the use of palm oil from Indonesia due to allegations of frequent forest burning to clear land for palm oil plantations (Allen et al., 2021).

Although the introduction section has indicated a decline in forest and land fires (karhutla) in Riau Province, there are still individuals engaging in land burning for clearance. However, Indonesia is not alone in facing this issue. Brazil recorded 2,287 forest fires in 2022, with some entrepreneurs continuing to use burning for land clearance, despite Brazil being the tenth largest palm oil producer globally (de Moraes, 2013; Escobar, 2019). Furthermore, South Africa has experienced forest fires caused by land clearing, both by companies and the government (Strydom & Savage, 2016; Sgqolana, 2021).

The author does not justify the practice of land burning for clearance; however, most forest fires related to land clearing occur in developing countries. The main underlying factors are human resource quality and the conditions of local governments. Therefore, improving community welfare and strengthening government institutions are necessary to address these issues effectively.

#### 4. Conclusions

The economic potential of palm oil production in Riau Province can be enhanced through more sustainable management of the plantation sector, thereby minimizing negative environmental impacts. Palm oil commodities contribute significantly to the regional Gross Domestic Product (GDP) of Riau Province, and this potential can be further optimized if the export price of crude palm oil (CPO) increases. Additionally, the growth of foreign trade in Riau Province and the potential revenue from palm oil commodity taxes can serve as strategic solutions to address forest and land fire problems, while simultaneously supporting ongoing environmental recovery efforts.

Palm oil itself is a highly demanded product in the global market, with demand predicted to continuously increase year by year. This condition provides incentives for Indonesian palm oil producers to boost their production. However, the industry faces major challenges in the form of international pressure related to environmental issues, such as the European Union's ban on the use of palm oil from Indonesia, which potentially hinders exports and industry growth.

On the other hand, the Government of the Republic of Indonesia has issued various regulations governing the clearing of palm oil plantations and environmental protection, including the community's right to a healthy environment. Nonetheless, regulatory gaps



exist, such as exceptions allowing land burning by indigenous communities based on “local wisdom” principles. These gaps are often exploited by certain parties to clear land through burning, causing adverse effects on the environment and society. Therefore, it is crucial to enhance oversight and strengthen regulatory enforcement to effectively prevent such illegal practices.

Although the incidence of forest and land fires (karhutla) in Riau Province has declined, there are still individuals who burn land to clear palm oil plantations. Similar phenomena also occur in countries like Brazil and South Africa. The main contributing factors to this issue are the suboptimal quality of human resources and the weak institutional capacity of local governments. Hence, efforts to improve community welfare and strengthen government institutions are needed to better and more sustainably manage the problem of land fires.

Based on the analysis conducted, the author offers several recommendations to relevant stakeholders to ensure that efforts to stop forest and land fires (karhutla) caused by the opening of palm oil plantations (PKS) in Riau Province can be implemented effectively. These efforts require synergistic cooperation among the community, companies, and the government.

The government needs to increase taxes on palm oil commodities and improve the relative export prices to sustainably support this sector. Additionally, the government should facilitate access for smallholder plantations to obtain ISPO certification and assist in the RSPO certification process so that palm oil production can become more legal and standardized. Law enforcement must also be strengthened by revoking the business licenses of companies proven to engage in land burning and imposing sufficiently severe criminal penalties and fines as a deterrent. The government should direct policies toward downstream processing of palm oil products to reduce dependence on upstream production. Furthermore, a reevaluation of regulations regarding land clearing and burning is crucial, accompanied by strict supervision and firm implementation of rules to prevent violations.

Companies, as producers, must comply with all business licensing requirements to ensure clear legality and follow ISPO or RSPO certification to support sustainable practices. The adoption of more modern technologies is also recommended to improve efficiency in land clearing, reducing dependence on manual labor and thereby minimizing the risk of land burning. Moreover, companies should strive to enhance the welfare of surrounding communities as part of their social responsibility. Most importantly, companies are obliged to comply with all government regulations to maintain environmental sustainability and business continuity.

The community, as individual consumers who have experienced improved income and welfare, are expected to increase their awareness of the importance of environmental protection. With better understanding, the risk of land clearing by burning can be significantly reduced. Growing environmental awareness among the public will play a crucial role in supporting the success of karhutla prevention efforts and preserving the natural environment in Riau Province.

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Not available.

**Conflicts of Interest**

The authors declare no conflict of interest.

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