

Sustainable Development Strategy of Dolok Sembelin Protected Forest: a Case Study in Pasir Tengah Village, Tanah Pinem District, Dairi Regency, Indonesia

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This study aims to examine community behavior in the development and management of protected forests in Pasir Tengah Village, Tanah Pinem District, Dairi Regency. The research employs a qualitative method with a phenomenological approach to explore community experiences and perspectives regarding protected forest policies and management practices. The research informants consist of local government officials and community members directly involved in forest management activities. Data were collected through literature review, field observations, in-depth interviews, and documentation, and were analyzed using the interactive model of Miles and Huberman, which includes data reduction, data display, and conclusion drawing. The findings indicate that the community plays an active role in the planning and management of protected forests by utilizing natural resources in a limited, controlled, and sustainable manner. The study also highlights the crucial role of the government in ensuring effective supervision and implementing appropriate policies to prevent forest degradation and promote sustainable forest governance. These findings are expected to provide practical and theoretical contributions to improving protected forest management and enhancing community welfare through sustainable environmental conservation.

Keywords: community behavior; government policy; forest management; protected forest; and environmental conservation.

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1. Introduction

Forests are natural ecosystems dominated by trees and diverse vegetation that play a fundamental role in maintaining ecological balance and supporting the survival of living organisms. As complex ecological systems, forests provide essential environmental services, including oxygen production, carbon sequestration, climate regulation, water cycle stabilization, and soil conservation. In addition to serving as habitats for a wide variety of flora and fauna, forests contribute significantly to biodiversity preservation and ecological resilience. The presence of healthy forest ecosystems is therefore critical not only for environmental sustainability but also for human well-being and long-term socio-economic development.

Beyond their ecological importance, forests also possess substantial social and economic value. Proper and sustainable forest management can generate multiple benefits, including income generation, employment opportunities, and improved community welfare. Forest-based activities such as agroforestry, ecotourism, and the utilization of timber and non-timber forest products provide sustainable livelihood options for local communities. Conversely, improper forest management practices, including illegal logging, land encroachment, and uncontrolled resource exploitation, can lead to environmental degradation, biodiversity loss, and reduced ecosystem services. Such degradation may also negatively affect local communities whose livelihoods depend directly or indirectly on forest resources.

In Indonesia, forests are recognized as strategic national assets that play a vital role in supporting ecological sustainability and economic development. According to Forestry Law Number 41 of 1999, forests are defined as ecosystems dominated by trees that function as environmental buffers, sources of natural resources, and contributors to social welfare. Article 24 of the law emphasizes that forest utilization must be conducted sustainably to ensure ecological balance while supporting economic development. This legal framework highlights the importance of balancing conservation objectives with the socio-economic needs of communities, particularly those living in and around forest areas.

Various challenges, including limited infrastructure, insufficient institutional capacity, lack of access to resources, and uneven regional development, continue to hinder effective forest governance and community welfare improvement. Pasir Tengah Village, located in Tanah Pinem District, Dairi Regency, North Sumatra Province, represents a significant example of a rural area closely connected to protected forest ecosystems. The village is located within a region that contains one of the largest protected forest areas in the regency, covering approximately 11,734 hectares. This vast forest area serves as an essential ecological buffer while also supporting the livelihoods of local communities. The village exhibits unique characteristics, particularly in its traditional forest management practices, which emphasize harmony between human activities and environmental sustainability. These traditional practices reflect local wisdom and community-based conservation approaches that contribute to maintaining forest integrity.

One of the most important forest areas within Pasir Tengah Village is the Dolok Sembelin Protected Forest, which covers approximately 175 hectares. This protected forest serves not only as a conservation area but also as a source of livelihood support for the local community. Residents utilize non-timber forest products, such as fruits, medicinal plants, and other natural resources, in a sustainable manner to supplement their income. This utilization demonstrates the potential of protected forests to support local economies without compromising environmental sustainability when managed responsibly. Agriculture remains the primary livelihood of the community in Pasir Tengah Village. Local farmers cultivate various agricultural commodities, including corn, cocoa, coffee, durian, and candlenut, which contribute significantly to household income. These agricultural activities are often integrated with forest ecosystems, forming agroforestry systems that allow communities to benefit economically while maintaining ecological balance. In addition, local residents demonstrate environmental awareness by replanting trees after harvesting forest resources. This practice contributes to forest regeneration and reflects a sustainable approach to resource management.

Community participation plays a critical role in ensuring the sustainability of protected forest management. Local communities serve as key stakeholders and agents of change in conservation efforts. Their involvement in forest planning, monitoring, and utilization helps ensure that forest resources are managed responsibly and sustainably. Environmental education programs, community-based conservation initiatives, and awareness campaigns are essential in strengthening community capacity and promoting sustainable behavior. Increased community awareness can significantly reduce illegal activities such as illegal logging and land encroachment.

In conclusion, protected forests play a vital role in maintaining environmental sustainability and supporting community livelihoods. Pasir Tengah Village, with its Dolok Sembelin Protected Forest, represents an example of community-based forest management that integrates conservation and economic utilization. Although challenges remain, including limited economic diversification and potential land encroachment, sustainable forest utilization and effective governance can enhance both environmental sustainability and community welfare. Strengthening community participation, improving environmental education, and enhancing government support are essential strategies for ensuring sustainable protected forest

management. Through collaborative efforts between communities and government institutions, protected forests can continue to provide ecological, economic, and social benefits for present and future generations.

2. Literature Review

Primary Research

According to Koentjaraningrat in his book "Introduction to Anthropology," protected forests are forest areas that have a specific function in maintaining ecological and environmental balance, as well as protecting the natural resources within them. From an anthropological perspective, this concept encompasses the relationship between humans and the environment, which is not only ecological but also cultural. Protected forests, from this perspective, are a manifestation of policies or efforts taken by communities or governments to preserve nature and maintain ecosystem balance to ensure the sustainability of human life. Regulation of the Minister of Environment and Forestry (Permen LHK) Number 8 of 2021:

1. Forest management, which includes zoning and mapping of forest areas.
2. Preparation of forest management plans, both at the national, provincial and management unit levels.
3. Utilization of forests in protected forests and production forests with the principle of sustainability

According to the theory of Lawrence Green and his colleagues (in Notoatmodjo, 2007), human behavior is influenced by two main factors, namely behavioral factors (behavior causes) and non-behavior factors (non-behavior causes), where behavior itself is formed from three components: predisposing factors, enabling factors, and reinforcing factors. Predisposing factors include knowledge and attitudes, where knowledge supported by awareness and positive attitudes will make behavior more durable, while attitudes consist of components of affect (emotion), cognition (evaluative beliefs), and behavior (tendency to act), which have levels ranging from accepting, responding, appreciating, to being responsible. Enabling factors include the physical condition of the environment, the availability of facilities, supporting tools, and training, while reinforcing factors include regulations, supervision, and applicable laws. In the context of forests, community attitudes are generally high, with the majority supporting farming activities around protected forests and hoping that forests can be used for agricultural land, although some parties reject such use because they are concerned that it will reduce the ecological function and environmental benefits of protected forests.

Sustainable Forest Management and Protected Forest Functions

Protected forests play a crucial role in maintaining ecological balance, biodiversity conservation, watershed protection, and climate regulation. Sustainable forest management (SFM) refers to the stewardship and use of forest resources in a way that maintains their biodiversity, productivity, regeneration capacity, and ecological functions while fulfilling economic and social needs for present and future generations. SFM integrates environmental protection, economic development, and social equity as key pillars of sustainability (FAO, 2015; UNEP, 2020). Protected forests also function as critical environmental buffers that prevent soil erosion, regulate hydrological cycles, and reduce the risk of natural disasters such as floods and landslides. Forest ecosystems serve as carbon sinks and contribute significantly to climate change mitigation by absorbing atmospheric carbon dioxide (IPCC, 2021). Therefore, effective forest management strategies are essential to ensure ecological stability and sustainable regional development. In Indonesia, protected forests are regulated under national forestry policies to preserve ecological integrity while allowing controlled utilization for environmental services and

community welfare. Sustainable forest management policies emphasize conservation, ecosystem restoration, and community participation to ensure long-term environmental sustainability (Ministry of Environment and Forestry, 2022).

Community-Based Forest Management and Local Participation

Community participation is widely recognized as a fundamental component of sustainable forest management. Community-based forest management (CBFM) emphasizes the involvement of local communities in forest conservation, management, and decision-making processes. This approach enhances environmental protection while improving local livelihoods and reducing forest degradation.

Local communities play an essential role in protecting forest ecosystems through traditional knowledge, conservation practices, and sustainable resource utilization. Indigenous and local communities often possess valuable ecological knowledge that contributes to forest conservation and sustainable development. Ecological conservation focuses on protecting biodiversity, preventing deforestation, and maintaining ecosystem services. Economic sustainability involves developing environmentally friendly economic activities such as ecotourism, agroforestry, and non-timber forest product utilization. Social sustainability emphasizes community empowerment, poverty reduction, and equitable access to natural resources.

Sustainable forest development also requires spatial planning to ensure proper land use allocation and environmental protection. Spatial analysis can help identify suitable areas for conservation, tourism development, and sustainable resource utilization while minimizing environmental risks.

Ecotourism as a Sustainable Development Strategy for Protected Forests

Ecotourism is recognized as an effective strategy for promoting sustainable forest development while preserving environmental integrity. Ecotourism refers to responsible travel to natural areas that conserves the environment, sustains the well-being of local people, and promotes environmental education. Protected forests with high biodiversity, scenic landscapes, and unique ecosystems have significant potential for ecotourism development. Ecotourism contributes to environmental conservation by generating financial resources for forest protection and raising awareness about environmental sustainability. Ecotourism also provides economic benefits to local communities by creating employment opportunities, increasing income, and supporting local businesses. Sustainable ecotourism development must prioritize environmental protection, community participation, and cultural preservation. Spatial planning is an essential component of sustainable forest management. Spatial analysis helps identify suitable areas for conservation, tourism development, and sustainable land use. Geographic Information System (GIS) tools are widely used to analyze environmental conditions, accessibility, land suitability, and ecological sensitivity. Spatial planning ensures that development activities do not compromise ecological integrity and environmental sustainability. Proper spatial planning can reduce environmental risks such as deforestation, landslides, and ecosystem degradation. Spatial analysis also supports decision-making processes by providing accurate information on forest conditions, land use patterns, and environmental risks. This approach helps policymakers develop effective forest management strategies.

Sustainable Forest Development in Indonesia

Indonesia has significant forest resources that play an important role in environmental sustainability, biodiversity conservation, and socio-economic development. Protected forests in Indonesia provide ecosystem services such as water regulation, carbon storage, biodiversity conservation, and disaster mitigation. However, forest areas face various challenges, including deforestation, land-use change, illegal logging, and environmental degradation. Sustainable forest management strategies are necessary to

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address these challenges and ensure long-term forest sustainability. The Indonesian government promotes sustainable forest development through conservation policies, community-based forest management programs, and ecotourism development initiatives. These strategies aim to protect forest ecosystems while supporting economic development and community welfare. Previous studies have emphasized the importance of sustainable forest management, community participation, and ecotourism development in forest conservation. However, limited research has focused on integrated sustainable development strategies that combine spatial analysis, community participation, and ecotourism development in protected forest areas, particularly in Dolok Sembelin Protected Forest. This study contributes to the literature by developing an integrated sustainable development strategy for Dolok Sembelin Protected Forest using spatial analysis, sustainable forest management principles, and community-based conservation approaches. This research provides practical implications for policymakers, forest managers, and local communities in promoting sustainable forest development while preserving ecological integrity.

3. Research Methods

This study employs a qualitative research design using a case study approach to comprehensively examine the sustainable development strategy of the Dolok Sembelin Protected Forest in Pasir Tengah Village, Tanah Pinem District, Dairi Regency, Indonesia. A qualitative approach is appropriate because it allows for an in-depth exploration of social, cultural, and environmental phenomena from the perspective of local communities who directly interact with forest resources. This approach facilitates the interpretation of meanings, values, and practices embedded in traditional forest management systems within their natural context. The case study method was selected to provide a detailed and contextualized understanding of sustainable forest management practices in a specific geographical and socio-cultural setting. This design enables the researcher to analyze complex interactions among ecological conditions, local wisdom, and community participation in maintaining forest sustainability. The research was conducted in Pasir Tengah Village, located in Tanah Pinem District, Dairi Regency, North Sumatra Province, Indonesia. This village is inhabited predominantly by the indigenous Pakpak Batak community, whose livelihoods are closely connected to forest resources. The study area includes the Dolok Sembelin Protected Forest, which plays a critical role in maintaining ecological balance, supporting biodiversity, and providing economic resources for local communities. The selection of this location was based on its relevance as a representative case of community-based protected forest management supported by traditional ecological knowledge. Data were collected using multiple qualitative techniques to ensure depth and reliability through triangulation. These techniques include participatory observation, in-depth interviews, and document analysis. Participatory observation was conducted to directly examine the environmental conditions, community activities, and traditional forest management practices. This method enabled the researcher to understand social interactions, cultural norms, and ecological practices influencing forest sustainability. In-depth interviews were carried out with key informants, including village leaders, traditional authorities, forest users, and local residents. An interview guide was prepared to ensure consistency while allowing flexibility to explore emerging themes. These interviews provided insights into community perceptions, forest utilization practices, conservation awareness, and local governance mechanisms. Documentation and literature review were also conducted to complement primary data. This included reviewing government regulations, forest management reports, and relevant academic literature related to sustainable forest management and community-based conservation.



Figure 1. Concept of Method

Data analysis was conducted using thematic analysis, which involves systematically identifying, categorizing, and interpreting patterns and themes within the collected data. The analysis process includes several stages: data reduction, data organization, theme identification, and interpretation. First, raw data from interviews, observations, and documents were transcribed and organized. Second, relevant data were coded and categorized based on key themes such as community participation, traditional ecological knowledge, forest utilization practices, conservation strategies, and sustainability challenges. Third, relationships among themes were analyzed to understand the interaction between social, economic, and ecological factors influencing forest sustainability. This analytical process enables the identification of sustainable development strategies that integrate environmental conservation, community livelihoods, and local cultural values. To ensure research validity and credibility, this study applied data triangulation by comparing information obtained from different sources, including observations, interviews, and documentation. This approach enhances the accuracy and reliability of the findings. Additionally, prolonged engagement in the field and detailed documentation were used to strengthen the trustworthiness of the research results.

4. Result

Community-Based Forest Management Practices

The findings reveal that the Dolok Sembelin Protected Forest is managed through a strong community-based system rooted in the traditional ecological knowledge of the Pakpak Batak indigenous community. Participatory observation and in-depth interviews indicate that local forest governance is guided by customary norms, informal regulations, and collective responsibility for environmental sustainability.

One of the most important principles practiced by the community is the “plant one, take one” approach, whereby each tree harvested must be replaced with a newly planted tree. This system demonstrates a locally embedded conservation mechanism that ensures the continuity of forest regeneration. Furthermore, the community restricts the types and quantities of forest products extracted, particularly in

ecologically sensitive zones such as watershed protection areas, wildlife habitats, and steep slopes vulnerable to erosion and landslides.

These findings indicate that indigenous governance systems function as effective informal institutions for sustainable forest management. The presence of collective agreements and traditional leadership structures strengthens compliance and promotes environmentally responsible behavior.

Socio-Economic Dependence on Forest Resources

The Dolok Sembelin Protected Forest plays a critical role in supporting the livelihoods of the Pasir Tengah Village community. The majority of residents depend on both timber and non-timber forest products (NTFPs), including medicinal plants, fruits, resins, and agricultural support resources.

Interviews revealed that forest resources contribute significantly to household income, particularly for families engaged in agriculture. Forest ecosystems provide ecological services that support coffee cultivation, soil fertility, and water availability. The forest also acts as a natural buffer that stabilizes local climate conditions and prevents environmental degradation. However, the economic reliance on forest resources also presents sustainability challenges. Without proper regulation and monitoring, excessive exploitation may threaten forest integrity. Therefore, balancing economic utilization and ecological conservation is essential to ensure long-term sustainability.

Traditional ecological knowledge (TEK) is a fundamental component of forest sustainability in Dolok Sembelin Protected Forest. The Pakpak Batak community has inherited forest management practices through generations, which include selective harvesting, natural regeneration, and conservation of protected areas. The community recognizes the ecological importance of maintaining forest structure and biodiversity. Certain areas are designated as conservation zones where extraction activities are prohibited. These areas serve as biodiversity reservoirs and ecological buffers that protect against environmental risks such as floods, landslides, and soil erosion.

Community awareness of environmental risks has contributed to relatively stable forest conditions despite limited technological intervention. This finding confirms that indigenous knowledge systems can serve as effective frameworks for environmental management and biodiversity conservation.

Threats to Forest Sustainability

Despite its relatively stable condition, the Dolok Sembelin Protected Forest faces several sustainability challenges. The primary threat identified is the gradual conversion of primary forest into secondary forest due to human activities and natural disturbances. Changes in vegetation composition have been observed, where native tree species such as meranti and teak are gradually replaced by commercially valuable species such as candlenut and durian. While these species provide economic benefits, they may reduce biodiversity and alter ecosystem balance. In addition, increasing population pressure and economic needs create potential risks of overexploitation. Without effective management strategies, these pressures could compromise forest ecological integrity.

The study found that active community participation is a key factor contributing to forest sustainability. Local residents are directly involved in monitoring forest conditions, enforcing customary rules, and implementing conservation practices.

Community participation strengthens environmental awareness and promotes shared responsibility in forest protection. This participatory approach reduces the risk of illegal logging and environmental degradation while supporting sustainable resource use. The involvement of traditional leaders also

enhances governance effectiveness by integrating formal conservation objectives with local cultural values.

Sustainable Development Strategy for Dolok Sembelin Protected Forest

Based on the findings, several strategic priorities were identified to support sustainable forest management:

- a. Empowering local communities through participatory forest governance can enhance conservation outcomes. Recognizing indigenous management systems and integrating them into formal policies can improve sustainability.
- b. Promoting reforestation programs using native species and strengthening the “plant one, take one” principle can ensure forest regeneration and biodiversity conservation.
- c. Developing alternative income sources such as agroforestry, ecotourism, and sustainable non-timber forest product utilization can reduce pressure on forest ecosystems.
- d. Collaboration between local communities, government agencies, and conservation organizations is necessary to strengthen forest protection and policy implementation.

The findings demonstrate that sustainable forest management in Dolok Sembelin Protected Forest is strongly influenced by community participation, traditional ecological knowledge, and socio-economic factors. Indigenous conservation practices have proven effective in maintaining forest sustainability despite limited external intervention.

Integrating traditional knowledge with modern conservation strategies can enhance forest resilience and support long-term sustainability goals. This approach aligns with sustainable development principles that emphasize ecological protection, social inclusion, and economic sustainability.

Government RelationsstandVillage Against PenmanagementForestLindung

The local government plays a crucial role in the development of the Dolok Sembelin Protected Forest, including in Pasir Tengah Village. Village government involvement is evident from the planning stage to the implementation of protected forest management. The primary goal of this participation is to ensure that forest management activities proceed smoothly without damaging the existing ecosystem, while also ensuring the forest continues to function as intended.

Village governments also play a strategic role in educating communities about sustainable forest management. Through outreach programs, communities are provided with an understanding of the ecological functions of forests, the impacts of forest destruction on the environment, and more environmentally friendly livelihood alternatives. This approach aims to raise public awareness and respect for forests as assets to be preserved, not simply sources of exploitation.

Furthermore, interviews revealed a strong commitment from the village government to protecting protected forests from the threat of destruction. The policies and programs implemented aim to prevent illegal logging and other activities that could damage the forest. With community participation, the village government has created a sustainable forest management system that provides economic benefits while preserving the environment.

Regular monitoring by village governments of community activities in protected forest areas is also crucial. Communities are given the freedom to utilize the forest, provided they do not damage the ecosystem. Village governments also assist communities, anticipate the risk of natural disasters such as floods and landslides, and ensure the protected forest's function is maintained.

Collaboration between village governments and communities is realized through systematic planning, organization, and implementation of forest management. This process includes designating conservation areas, developing management plans, establishing them, and monitoring and administering activities. A shared commitment between the government and communities is key to successfully preserving protected forests while maximizing ecological and economic benefits for surrounding communities.

Policy Evaluation of Protected Forest Management in Pasir Tengah Village

Protected Forest Management in Pasir Tengah Village implements a unique system that gives the community the freedom to regulate their activities based on oral rules passed down through generations. This system reflects local wisdom deeply rooted in local culture, where unwritten agreements serve as the primary guideline for forest preservation. This traditional practice has proven effective in maintaining ecosystem balance over the years.

Public awareness of the function of protected forests is a crucial factor in curbing over-management. This knowledge is not merely theoretical, but is reflected in everyday life, as communities recognize the role of forests as life support, water regulators, erosion prevention, and habitats for flora and fauna. This deep understanding creates a natural defense that is more effective than formal regulations, stemming from a belief in the dependence of their livelihoods on forest sustainability.

Communities manage the forest by using wood for construction, while also replanting replacement trees such as candlenut. Besides providing a source of supplemental income, the forest is also used for hunting and obtaining clean water. These numerous benefits are the primary reason why communities diligently protect the forest, as it is considered a valuable source of life.

The Pasir Tengah Village Government grants the community freedom of management as long as forest management does not damage the ecosystem. The village government also actively monitors all activities in protected forest areas. Furthermore, the government plays a role in community development and empowerment and has the authority to manage forest potential for village welfare. This involvement ensures that forest management remains focused and sustainable.

Customary institutions play a central role in protected forest management, as strong local cultures are still well-preserved. These institutions are authorized to regulate forest access, use, and protection, resolve conflicts, and impose customary sanctions on rule violators. Community recognition of customary institutions is historical, spiritual, and emotional, fostering a sense of ownership and collective responsibility to safeguard forest areas and customary lands for future generations. Community compliance with customary rules is key to the success of sustainable protected forest management.

5. Conclusion

Protected forest management in Pasir Tengah Village aims to improve community well-being through the sustainable use of forest products. Residents harvest wood for household needs and building materials, but do not sell it, thus preserving the forest's potential and preventing overexploitation. Public awareness of the forest's function also limits actions that could damage the ecosystem, while local government oversight helps minimize the risk of disasters such as landslides and floods. Cooperation between the community and the village government is excellent, as evidenced by their involvement in all stages of management, from planning and implementation to monitoring. Communities are given the freedom to follow the verbal rules that have been mutually agreed upon, with government oversight to ensure ecosystem sustainability. This approach ensures wise forest use, preserves the environment, and provides economic benefits to residents.

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