



Forest Depletion in Indonesia: An Environmental Economics Perspective on Sustainability and Community Welfare

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Abstract

Forest depletion in Indonesia has become a major issue due to its environmental, economic, and social impacts. This study aims to analyze the trends and main causes of forest depletion in Indonesia and examine its economic, environmental, and social consequences. This research employed a descriptive qualitative approach using a literature review method. Data were collected from scientific journals, government reports, books, and relevant academic publications obtained through Google Scholar, ResearchGate, and Garuda. The data were analyzed systematically through data reduction, classification, validation, comparative interpretation, and integration with environmental economics theory. The findings indicate that forest depletion in Indonesia is primarily caused by plantation expansion, mining activities, illegal logging, infrastructure development, and weak environmental governance. Although forest exploitation contributes to short-term economic growth, it also generates long-term environmental losses that are often excluded from conventional Gross Domestic Product (GDP) calculations. Furthermore, deforestation contributes to biodiversity loss, climate change, soil degradation, water disruption, and increased risks of natural disasters such as floods and landslides. These impacts directly affect community welfare, particularly among rural and indigenous populations that depend on forest ecosystems. This study concludes that forest depletion in Indonesia is a multidimensional issue requiring integrated and sustainable policies involving environmental conservation, economic sustainability, social inclusion, and stronger governance to support long-term ecological and community resilience.

Keywords: deforestation, environmental economics, environmental degradation, sustainable development, ecosystem sustainability, biodiversity loss, forest exploitation, environmental policy, natural resource management



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Introduction

Indonesia's forests constitute strategic natural resources that play a crucial role in sustaining ecological balance, economic development, and social welfare. Forest

ecosystems provide environmental services such as carbon sequestration, biodiversity conservation, water regulation, and climate stabilization, while simultaneously supporting the livelihoods of millions of people who

depend on forest resources. However, rapid exploitation of forest resources over recent decades has triggered severe environmental degradation and forest depletion in various regions of Indonesia [1]. Forest depletion refers to the decline in the quantity and quality of forest resources due to excessive utilization that is not accompanied by adequate conservation and restoration efforts [2]. This issue has become increasingly significant because it not only threatens ecological sustainability but also generates substantial economic and social consequences.

Indonesia has experienced one of the highest rates of tropical deforestation in the world. A study published in *Nature Climate Change* reported that Indonesia lost approximately 6.02 million hectares of primary forest between 2000 and 2012 [3]. This phenomenon has been driven by various factors, including logging activities, mining expansion, land conversion for plantations and agriculture, infrastructure development, and weak environmental governance. The increasing rate of deforestation indicates an imbalance between economic exploitation and environmental conservation [4]. Although forest exploitation contributes to economic growth through employment opportunities, industrial expansion, and state revenue generation, such benefits are often short-term in nature and accompanied by long-term environmental losses [5].

The environmental impacts of deforestation include biodiversity loss, soil degradation, ecosystem destruction, water pollution, and increased vulnerability to natural disasters such as floods, landslides, and droughts. In addition, deforestation contributes significantly to greenhouse gas emissions and

climate change, which further threaten sustainable development. Beyond ecological damage, forest depletion also affects the social and economic conditions of local communities, particularly those whose livelihoods depend directly on forest ecosystems. Changes in land use and environmental degradation often result in declining agricultural productivity, loss of traditional livelihoods, and reduced quality of life in rural areas [6].

From an economic perspective, one of the major challenges in addressing forest depletion lies in the limitations of conventional economic indicators. Gross Domestic Product (GDP), which is commonly used to measure economic performance, often fails to incorporate environmental degradation and natural resource depletion into its calculations. Consequently, economic growth generated through forest exploitation may appear beneficial in statistical terms, despite causing substantial environmental losses. Research conducted by Li et al. [7] emphasized the importance of environmental GDP calculations that account for forest depletion and degradation as economic losses. Such an approach provides a more accurate representation of national economic conditions and supports the formulation of sustainable development policies.

Previous studies have examined the relationship between deforestation, economic growth, and environmental degradation from different perspectives. King et al [8] highlighted the dual impact of forest exploitation, showing that forestry activities may stimulate economic activity in the short term while simultaneously accelerating environmental degradation and climate change. Meanwhile, Caravaggio [2] focused on the integration of environmental

values into GDP calculations using an environmental economics approach. In contrast, Wilwatikta [9] analyzed the environmental and social impacts of natural resource exploration in tropical forest areas of Kalimantan, particularly in relation to mining activities and land conversion.

Although previous studies provide valuable insights, most existing research remains fragmented and sectoral in nature. Some studies focus primarily on quantitative economic calculations, while others emphasize environmental impacts or specific regional case studies [10]. As a result, there is still limited research that comprehensively integrates economic, environmental, and social dimensions into a unified analytical framework. This condition creates an important research gap because the complexity of forest depletion cannot be adequately understood through isolated perspectives alone [11]. A more integrative approach is needed to explain the interconnected relationship between economic development, environmental sustainability, and community welfare.

Therefore, this study aims to provide a comprehensive analysis of the economic and environmental impacts of forest depletion in Indonesia by integrating empirical evidence, environmental economic analysis, and social perspectives within a single framework [12]. The novelty of this research lies in its integrative approach that combines macroeconomic analysis, environmental impact assessment, and empirical community-based perspectives to provide a more holistic understanding of deforestation issues in Indonesia. In addition, this study emphasizes the importance of incorporating environmental losses into economic development analysis to

support sustainable forest management policies.

The research addresses three main questions: (1) What are the trends and primary causes of deforestation in Indonesia; (2) What are the economic and environmental impacts of deforestation on Indonesian society; and (3) What policies and strategic solutions have been implemented by the government to address forest depletion. Accordingly, this study aims to analyze deforestation trends and their driving factors, evaluate the economic and environmental impacts of forest depletion, and examine government policies related to forest conservation and sustainable resource management.

This study is grounded in environmental economics theory, which explains that economic activities involving excessive exploitation of natural resources generate negative externalities in the form of environmental degradation [13]. According to this perspective, environmental costs are often excluded from conventional economic calculations, resulting in market failures and unsustainable resource utilization. In the context of Indonesia, forest exploitation may provide short-term economic benefits; however, it simultaneously creates long-term ecological and social costs that threaten sustainable development [14]. Therefore, sustainable forest management requires a balance between economic utilization and environmental conservation in order to ensure intergenerational equity and ecological sustainability [15].

Overall, this study is expected to contribute both theoretically and practically to the discourse on sustainable forest management in Indonesia. Theoretically, this research enriches

the literature on environmental economics and sustainable development through an integrated analytical framework. Practically, the findings are expected to provide recommendations for policymakers in formulating more effective and sustainable forest management strategies that consider economic, environmental, and social dimensions simultaneously.

Method

This study employed a descriptive qualitative approach to analyze the economic and environmental impacts of forest depletion in Indonesia. Qualitative research is intended to generate descriptive data in the form of written or spoken information that enables researchers to understand social and environmental phenomena comprehensively [16]. The qualitative approach was considered appropriate because this study focused on interpreting and synthesizing various scientific findings related to deforestation, environmental degradation, and their economic implications within the Indonesian context.

The research method used in this study was a literature review. This method was conducted by systematically collecting, reviewing, and analyzing scientific literature relevant to the research topic. The study focused on examining the trends, causes, and impacts of forest depletion in Indonesia during the period from the 2000s to the 2010s, while also considering recent scientific publications to ensure the relevance and contextual accuracy of the analysis.

The data sources used in this research consisted of primary and secondary data. Primary data referred to scientific journal articles directly related to forest depletion, deforestation, environmental economics, and

sustainable forest management. Secondary data included supporting references such as academic books, government reports, policy documents, statistical reports, and other relevant scientific publications. Data collection was conducted through digital literature searches using several academic databases and scientific platforms, including Google Scholar, ResearchGate, Garuda, and other national and international journal portals. The search process employed keywords such as “forest depletion,” “deforestation in Indonesia,” “environmental economics,” “forest degradation,” and “impacts of forest exploitation.”

To ensure the quality and relevance of the reviewed literature, the selection criteria for scientific articles included: (1) publications related to the economic and environmental impacts of deforestation in Indonesia; (2) articles published in scientific journals between 2020 and 2025; (3) studies containing empirical findings or conceptual discussions relevant to environmental sustainability and forest resource management; and (4) articles with clear methodological explanations and credible academic sources. Additional supporting data were obtained from official government publications and environmental reports to strengthen the validity of the analysis. The overall research procedure and stages of analysis conducted in this study are presented in Figure 1.

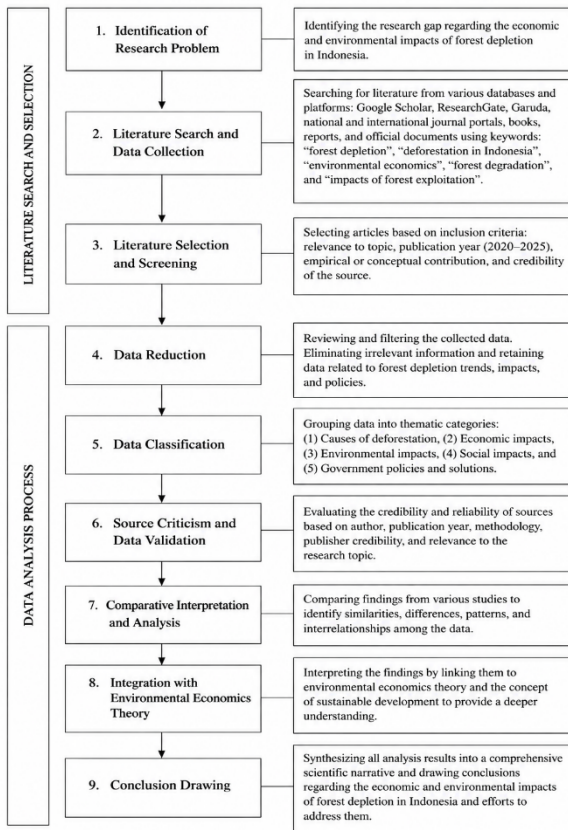


Figure 1. Research Flow of the Study

The data analysis process was conducted systematically through several stages. The first stage was the identification of the research problem, which focused on recognizing the research gap related to the economic and environmental impacts of forest depletion in Indonesia. The second stage involved literature search and data collection through various academic databases and scientific platforms. Subsequently, literature selection and screening were conducted based on inclusion criteria such as topic relevance, publication year, empirical contribution, and source credibility.

The next stage was data reduction, in which the collected literature and information were reviewed and filtered according to the research objectives. At this stage, irrelevant data and information unrelated to forest depletion trends,

environmental impacts, economic consequences, and government policies were excluded from the analysis. The selected data were then classified into several thematic categories, including the causes of deforestation, economic impacts, environmental impacts, social consequences, and government policies and solutions. This classification facilitated a more structured and comprehensive analysis of the relationships among the identified variables and findings.

Furthermore, source criticism and data validation were conducted to evaluate the credibility and reliability of the selected references. This evaluation considered several aspects, including the author's academic background, publication year, research methodology, publisher credibility, and relevance to the research topic. This process ensured that the data and references used in the study were scientifically valid and trustworthy.

The subsequent stage involved comparative interpretation and analysis. At this stage, the researcher compared findings from various previous studies to identify similarities, differences, patterns, and interrelationships among the reviewed literature. Comparative analysis was conducted to understand how deforestation and forest exploitation influence environmental conditions, economic sustainability, and community welfare in Indonesia.

To strengthen the analytical framework, the findings were interpreted using environmental economics theory and sustainable development concepts. This theoretical integration enabled a deeper understanding of the relationship between economic activities, environmental degradation, and sustainability issues associated with forest resource management.

The final stage involved drawing conclusions and synthesizing the research findings into a coherent scientific narrative. Conclusions were formulated based on the overall interpretation and analysis of the reviewed literature. Through this process, the study provides a comprehensive understanding of the economic and environmental impacts of forest depletion in Indonesia, as well as the effectiveness of policies and strategies implemented to address deforestation and promote sustainable forest management.

Result and Discussion

Based on the results and analysis conducted in this study, several major findings were identified regarding the trends, impacts, and policy responses related to forest depletion in Indonesia. The discussion demonstrates that deforestation is not merely an environmental issue, but also a multidimensional problem closely linked to economic development, social welfare, and sustainable resource management. Furthermore, the findings indicate that the impacts of forest depletion extend beyond ecological degradation and directly affect the economic resilience and quality of life of communities dependent on forest ecosystems. In this context, the study highlights three main points of discussion as follows:

a. Trends and Main Causes of Forest Depletion in Indonesia

Forest depletion in Indonesia remains one of the most critical environmental and socio-economic issues in Southeast Asia. Indonesia possesses one of the largest tropical forest areas in the world, functioning not only as a biodiversity hotspot but also as an important global carbon sink [8]. However, over the past

several decades, forest ecosystems in Indonesia have experienced severe degradation due to extensive exploitation of natural resources, land conversion, and weak environmental governance. The issue of forest depletion is closely associated with the increasing rate of deforestation, which reflects the imbalance between economic development and environmental sustainability [17].

Historically, forest management practices in Indonesia have been highly extractive since the colonial era. Forests were primarily viewed as economic commodities capable of generating state revenue through timber extraction and plantation development without sufficient consideration for ecological sustainability [18]. After independence, the pressure on forest areas intensified due to rapid industrialization, expansion of agricultural land, mining development, and infrastructure projects. These activities significantly accelerated deforestation across several major regions, including Kalimantan, Sumatra, Papua, and Sulawesi [19].

Recent data indicate that Indonesia experienced fluctuating but generally high deforestation rates during the early 2000s. The deforestation rate reached its peak in 2015 at approximately 1.09 million hectares before gradually declining due to various policy interventions implemented by the government [20]. The reduction in deforestation rates after 2016 demonstrates that policy measures such as the moratorium on new forest permits, forest rehabilitation programs, and stricter law enforcement have contributed positively to forest conservation efforts. Nevertheless, forest depletion continues to occur because economic pressures and land-use demands remain

extremely high, particularly in regions rich in natural resources.

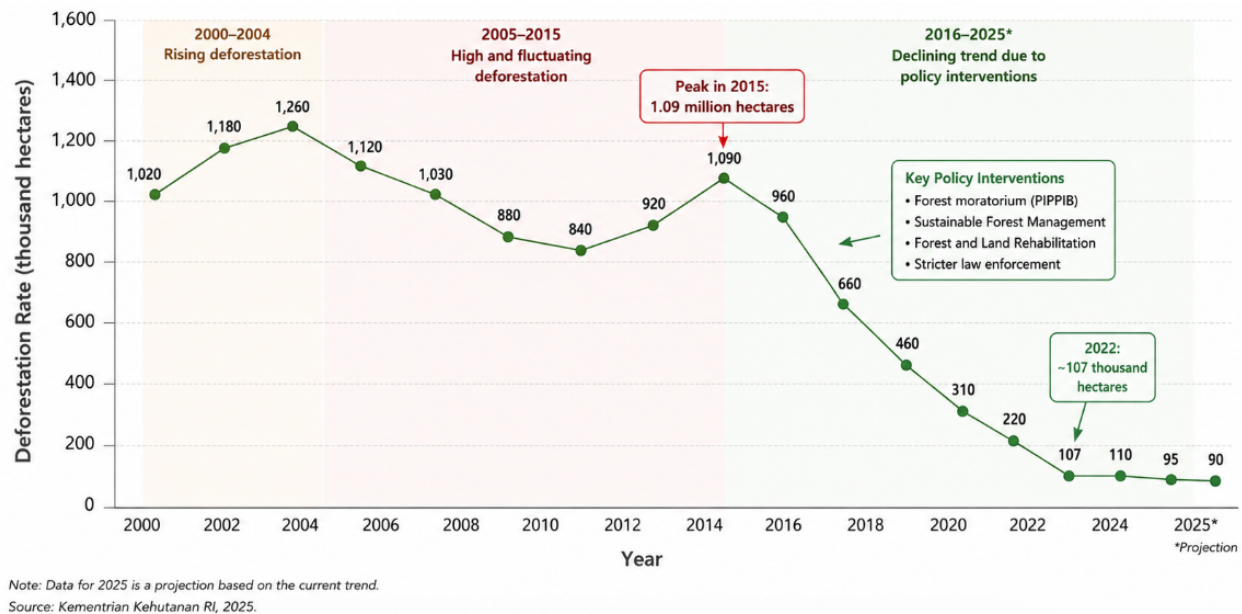


Figure 2. Deforestation Trends in Indonesia (2000–2025)

Figure 2 illustrates the trend of deforestation rates in Indonesia over the last two decades. The graph demonstrates a substantial increase in forest loss during the early 2000s, followed by fluctuating rates that culminated in a significant peak in 2015. This condition reflects the strong influence of plantation expansion, mining activities, and large-scale land conversion during that period. Following the implementation of stricter environmental policies and forest management reforms after 2016, the deforestation rate gradually declined. The graph also indicates that policy interventions, such as forest moratorium programs and sustainable forest management initiatives, played an important role in reducing forest loss. However, despite the positive trend, the graph suggests that deforestation has not been completely eliminated. Continued pressure from economic development, infrastructure expansion, and

investment activities still threatens forest sustainability. Therefore, the figure highlights the importance of maintaining long-term environmental governance and strengthening sustainable development policies in Indonesia.

One of the primary drivers of forest depletion in Indonesia is the rapid expansion of oil palm plantations. The palm oil industry has become one of the country's most significant economic sectors due to its contribution to exports and employment generation [21]. However, the expansion of plantations has often occurred through the conversion of tropical forests into agricultural land. Between 1990 and 2010, the area of oil palm plantations increased dramatically from 1.1 million hectares to approximately 7.8 million hectares (Susanto, 2024). This expansion has contributed substantially to forest loss, particularly in Kalimantan and Sumatra, where large-scale plantation investments dominate land use.

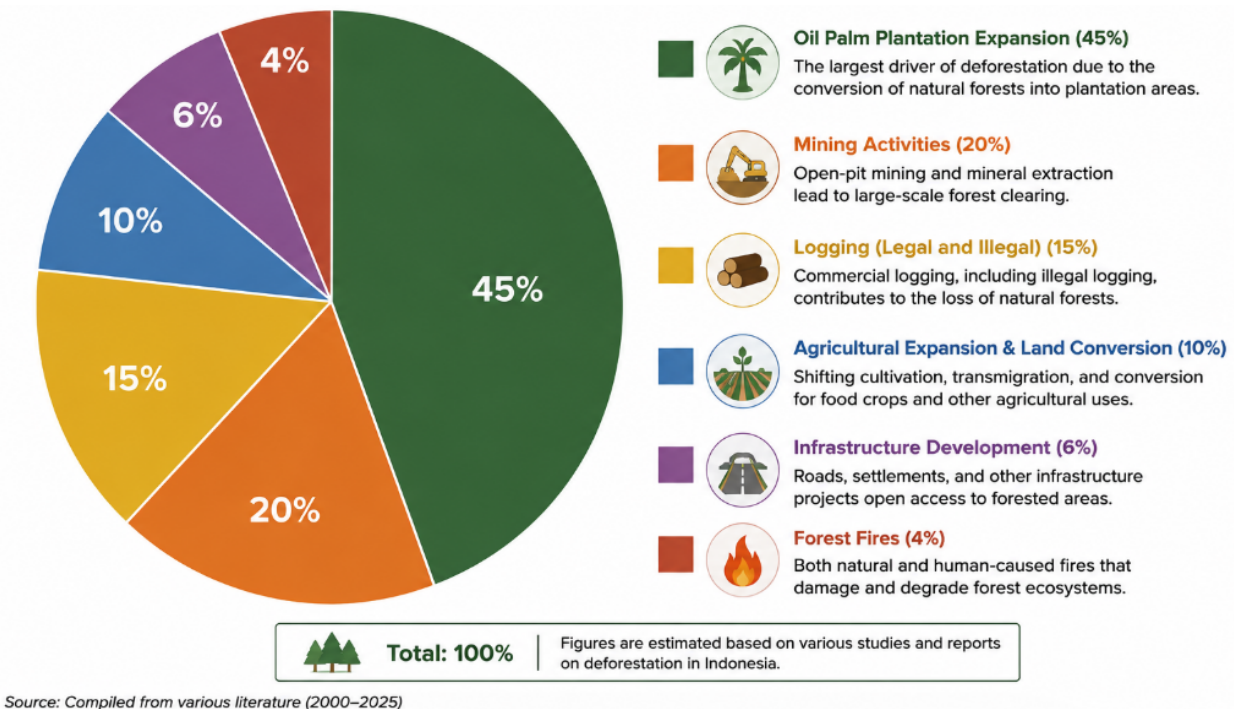


Figure 3. Main Causes of Forest Depletion in Indonesia

Figure 3 presents the major factors contributing to forest depletion in Indonesia. The illustration shows that oil palm plantation expansion represents the largest driver of deforestation, followed by mining activities, legal and illegal logging, agricultural expansion, infrastructure development, and forest fires. The dominance of plantation expansion indicates the strong relationship between economic growth and environmental degradation in Indonesia. Meanwhile, illegal logging and mining activities continue to exacerbate ecosystem destruction due to weak law enforcement and inadequate monitoring systems. The figure also highlights how infrastructure development indirectly accelerates forest degradation by opening access to previously protected forest areas. In addition, forest fires, particularly in peatland areas, contribute significantly to forest destruction and carbon emissions. Overall, the

illustration demonstrates that forest depletion in Indonesia is not caused by a single factor but rather by interconnected structural and economic pressures that collectively intensify environmental degradation.

In addition to plantation expansion, illegal logging remains another major contributor to forest depletion. Weak supervision and inconsistent law enforcement have enabled illegal timber extraction to continue in several forest regions, including protected conservation areas [22]. Illegal logging not only reduces forest cover but also disrupts ecosystem balance and accelerates biodiversity loss. Indonesia is recognized as one of the countries with the highest levels of biodiversity and species endemism in the world. Consequently, forest destruction directly threatens the survival of endemic flora and fauna species that cannot easily adapt to habitat loss.

Table 1. Major Drivers of Forest Depletion in Indonesia and Their Impacts

Main Driver	Main Activity	Environmental Impact	Economic and Social Consequence
Oil Palm Plantation Expansion	Conversion of tropical forests into plantation areas	Deforestation, biodiversity loss, ecosystem fragmentation	Increased export revenue and employment opportunities, but reduced ecological sustainability
Mining Activities	Open-pit mining and mineral extraction in forest regions	Soil degradation, water pollution, forest destruction	Short-term economic growth accompanied by environmental restoration costs
Illegal and Legal Logging	Commercial timber extraction and illegal logging operations	Habitat destruction, loss of endemic species, carbon emissions	Timber industry income increases, but long-term ecosystem services decline
Agricultural Expansion and Land Conversion	Expansion of farming areas and settlement development	Forest cover reduction, soil erosion, decreased water absorption	Increased food production and land availability, but rising flood and drought risks
Infrastructure Development	Construction of roads, industrial zones, and settlements	Forest fragmentation and increased access to protected forests	Improved regional connectivity, but accelerated land-use change
Forest Fires	Human-induced and natural forest burning	Air pollution, peatland destruction, greenhouse gas emissions	Economic losses from disasters, health impacts, and ecosystem damage

Table 1 provides a comparative overview of the main drivers of forest depletion in Indonesia and their environmental, economic, and social impacts. The table demonstrates that each driver of deforestation generates both short-term economic benefits and long-term environmental consequences. For example, plantation expansion and mining activities contribute to employment opportunities and export revenues but simultaneously result in biodiversity loss, soil degradation, and ecosystem fragmentation. Similarly, infrastructure development improves regional connectivity and economic growth while accelerating land-use change and forest fragmentation [23]. The table also highlights that illegal logging and forest fires generate severe ecological damage that ultimately affects community welfare and environmental sustainability. Through this comparison, it becomes evident that economic development strategies relying heavily on natural resource

exploitation often neglect the ecological costs associated with forest degradation [24]. Therefore, a balance between economic interests and environmental sustainability is essential for ensuring long-term development.

Another structural factor contributing to forest depletion is weak environmental governance and low public awareness regarding ecosystem sustainability. Overlapping regulations, inconsistent environmental policies, and limited institutional coordination frequently hinder effective forest management [25]. Furthermore, local communities and private sector actors often prioritize short-term economic gains over environmental conservation because of limited awareness regarding the long-term ecological value of forests. Economic inequality and poverty in forest-adjacent communities also increase dependence on forest exploitation activities, thereby intensifying deforestation pressures [26].

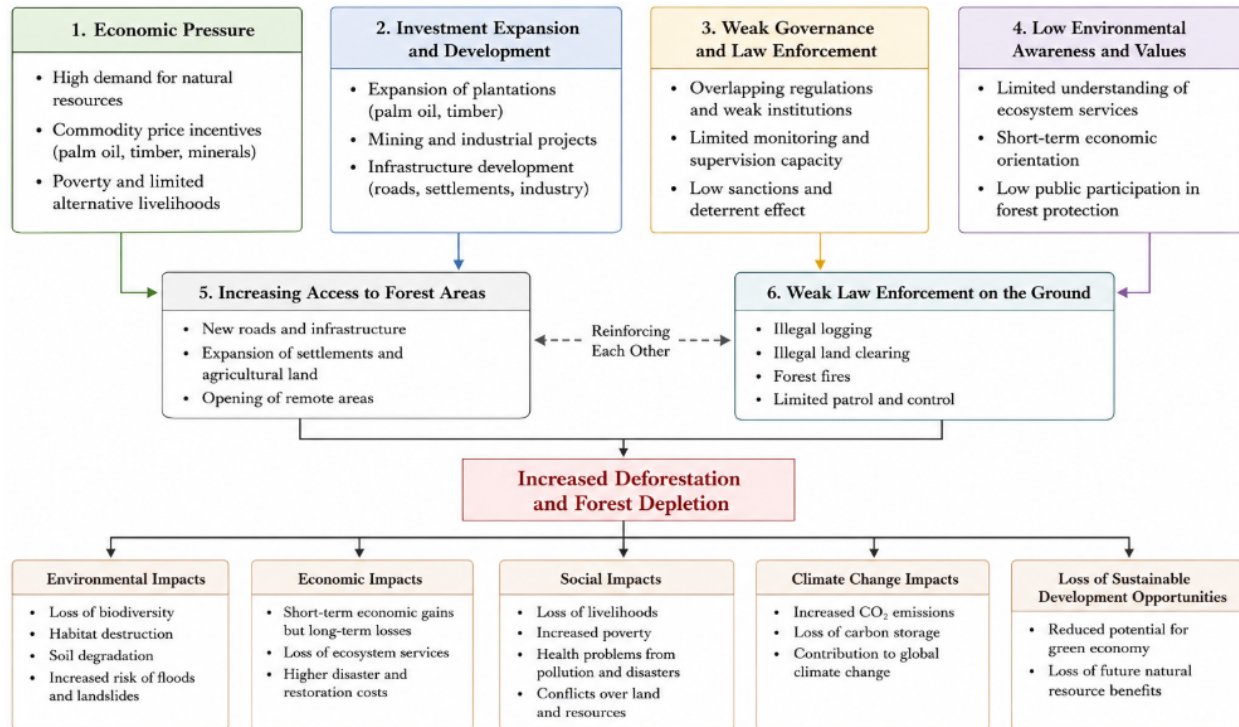


Figure 4. Structural Factors Causing Forest Depletion in Indonesia

Figure 4 illustrates the interconnected structural factors contributing to forest depletion in Indonesia. The diagram shows that economic pressure, investment expansion, weak governance, and low environmental awareness collectively reinforce one another and lead to increased deforestation. The illustration also demonstrates how infrastructure development and weak law enforcement facilitate illegal logging, land conversion, and forest fires. These interconnected factors ultimately generate environmental, economic, and social impacts, including biodiversity loss, climate change, poverty, and ecosystem degradation. The figure emphasizes that forest depletion in Indonesia is a multidimensional issue that cannot be addressed solely through regulatory policies. Instead, integrated approaches involving environmental governance reform, community participation, sustainable economic

transformation, and stronger institutional coordination are required [27]. The diagram further highlights the importance of balancing economic development with ecosystem conservation to achieve long-term sustainability.

Overall, the trend and causes of forest depletion in Indonesia indicate that deforestation is driven by complex interactions among economic, political, institutional, and social factors. Although recent policy interventions have successfully reduced deforestation rates, sustainable forest management remains a major challenge due to ongoing development pressures and weak environmental governance. Therefore, comprehensive and multidisciplinary approaches are necessary to ensure that economic growth does not occur at the expense of ecological sustainability and community well-being [28].

b. The Impact of Deforestation on the Economic and Environmental Conditions of Indonesian Communities

Deforestation in Indonesia has generated complex economic and environmental consequences that directly affect the sustainability of ecosystems and the welfare of communities. Forest exploitation has long been considered an important driver of economic growth because it contributes to employment opportunities, export revenues, and industrial development through the utilization of timber, mining resources, and plantation commodities [29]. However, the economic benefits generated from forest exploitation are generally short-term in nature and are often accompanied by substantial environmental degradation and long-term socio-economic losses. This condition reflects the imbalance between economic development and environmental

sustainability in Indonesia's forest resource management system.

From an economic perspective, the forestry sector contributes significantly to regional and national income. Logging industries, plantation expansion, and mining activities create employment opportunities and stimulate local economic activity. Nevertheless, conventional economic calculations frequently fail to incorporate the environmental costs caused by deforestation and forest degradation. As emphasized in environmental economics theory, environmental damage should be considered a form of economic loss because it reduces the value of ecosystem services and natural capital [30]. Consequently, economic growth resulting from forest exploitation may appear positive in conventional Gross Domestic Product (GDP) statistics, while in reality the country experiences substantial ecological and economic losses.

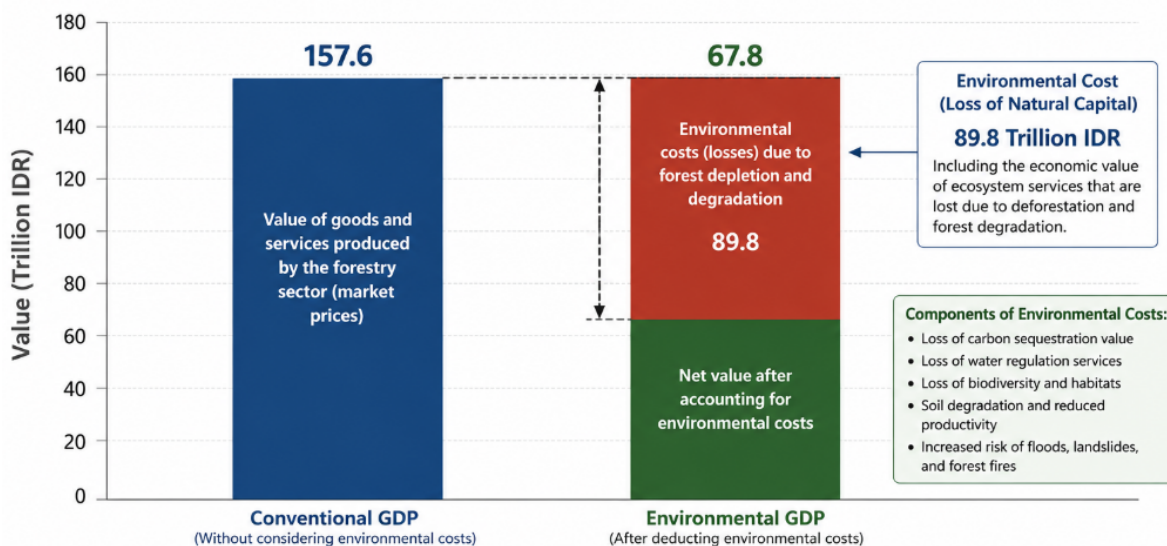


Figure 5. Conventional GDP vs Environmental GDP in the Forestry Sector

Source: Badan dan Data Informasi (2022), Ministry of Environment and Forestry (KLHK, 2022)

Figure 5 illustrates the comparison between conventional GDP and environmental GDP within Indonesia's forestry sector. The

illustration demonstrates that conventional GDP calculations tend to overestimate the actual contribution of the forestry sector

because environmental degradation costs are excluded from the analysis. After incorporating environmental costs such as biodiversity loss, carbon emissions, soil degradation, and ecosystem destruction, the net economic contribution of the forestry sector decreases significantly. This finding supports the argument that economic development based solely on resource exploitation is unsustainable in the long term. The figure also highlights the importance of integrating environmental accounting into national economic measurement systems. By considering environmental losses as part of economic calculations, policymakers can formulate more accurate and sustainable development strategies. Furthermore, the illustration reinforces the concept that forests should not only be viewed

as sources of raw materials but also as providers of valuable ecosystem services that support economic and social stability [31].

Forest ecosystems provide a wide range of ecological services that possess significant economic value. These ecosystem services include carbon sequestration, water regulation, biodiversity conservation, soil protection, and disaster mitigation [32]. However, these environmental functions are rarely included in conventional economic calculations. As a result, deforestation often creates hidden economic losses that become visible only after environmental disasters occur. Floods, landslides, droughts, and declining agricultural productivity are examples of indirect economic consequences caused by ecosystem degradation.

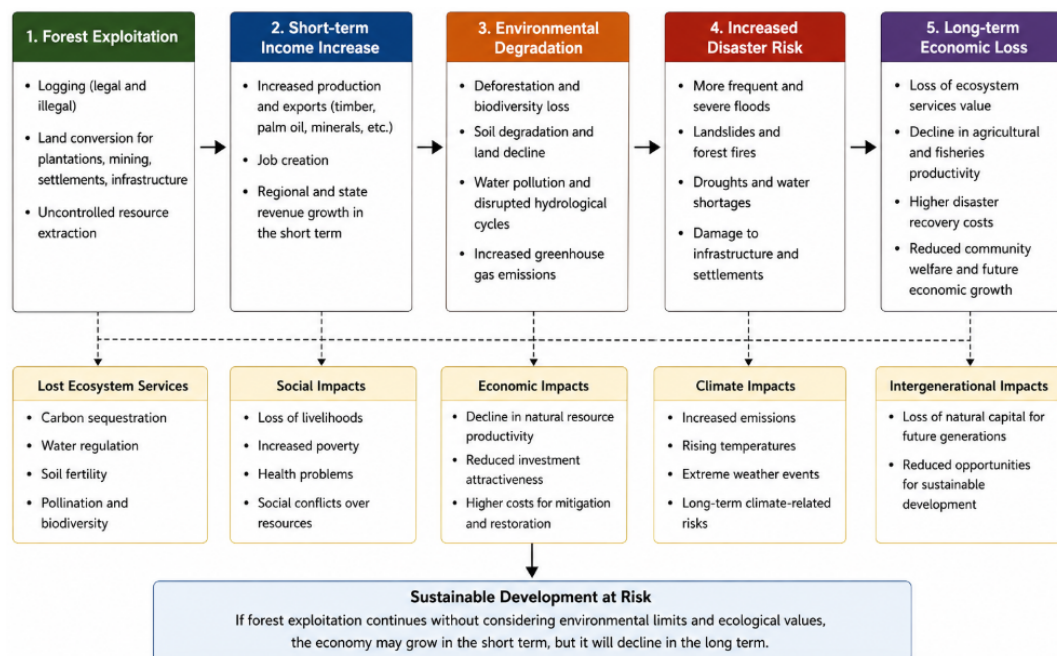


Figure 6. Economic Chain of Forest Exploitation

Figure 6 explains the relationship between forest exploitation and its long-term economic consequences. The diagram demonstrates that forest exploitation initially generates economic

benefits through increased production, employment, and export revenues. However, continuous exploitation eventually causes environmental degradation, including

deforestation, biodiversity loss, and ecosystem instability. These environmental changes subsequently increase disaster risks and reduce ecosystem productivity, which in turn generate larger economic losses in the future [33]. The figure also illustrates that the economic impacts of environmental degradation extend beyond ecological damage and directly influence social welfare, infrastructure resilience, and long-term development opportunities. Through this flow analysis, it becomes evident that short-term economic gains obtained from forest exploitation are often outweighed by the long-term costs associated with environmental destruction. Therefore, sustainable forest management is necessary to ensure that economic development remains environmentally and socially sustainable.

Environmental degradation caused by deforestation also affects the livelihoods of local communities, especially those living near forest areas. Communities that depend on forest resources for agriculture, fisheries, water supply, and traditional economic activities experience declining productivity due to soil degradation and ecosystem disruption [34]. Forest destruction also increases the vulnerability of rural populations to natural disasters, thereby worsening poverty and socio-economic inequality. Studies conducted in Papua and Kalimantan show that deforestation contributes directly to increased flood frequency, water scarcity, and reduced agricultural yields, all of which negatively impact community welfare [35].

Table 2. Economic Value of Forest Ecosystem Services and the Impacts of Deforestation

Ecosystem Service	Main Ecological Function	Economic Value and Contribution	Impact of Forest Depletion
Carbon Sequestration	Absorbing and storing atmospheric carbon	Reduces greenhouse gas emissions and supports climate stability	Increased CO ₂ emissions and acceleration of climate change
Water Regulation	Maintaining hydrological cycles and water availability	Supports agriculture, fisheries, and clean water supply	Increased floods, droughts, and water scarcity
Biodiversity Conservation	Preserving flora, fauna, and ecosystem balance	Supports ecotourism, scientific research, and medicinal resources	Loss of endemic species and ecosystem instability
Soil Protection and Fertility	Preventing erosion and maintaining soil quality	Enhances agricultural productivity and food security	Soil degradation and declining agricultural yields
Natural Disaster Prevention	Reducing risks of floods and landslides	Minimizes disaster recovery and infrastructure repair costs	Higher disaster frequency and economic losses
Forest Resources and Livelihoods	Providing timber and non-timber forest products	Supports local income and employment opportunities	Loss of traditional livelihoods and increased rural poverty

Table 2 presents the major ecosystem services provided by forests and the economic consequences associated with forest depletion. The table demonstrates that forests perform critical ecological functions such as carbon absorption, hydrological regulation,

biodiversity conservation, and soil protection. These ecosystem services support various economic sectors, including agriculture, fisheries, tourism, and public health. However, deforestation significantly reduces the effectiveness of these ecological services,

thereby increasing environmental and economic vulnerability. For instance, the loss of forest cover contributes to rising greenhouse gas emissions, reduced water availability, declining soil fertility, and more frequent natural disasters. The table also indicates that forest degradation directly affects local livelihoods because many rural communities rely on forest ecosystems for subsistence and economic activities. Consequently, preserving forest ecosystems is not only an environmental necessity but also an important strategy for maintaining long-term economic resilience and social stability [36].

On a broader environmental scale, deforestation contributes significantly to global

climate change. Forest destruction releases large quantities of stored carbon into the atmosphere, thereby increasing greenhouse gas emissions [37]. Indonesia, which possesses extensive tropical forests and peatlands, is particularly vulnerable to climate-related environmental changes resulting from deforestation. Increased temperatures, shifting rainfall patterns, and prolonged droughts have become more frequent in several regions affected by forest degradation [38]. Furthermore, biodiversity loss resulting from habitat destruction threatens the survival of endemic species and weakens ecosystem resilience.

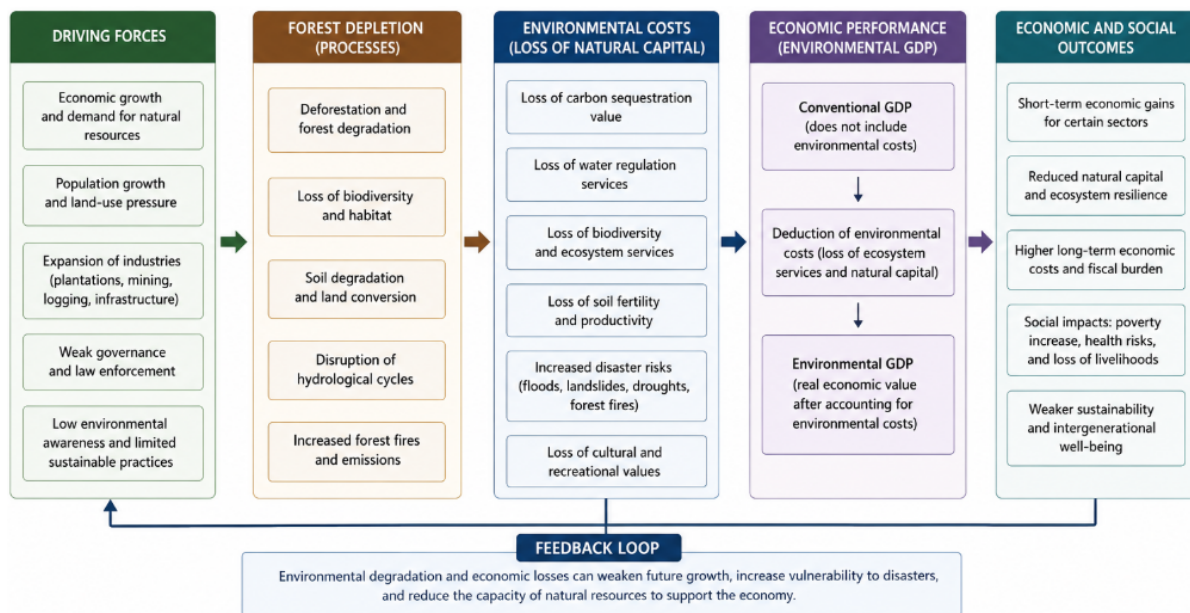


Figure 7. Conceptual Framework: Forest Depletion, Environmental Costs, and Economic Performance

Figure 7 presents a conceptual framework explaining the relationship between forest depletion, environmental costs, and economic performance. The framework demonstrates that economic growth driven by forest exploitation often ignores the ecological costs associated with environmental degradation. The diagram

illustrates how deforestation leads to biodiversity loss, ecosystem disruption, increased disaster risks, and declining natural resource productivity. These environmental impacts subsequently reduce long-term economic performance and increase social vulnerability [39]. The framework also

emphasizes the importance of environmental GDP as an alternative indicator capable of reflecting the real economic value after accounting for environmental losses. Additionally, the figure highlights the interconnected relationship between environmental sustainability and economic resilience. Ignoring environmental costs in development planning may create temporary economic gains, but it ultimately undermines future development opportunities and intergenerational welfare [40]. Therefore, the framework reinforces the need for sustainable development policies that integrate economic growth, environmental conservation, and social equity simultaneously.

Overall, the findings indicate that deforestation in Indonesia creates multidimensional impacts involving environmental degradation, economic instability, and declining community welfare. Although forest exploitation may stimulate short-term economic growth, the long-term environmental and economic costs are substantially greater. Therefore, sustainable forest management and environmental accounting are essential for ensuring that economic development does not compromise ecosystem sustainability and social well-being [41].

c. Environmental Degradation and Social Consequences of Deforestation

Deforestation in Indonesia has generated severe environmental degradation and extensive social consequences that threaten both ecological sustainability and community well-being. Forest ecosystems function as critical environmental regulators by maintaining biodiversity, stabilizing climate

systems, regulating hydrological cycles, and supporting the livelihoods of millions of people living in and around forest areas [42]. However, large-scale forest conversion caused by plantation expansion, illegal logging, mining activities, and infrastructure development has significantly reduced the ecological capacity of forests to provide these essential ecosystem services. As a result, environmental degradation resulting from deforestation has increasingly affected social, economic, and cultural conditions across various regions in Indonesia.

One of the most visible environmental impacts of deforestation is biodiversity loss. Indonesia is recognized as one of the world's megabiodiversity countries, hosting thousands of endemic plant and animal species distributed across tropical forest ecosystems in Sumatra, Papua, Kalimantan, and Wallacea [43]. Forest destruction and habitat fragmentation directly threaten the survival of these endemic species because many organisms depend on stable forest ecosystems for food, shelter, and reproduction. Research conducted in the Wallacea region indicates that forest conversion between 2015 and 2022 caused a substantial decline in biodiversity and ecological services due to habitat destruction and ecosystem fragmentation [44]. The loss of biodiversity not only weakens ecological balance but also reduces the potential for scientific research, ecotourism, and natural resource sustainability.

Another significant environmental consequence of deforestation is the disruption of hydrological systems. Forest ecosystems play an essential role in regulating water cycles, maintaining groundwater reserves, and reducing surface runoff. The loss of forest cover decreases water infiltration capacity, resulting in increased flooding during rainy seasons and

prolonged droughts during dry periods [45]. Several regions in Indonesia, including Kalimantan, Papua, and Sumatra, have experienced more frequent floods and landslides due to large-scale land conversion and forest degradation. In addition, water pollution caused by mining activities and soil

erosion further reduces water quality and threatens public health. Communities living in forest-adjacent areas often experience clean water shortages and declining agricultural productivity because of disrupted environmental systems.

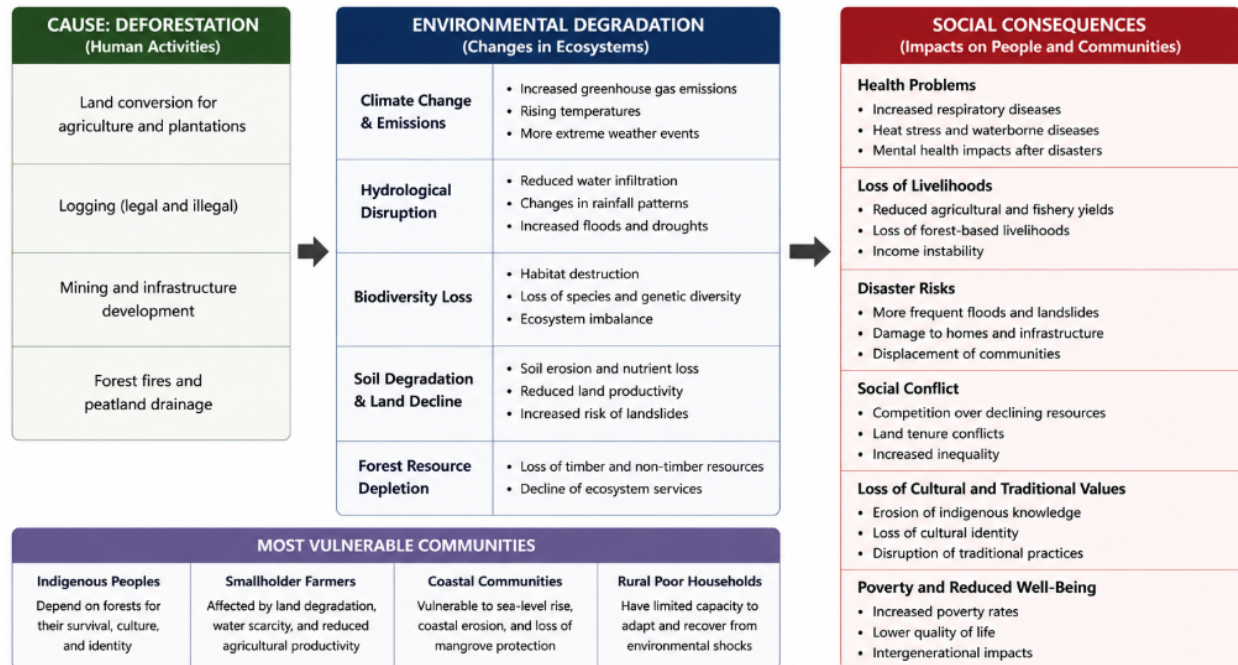


Figure 8. Environmental Degradation and Social Consequences of Deforestation

Figure 8 illustrates the causal relationship between deforestation, environmental degradation, and social consequences experienced by communities. The diagram demonstrates that deforestation caused by plantation expansion, logging, mining, and forest fires leads to climate instability, biodiversity loss, hydrological disruption, and declining land productivity. These environmental changes subsequently create various social problems, including health issues, loss of livelihoods, social conflict, poverty, and declining community welfare. The figure also highlights that vulnerable groups such as indigenous communities, smallholder farmers,

and rural populations are disproportionately affected by environmental degradation because they depend directly on forest ecosystems for their livelihoods and cultural identity. Through this framework, it becomes evident that deforestation is not merely an ecological issue but also a social justice issue that influences economic stability, public health, and long-term human development [31]. Therefore, forest conservation is essential not only for ecosystem protection but also for maintaining social resilience and sustainable livelihoods.

Deforestation also contributes significantly to climate change through increased greenhouse gas emissions. Tropical forests

function as major carbon sinks that absorb and store atmospheric carbon dioxide. However, when forests are cleared or burned, large amounts of stored carbon are released into the atmosphere, accelerating global warming and climate instability [20]. Indonesia has frequently experienced peatland and forest fires, particularly in Sumatra and Kalimantan, which

contribute substantially to regional haze pollution and greenhouse gas emissions. Climate change resulting from deforestation has intensified extreme weather events, rising temperatures, and environmental uncertainty, thereby affecting agricultural production and food security in many rural regions.

Table 3. Environmental Degradation and Social Consequences of Deforestation in Indonesia

Dimension	Environmental Impacts	Social Consequences	Economic Consequences
Climate and Atmosphere	Increased greenhouse gas emissions, rising temperatures, and climate instability	Increased respiratory diseases, heat stress, and reduced quality of life	Higher adaptation and mitigation costs, reduced labor productivity
Hydrology and Water Resources	Reduced water infiltration, disrupted hydrological cycles, and declining water quality	Water scarcity, conflicts over water resources, and declining public health	Increased water treatment costs and reduced agricultural productivity
Soil and Land Productivity	Soil erosion, nutrient depletion, and declining land fertility	Reduced agricultural yields and food insecurity	Lower farmer income and higher land restoration costs
Biodiversity and Ecosystems	Habitat destruction, species extinction, and ecosystem imbalance	Loss of traditional forest-based livelihoods and cultural values	Reduced ecotourism potential and loss of ecosystem service benefits
Disaster and Environmental Risk	Increased floods, landslides, droughts, and forest fires	Community displacement, infrastructure damage, and social vulnerability	High disaster recovery costs and declining regional economic resilience
Social and Cultural Life	Degradation of customary forests and environmental resources	Loss of indigenous knowledge, cultural identity, and social cohesion	Reduced long-term community sustainability and increased social conflict costs

Table 3 presents the multidimensional impacts of deforestation on environmental, social, and economic conditions in Indonesia. The table demonstrates that environmental degradation affects various sectors simultaneously, including climate systems, hydrology, soil productivity, biodiversity, disaster risks, and socio-cultural life. Climate-related impacts such as rising temperatures and greenhouse gas emissions contribute to increased public health risks and reduced labor productivity [46]. Similarly, hydrological disruption caused by forest loss increases water scarcity and conflicts over water resources. The table also indicates that biodiversity loss and

ecosystem destruction weaken traditional livelihoods, reduce ecotourism opportunities, and threaten indigenous cultural practices that depend on forest ecosystems. Furthermore, the increasing frequency of floods, landslides, and forest fires creates substantial economic losses through infrastructure damage, disaster recovery costs, and declining agricultural productivity [47]. Therefore, the table emphasizes that environmental degradation resulting from deforestation generates interconnected consequences that affect ecological sustainability, economic stability, and community resilience simultaneously.

The social consequences of deforestation are particularly severe for indigenous peoples and rural communities whose livelihoods depend heavily on forest resources. Forest destruction often causes the loss of traditional economic activities such as subsistence agriculture, forest product collection, fisheries, and ecotourism-related activities [22]. In many cases, communities displaced by plantation expansion or mining projects experience

declining income levels and increased poverty. Furthermore, environmental degradation contributes to social conflicts related to land ownership, resource competition, and environmental injustice. Indigenous communities frequently face marginalization because their customary land rights are not adequately protected within development policies [48].

Table 4. Relationship Between Deforestation, Environmental Damage, and Community Vulnerability in Indonesia

Main Environmental Issue	Environmental Consequence	Social Impact on Communities	Long-Term Development Impact
Deforestation and Forest Conversion	Loss of forest cover and ecosystem fragmentation	Reduced access to forest resources and livelihoods	Declining environmental sustainability and ecological resilience
Biodiversity Loss	Extinction of endemic species and habitat destruction	Loss of traditional medicinal resources and indigenous knowledge	Reduced scientific, ecological, and ecotourism potential
Soil Degradation and Erosion	Declining soil fertility and land productivity	Lower agricultural yields and increased food insecurity	Weakening rural economic stability and higher restoration costs
Water Pollution and Hydrological Disruption	Reduced water quality and increased flood risks	Clean water scarcity and increased health problems	Rising infrastructure and public health expenditures
Increased Carbon Emissions	Acceleration of climate change and temperature rise	Greater exposure to climate-related disasters and diseases	Increased climate adaptation costs and reduced economic resilience
Forest Fires and Peatland Damage	Air pollution and ecosystem destruction	Respiratory illnesses, school disruption, and community displacement	Economic losses from disasters and reduced investment attractiveness

Table 4 explains the relationship between environmental degradation and increasing community vulnerability caused by deforestation. The table shows that environmental problems such as biodiversity loss, soil degradation, water pollution, and forest fires directly affect social welfare and long-term development opportunities. Declining agricultural productivity due to soil erosion and water scarcity increases food insecurity among rural populations, while climate-related disasters create displacement

and economic instability. The table also highlights how increased carbon emissions and environmental destruction contribute to broader climate change impacts that reduce economic resilience and increase adaptation costs. Moreover, forest fires and peatland destruction generate severe public health problems, particularly respiratory illnesses caused by haze pollution. Through this analysis, it becomes evident that environmental degradation not only damages ecosystems but also undermines human security, public health, and sustainable

development capacity [41]. Consequently, effective forest conservation policies are essential for protecting both ecological integrity and social well-being.

In addition to economic and social impacts, deforestation also threatens cultural sustainability and local knowledge systems. Indigenous communities in Indonesia possess traditional ecological knowledge related to

forest management, medicinal plants, and sustainable natural resource utilization [42], [49]. However, environmental degradation and land conversion frequently erode these cultural practices and weaken social cohesion within local communities. The loss of customary forests not only eliminates economic resources but also threatens cultural identity and intergenerational knowledge transfer.

Table 5. Pathways from Deforestation to Social Consequences and Mitigation Strategies

Deforestation Driver	Environmental Impact	Social Consequence	Mitigation and Policy Response
Expansion of Agriculture and Plantations	Forest conversion, habitat fragmentation, and biodiversity loss	Loss of traditional livelihoods and increased land conflicts	Sustainable land-use planning and agroforestry development
Illegal and Excessive Logging	Ecosystem degradation, soil erosion, and declining forest productivity	Reduced access to forest resources and declining community income	Strengthening forest law enforcement and community forest management
Mining and Infrastructure Development	Water pollution, land degradation, and deforestation	Health problems, displacement of communities, and social disruption	Environmental impact assessment and ecological restoration programs
Forest Fires and Peatland Burning	Air pollution, carbon emissions, and ecosystem destruction	Respiratory diseases, school disruption, and economic losses	Peatland restoration and community-based fire prevention systems
Weak Governance and Corruption	Uncontrolled exploitation and weak environmental protection	Social inequality, marginalization of indigenous communities, and declining trust in institutions	Institutional reform, transparency, and participatory forest governance
Population Growth and Land Pressure	Increased land conversion and overexploitation of natural resources	Competition over land and water resources, increased poverty	Integrated spatial planning and sustainable rural development programs

Table 5 presents the pathways linking deforestation drivers with environmental impacts, social consequences, and possible mitigation strategies. The table demonstrates that plantation expansion, logging, mining activities, forest fires, and weak governance collectively contribute to ecosystem degradation and social vulnerability. These environmental changes subsequently generate poverty, social conflict, health problems, and displacement among affected communities. The table also emphasizes that addressing

deforestation requires integrated policy responses involving environmental governance reform, sustainable land-use planning, community participation, and ecosystem restoration [50]. Strengthening institutional transparency, enforcing environmental regulations, and supporting community-based forest management are essential strategies for reducing deforestation pressures. Furthermore, sustainable rural development programs and ecological restoration initiatives can help improve community resilience while

maintaining environmental sustainability. Therefore, the table reinforces the importance of multidisciplinary and collaborative approaches in overcoming the environmental and social consequences of deforestation in Indonesia.

Overall, the findings demonstrate that deforestation in Indonesia creates interconnected environmental, economic, social, and cultural consequences. Environmental degradation weakens ecosystem resilience, increases disaster risks, and threatens biodiversity conservation, while simultaneously worsening poverty, social inequality, and community vulnerability. Consequently, sustainable forest management policies must prioritize ecological protection, social justice, and long-term environmental sustainability to ensure balanced and inclusive development [51].

Conclusion

Forest depletion in Indonesia remains a multidimensional issue closely related to economic development, environmental sustainability, and social welfare. The findings of this study indicate that deforestation in Indonesia is primarily driven by structural factors such as plantation expansion, mining activities, illegal logging, infrastructure development, weak environmental governance, and increasing economic pressures on natural resources. Although the government has implemented various conservation and forest management policies that have contributed to reducing deforestation rates in recent years, pressure on forest ecosystems continues due to the ongoing demand for land and natural resource exploitation.

This study also demonstrates that forest exploitation generates short-term economic benefits through employment opportunities, export revenues, and regional economic growth. However, these benefits are often accompanied by substantial long-term environmental and economic losses. Conventional economic indicators, particularly Gross Domestic Product (GDP), tend to overestimate economic growth because they do not adequately account for environmental degradation and the depletion of natural capital. In reality, forests provide essential ecosystem services such as carbon sequestration, biodiversity conservation, hydrological regulation, and disaster mitigation, all of which possess significant economic and ecological value.

Furthermore, the environmental consequences of deforestation have become increasingly severe and interconnected. Forest degradation contributes to biodiversity loss, climate change, hydrological disruption, soil degradation, and increased risks of natural disasters such as floods, landslides, droughts, and forest fires. These environmental impacts directly affect the social and economic conditions of communities, particularly indigenous peoples and rural populations that depend heavily on forest ecosystems for their livelihoods and cultural identity. Deforestation also increases poverty, social inequality, public health risks, and social conflicts related to land and resource competition.

The study highlights that environmental degradation caused by deforestation is not merely an ecological issue but also a social justice and sustainable development issue. Therefore, addressing forest depletion requires comprehensive and integrated approaches that

combine environmental conservation, sustainable economic development, social inclusion, and institutional reform. Sustainable forest management cannot rely solely on regulatory instruments; it must also involve stronger law enforcement, transparent governance, active community participation, ecological restoration, and the integration of environmental accounting into development planning.

Overall, this study concludes that sustainable forest management is essential for maintaining ecological balance, strengthening economic resilience, and improving community welfare in Indonesia. Future development policies should prioritize long-term environmental sustainability by balancing economic interests with ecosystem conservation. Through integrated and collaborative efforts involving government institutions, local communities, researchers, and the private sector, Indonesia can achieve more sustainable forest governance that supports both present and future generations.

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