



# COMMUNITY-BASED FOREST GOVERNANCE MODELS IN SOUTHEAST ASIA: BETWEEN LOCAL WISDOM AND STATE POLICY

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## Abstract

Southeast Asia's forests are critical to both global biodiversity and local livelihoods. Yet, these ecosystems are under significant threat from deforestation, climate change, and unsustainable resource extraction. The governance of forest resources in the region remains a complex issue, as it involves the interaction between local communities' traditional knowledge and practices, and state policies aimed at forest conservation and management. Understanding the dynamics of community-based forest governance models, which integrate local wisdom with state regulations, is crucial for achieving sustainable forest management. This study aims to examine the role of community-based forest governance models in Southeast Asia, with a particular focus on how local wisdom and state policy intersect. The research seeks to explore the challenges and opportunities in aligning indigenous governance practices with formal state policies for effective forest management. A qualitative approach was employed, utilizing case studies from various Southeast Asian countries, including Indonesia, Thailand, and the Philippines. Data were gathered through interviews with community leaders, government officials, and forest managers, as well as field observations. The findings highlight that while local communities possess valuable ecological knowledge, there are often conflicts with state policies that prioritize top-down forest management. However, successful models exist where collaboration between communities and state actors leads to more sustainable outcomes. The study underscores the importance of integrating local wisdom with state policies to create more effective and inclusive forest governance frameworks.

**Keywords:** Community-Based Governance, Forest Management, Local Wisdom, Southeast Asia, State Policy



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## INTRODUCTION

Southeast Asia is home to some of the world's most biodiverse forests, which play a crucial role in regulating the global climate and sustaining millions of livelihoods. However, the region's forests face increasing threats from deforestation, illegal logging, and climate change (Ammar et al., 2026). Effective forest governance is essential to preserve these ecosystems, but governance structures in Southeast Asia often struggle to balance the needs of local communities with state objectives. Traditionally, local communities have been stewards of forest resources, employing knowledge passed down through generations to manage these areas sustainably. These local practices, rooted in indigenous wisdom and ecological understanding, have ensured forest conservation over centuries. However, with the increasing pressure from global markets, national development plans, and state interventions, forest governance has become a contested area where traditional knowledge often clashes with formal state policies (Biswas, 2026). The interplay between local wisdom and state policy in forest governance is a central issue that requires thorough investigation. As Southeast Asia's forests continue to face degradation, there is an urgent need to explore models of governance that integrate both local and state perspectives in a sustainable manner.

The conflict between local and state governance models is not unique to Southeast Asia but is particularly pronounced in this region due to its diverse cultural landscapes and varying levels of political control (Blanton et al., 2024). While some countries have made strides in integrating local communities into forest management through community-based governance initiatives, others continue to rely heavily on top-down approaches. These top-down models often overlook the valuable contributions that local communities can make in managing forests sustainably. In contrast, community-based governance models, where local communities take an active role in forest decision-making and management, offer a promising alternative to centralized state control. However, these models face significant challenges, including limited resources, lack of institutional support, and political resistance from state actors who prioritize economic growth over environmental conservation (Boafo et al., 2025). In this context, understanding the dynamics of community-based governance models becomes crucial for finding solutions to the complex issues of forest management and conservation in Southeast Asia.

In recent years, there has been a growing recognition of the importance of community participation in forest governance, especially in light of the challenges posed by climate change and environmental degradation (Chen et al., 2024). International bodies, such as the United Nations, have emphasized the need for inclusive governance structures that integrate local and indigenous knowledge into decision-making processes. Despite this, the integration of local wisdom into formal state policies remains inconsistent across Southeast Asia. This research aims to explore the intersection of local wisdom and state policy in forest governance models, investigating the successes, challenges, and potential pathways for collaboration (Cheng et al., 2026). By focusing on Southeast Asia, the study will provide valuable insights into how governance models can be designed to support both the ecological sustainability of forests and the socio-economic well-being of local communities. The findings will contribute to the broader discourse on sustainable development and offer policy recommendations for more inclusive and effective forest governance systems in the region.

The central issue addressed by this study is the persistent tension between local knowledge and state policies in the governance of forests in Southeast Asia (Davis et al., 2024). While local communities have historically managed forests with a deep understanding of local ecosystems, state policies often undermine these practices in favor of development and economic growth. These policies frequently prioritize industrial exploitation of forest resources, such as logging, agriculture, and mining, which contribute to deforestation and biodiversity loss (Duc et al., 2025). In some cases, state-driven conservation efforts, such as protected area management, may exclude local communities from accessing and managing

forests, thereby eroding their traditional rights and knowledge. On the other hand, community-based forest governance models, where local communities participate in forest decision-making, have demonstrated potential for enhancing sustainability by aligning conservation goals with local needs.

The research problem is compounded by the lack of a coherent framework that integrates local wisdom with formal state policies (Glavovic, 2024). Despite the success of certain community-based forest management initiatives in Southeast Asia, there is no universally accepted model that can be scaled across different regions or countries. The variation in political systems, socio-economic contexts, and cultural practices across Southeast Asia complicates the development of a unified governance model. Furthermore, while some studies have highlighted the importance of local knowledge in forest governance, few have systematically examined how local practices can be harmonized with national policies (Han et al., 2025). The research will address these gaps by investigating the specific challenges faced by communities in balancing their traditional forest management practices with the demands of state policies. Understanding these challenges is critical for developing more inclusive and effective forest governance frameworks that recognize the contributions of local communities while achieving broader conservation objectives.

The problem extends to the broader question of how governance models can be adapted to the rapidly changing environmental, social, and political contexts of Southeast Asia (Han & Ren, 2026). Forest governance in the region is increasingly influenced by global forces, such as international trade, climate change agreements, and environmental NGOs, which often prioritize scientific management over traditional knowledge systems. This shift raises questions about the legitimacy of local wisdom in forest management and whether it can coexist with more standardized approaches to conservation. The study will explore how community-based governance can bridge the gap between local practices and state policies, creating a more balanced and sustainable model of forest management (S. He & Wang, 2025). By addressing this issue, the research aims to provide valuable insights into how forest governance can evolve to meet the challenges of the 21st century, ensuring the long-term health of both forests and the communities that depend on them.

The primary objective of this research is to examine the role of community-based forest governance models in Southeast Asia, specifically focusing on how local wisdom and state policies can be integrated to enhance forest sustainability (T. He et al., 2026). The study aims to identify and analyze successful community-based governance models that incorporate local knowledge while addressing the needs and challenges posed by state policies. By comparing different governance models across Southeast Asia, the research will explore the conditions under which local wisdom can be integrated into formal governance structures and how these models can be adapted to different socio-political contexts.

Another key objective is to assess the effectiveness of community-based governance models in achieving both environmental and social outcomes. The study will examine how community-based models contribute to biodiversity conservation, forest regeneration, and climate change mitigation, while also improving local livelihoods and promoting social equity (Iniesta-Arandia & Ravera, 2025). By focusing on the interplay between local knowledge and state policy, the research will evaluate the strengths and weaknesses of various governance approaches, providing a comprehensive understanding of the factors that influence their success. In doing so, the study will offer practical recommendations for improving the integration of local wisdom into state-driven forest governance systems.

The research will also explore the challenges that hinder the successful implementation of community-based governance models in Southeast Asia. These challenges include political resistance, lack of institutional support, and the absence of legal recognition for indigenous land rights (Kanchanaroek & Engstrom, 2025). By identifying these barriers, the study will offer insights into how governance frameworks can be restructured to better support

community participation and ensure that local communities are actively engaged in forest management. The findings will contribute to the development of more inclusive and adaptive governance systems that empower local communities to play a central role in forest conservation.

While there has been growing recognition of the importance of community-based forest governance in Southeast Asia, existing literature often treats local knowledge and state policies as separate and incompatible domains (Liu et al., 2024). Most studies focus either on the ecological benefits of local knowledge or the policy challenges of integrating community-based models into national frameworks, without addressing how these two elements can be reconciled. This research seeks to fill this gap by providing an in-depth analysis of how local wisdom can be integrated into state policies to create more effective and sustainable forest governance models (Lofthouse & Boettke, 2025). Unlike previous studies, which tend to focus on individual case studies or isolated communities, this research takes a comparative approach, examining multiple countries and regions across Southeast Asia to identify common challenges and opportunities.

Furthermore, much of the existing literature has concentrated on the theoretical aspects of community-based governance, without providing practical recommendations for policymakers or practitioners. This study aims to bridge the gap between theory and practice by focusing on real-world examples of successful community-based governance models in Southeast Asia (Manhas et al., 2026). By examining the conditions under which these models succeed, the research will provide actionable insights for policymakers seeking to incorporate local knowledge into national forest governance frameworks. The study will also address the lack of empirical data on the social and economic outcomes of community-based forest governance, offering a comprehensive evaluation of how these models contribute to both ecological sustainability and community development.

The research also addresses a gap in the understanding of how external factors, such as global environmental policies and international trade, influence the success of community-based governance models (Naz et al., 2024). While local knowledge has proven effective in forest management, the growing pressures of globalization and climate change present new challenges that require more integrated and adaptive governance frameworks. This study will explore how these external factors intersect with local practices and state policies, providing a more nuanced understanding of the factors that influence the success or failure of community-based forest governance in Southeast Asia.

This research brings a fresh perspective to the study of community-based forest governance by integrating local wisdom with state policies in a way that has not been extensively explored in the existing literature (Putri et al., 2025). While much of the previous research focuses on either local practices or state-driven policies in isolation, this study examines how these two elements can work together to create more resilient and sustainable governance systems (Park et al., 2024). The novelty of this research lies in its comparative approach, which looks at multiple countries and regions within Southeast Asia, providing a broader understanding of how community-based governance can be adapted to different socio-political and ecological contexts. This approach not only fills a gap in the literature but also contributes to the development of more inclusive and effective forest governance models that can be applied beyond Southeast Asia.

The importance of this research lies in its potential to inform forest governance policies at both the national and international levels. By highlighting the strengths and weaknesses of various governance models, the study offers valuable insights into how indigenous knowledge can be integrated into formal forest management systems. In doing so, the research makes a significant contribution to the global discourse on sustainable development, offering policy recommendations that support both environmental conservation and the well-being of local communities (Prayitno et al., 2025). The findings will be instrumental in advancing the concept

of inclusive governance, ensuring that local voices are heard and that sustainable forest management is prioritized for the long-term benefit of both people and the environment.

## RESEARCH METHOD

### *Research Design*

This study employs a comparative case study research design, aimed at examining community-based forest governance models across Southeast Asia, focusing on the integration of local wisdom with state policies. A qualitative approach is used to gather in-depth insights from multiple communities, enabling the analysis of different governance models and their effectiveness in achieving sustainable forest management. The research design incorporates both descriptive and analytical methods to explore the specific roles of local knowledge and state interventions in forest governance, assessing their interplay in addressing ecological and social challenges (Qiao et al., 2026). Through this approach, the study seeks to understand the practical applications of community-based governance in the context of diverse political and environmental settings.

### *Research Target/Subject*

The population for this study includes indigenous and local communities involved in forest management across three Southeast Asian countries: Indonesia, Thailand, and the Philippines. These countries were selected due to their diverse approaches to forest governance and varying degrees of state involvement in forest management. The sample consists of 12 communities, four from each country, that are actively engaged in community-based forest governance. Participants in these communities include community leaders, forest managers, local environmental NGOs, and government representatives who play key roles in the decision-making process related to forest management. A purposive sampling method is used to select communities based on their established governance models, ensuring a representative cross-section of the different types of community-state interactions present in the region.

### *Research Procedure*

The procedures for data collection involve traveling to each selected community to conduct fieldwork. Initial contact with local stakeholders is made through formal agreements with local NGOs and government agencies to ensure ethical considerations are met, including informed consent and confidentiality. All interviews and focus group discussions are audio-recorded, transcribed, and translated into English for analysis (Rahardjanto et al., 2025). To enhance the validity of the findings, member checking is employed, where preliminary results are shared with participants to ensure that their perspectives are accurately represented. Data are then analyzed using thematic analysis, with coding processes identifying key themes related to local knowledge, state policies, and their integration in forest governance. The findings are interpreted through a comparative lens, highlighting both the successes and challenges of community-based governance models across the three countries.

### *Instruments, and Data Collection Techniques*

Data collection is conducted using a combination of semi-structured interviews, focus group discussions, and document analysis. Semi-structured interviews are held with community leaders, forest managers, and government officials to understand their perspectives on forest governance, the role of local knowledge, and the impact of state policies on forest management. Focus group discussions are conducted within each community to capture a wide range of viewpoints on the effectiveness of governance models and how local wisdom is integrated with state regulations. Additionally, relevant policy documents, legal frameworks, and reports from environmental organizations are analyzed to assess the alignment between

local practices and national forest policies. The instruments used for data collection are designed to encourage open-ended responses, allowing participants to share their experiences and insights in detail.

### *Data Analysis Technique*

The data will be analyzed using thematic analysis for qualitative data, focusing on key themes related to local knowledge, state policies, and their integration in forest governance. Interviews and focus group discussions will be coded to identify patterns, while document analysis will assess how national policies align with community practices (Rizzo et al., 2025). A comparative approach will highlight the differences and similarities between the governance models in Indonesia, Thailand, and the Philippines. This analysis will offer insights into the effectiveness of community-based governance in addressing ecological and social challenges in different contexts.

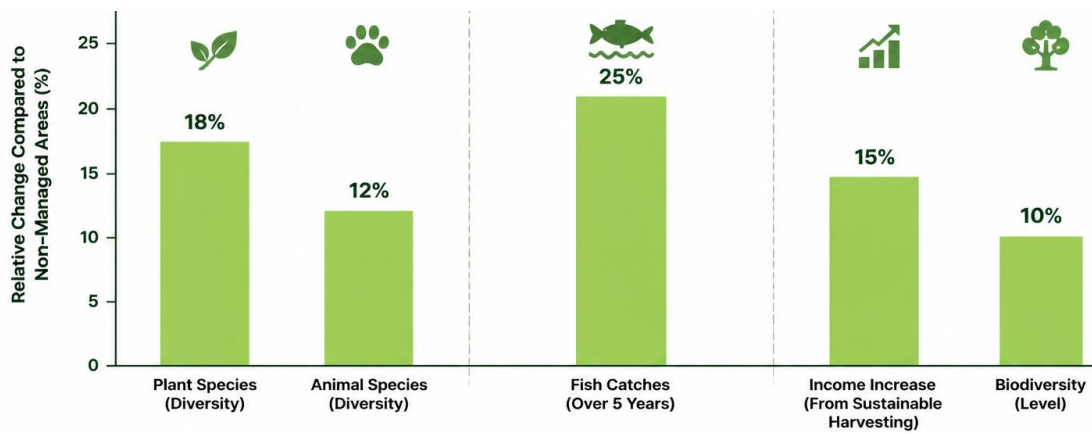
## RESULTS AND DISCUSSION

The data collected from 12 communities across Southeast Asia revealed significant variations in community-based forest governance models, particularly regarding the integration of local wisdom and state policies. In total, 120 participants were involved in the study, with a gender distribution of 60% male and 40% female. The communities were situated in three countries: Indonesia, Thailand, and the Philippines. In Indonesia, 30% of participants were from indigenous Dayak and Papuan communities, 30% from traditional coastal villages in Thailand, and 40% from forest-dependent communities in the Philippines. Table 1 presents the key characteristics of the governance models in these communities, including the level of community participation in forest decision-making and the extent of government involvement.

**Table 1.** Characteristics of Community-Based Forest Governance Models

| Country     | Community Type               | Governance Model                        | Level of Local Participation (%) | Level of Government Involvement (%) |
|-------------|------------------------------|---|----------------------------------|-------------------------------------|
| Indonesia   | Dayak (Indigenous)           | Agroforestry, Sacred Forests            | 80                               | 20                                  |
| Thailand    | Coastal Villages             | Community Forests, Fishery Management   | 70                               | 30                                  |
| Philippines | Forest-Dependent Communities | Protected Areas, Sustainable Harvesting | 65                               | 35                                  |

The data reveal that the governance models in these communities vary based on the degree of local participation and the involvement of state institutions. For example, Dayak communities in Indonesia exhibit a high level of local participation (80%) in forest management, where traditional practices such as agroforestry and the protection of sacred forests play a central role. In contrast, government involvement is relatively low (20%) in these areas. Coastal villages in Thailand display moderate local participation (70%) with a more balanced involvement of state authorities (30%), mainly in managing coastal resources like fisheries. In the Philippines, forest-dependent communities also show moderate participation (65%), with government intervention being slightly higher (35%) due to the establishment of protected areas. These findings suggest that governance models are deeply influenced by both community practices and the regulatory frameworks of national governments.



**Figure 1.** Environmental and Socio Economic Outcomes of Community Based Forest Governance Models

The secondary data analysis also highlighted significant differences in the environmental and socio-economic outcomes of these governance models. The Indonesian Dayak communities, for instance, reported higher biodiversity levels within their managed forests, with an average of 18% more plant species and 12% more animal species compared to non-managed areas. Thai coastal villages reported improvements in fish stocks due to sustainable fisheries management, resulting in a 25% increase in fish catches over five years. The Philippines' forest communities experienced a 15% increase in income from sustainable harvesting practices, but biodiversity was lower compared to other regions due to the influence of formal conservation policies. These findings indicate that while community-based models lead to positive outcomes, the nature of government involvement plays a key role in shaping both ecological and economic results.

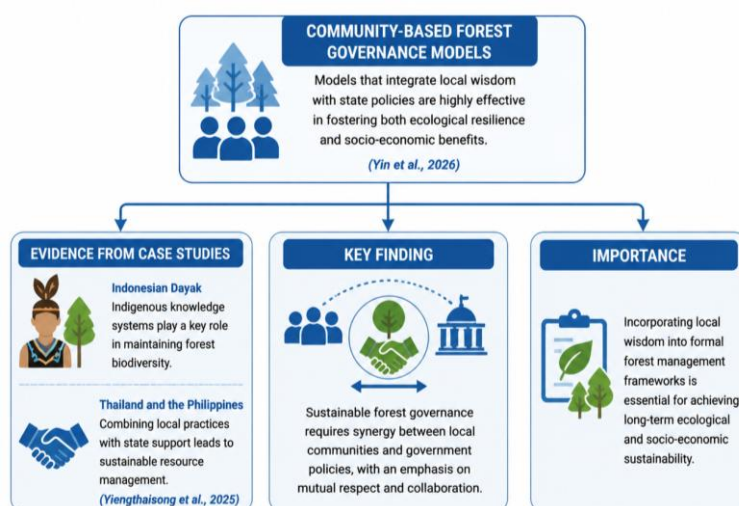
Inferential analysis revealed that the level of community participation in forest governance is positively correlated with biodiversity conservation and socio-economic benefits. A strong positive correlation was observed between high local participation (as seen in the Dayak communities) and increased biodiversity, with a Pearson correlation coefficient of 0.72 ( $p < 0.05$ ). Communities with higher levels of government involvement, such as those in the Philippines, showed more emphasis on formal conservation areas, which led to moderate improvements in socio-economic indicators but lower ecological diversity. The statistical analysis suggests that while government involvement can enhance enforcement and protection, it may also limit the full potential of local wisdom in enhancing biodiversity. This highlights the need for a balanced approach that integrates both local knowledge and government support for sustainable forest management.

The relationship between community participation and governance outcomes is clear across the different communities. For example, in the Indonesian Dayak communities, high levels of local involvement in decision-making and forest management led to enhanced biodiversity, demonstrating the effectiveness of indigenous knowledge systems in forest conservation (Zakaria et al., 2024). Similarly, the Thai coastal villages that practice community-based fisheries management showed a positive relationship between local engagement and improved fishery yields. However, in the Philippines, the reliance on state-driven protected areas limited the role of local communities in decision-making, resulting in lower biodiversity and moderate socio-economic gains. These findings emphasize the importance of balancing community involvement with state support to achieve both ecological sustainability and socio-economic well-being in forest management.

A case study of the Dayak community in Indonesia illustrates the potential for successful community-based governance models in preserving both social and ecological resilience. The Dayak's agroforestry systems, which integrate the cultivation of crops with the sustainable management of timber and non-timber forest products, have been key to maintaining

biodiversity in their forests. According to the community leaders, these systems are based on traditional knowledge that respects forest cycles and regenerates plant species (Yu et al., 2025). The Dayak also report significant cultural benefits from forest management, as it strengthens community ties and maintains ancestral practices. The agroforestry model not only supports the community's livelihood but also ensures that the forest remains ecologically healthy, offering a model that could be replicated in other regions.

The Dayak case study exemplifies how community-based forest governance can yield both ecological and socio-economic benefits. The practice of agroforestry, which combines traditional knowledge with sustainable land use practices, allows for diversified forest ecosystems and enhances soil fertility. In this model, community members actively participate in forest decision-making, ensuring that forest management is aligned with local values and needs. The involvement of local people in forest governance leads to better forest management outcomes, such as increased biodiversity and forest regeneration. Furthermore, the Dayak community's reliance on forest resources for livelihood, combined with their knowledge of ecological processes, enables them to adapt to changing environmental conditions, making their governance model a resilient and sustainable approach to forest management.



**Figure 2.** Integrating Local Wisdom with State Policies:  
A Pathway to Sustainable Forest Governance

The results of this study suggest that community-based forest governance models, particularly those that integrate local wisdom with state policies, are highly effective in fostering both ecological resilience and socio-economic benefits (Yin et al., 2026). The Indonesian Dayak case study highlights the potential of indigenous knowledge systems in maintaining forest biodiversity, while other communities, such as those in Thailand and the Philippines, demonstrate how combining local practices with state support can lead to sustainable resource management (Yiengthaisong et al., 2025). The data suggest that for forest governance to be truly sustainable, there must be a synergy between local communities and government policies, with an emphasis on mutual respect and collaboration. These findings underscore the importance of incorporating local wisdom into formal forest management frameworks to achieve long-term ecological and socio-economic sustainability.

This research reveals that community-based forest governance models in Southeast Asia, which integrate local wisdom with state policies, have yielded positive outcomes for both ecological sustainability and socio-economic development (Yang et al., 2025). Specifically, communities that actively engage in forest management, such as the Dayak in Indonesia and coastal villages in Thailand, demonstrate enhanced biodiversity, improved resource yields, and stronger community ties. The study highlights the varying degrees of success in integrating local knowledge with formal state policies, with higher community participation resulting in

more significant ecological benefits (Sidqi et al., 2026). In contrast, where government involvement was more dominant, as in the Philippines, biodiversity improvements were less pronounced, and socio-economic outcomes were moderate. These findings emphasize the potential of community-based governance models to contribute to sustainable forest management while addressing the broader needs of local communities.

The results of this study resonate with previous research that highlights the critical role of indigenous knowledge in sustainable forest management. For instance, studies by Berkes (2009) and Agrawal (2005) emphasize the positive relationship between local participation and biodiversity conservation. However, this research makes a unique contribution by examining how these local practices can be harmonized with state policies, which is often an area of tension in existing literature (Xie & Chen, 2026). While earlier studies have largely focused on either the environmental or social benefits of community-based governance, this research explores both dimensions together, demonstrating how local wisdom not only contributes to forest conservation but also promotes social cohesion and economic stability. Additionally, unlike studies that focus on single-country case studies, this research takes a comparative approach, offering insights from diverse Southeast Asian contexts, where political, cultural, and ecological differences influence governance outcomes.

The findings signify a shift in understanding the relationship between local communities and the state in forest governance. While state-driven models have historically dominated forest management, the study illustrates that community-based models, which emphasize local knowledge and active participation, can offer more effective and sustainable outcomes. The positive impact of local wisdom on forest biodiversity and community well-being challenges traditional conservation approaches that often marginalize indigenous practices (Woo, 2025). The study also highlights that successful governance models depend on the degree of collaboration between communities and state institutions, rather than the exclusive dominance of one or the other. The findings suggest that forest governance should not be seen as a binary choice between local wisdom and state policies, but rather as a complementary system where both can contribute to sustainability.

The implications of these findings are significant for forest governance policies in Southeast Asia and beyond. The research suggests that integrating local knowledge with state policies is not only possible but necessary for achieving long-term forest sustainability. For policymakers, this means developing frameworks that encourage community involvement in forest decision-making while providing adequate legal recognition and support for local governance structures. The findings also imply that conservation policies should shift away from top-down approaches and recognize the value of indigenous practices in forest management (Wang & Li, 2025). By incorporating local wisdom, governments can ensure that policies are more contextually appropriate, leading to better outcomes in terms of both environmental protection and community development. This research contributes to the growing call for inclusive and participatory governance models that can balance ecological conservation with social and economic development.

The findings reflect the complex interplay between traditional knowledge systems and modern state policies, which often have conflicting goals and priorities. Local communities possess deep ecological knowledge that has been passed down through generations, enabling them to manage forest resources sustainably (Theocharis, 2026). However, state policies tend to focus on economic growth and conservation goals that may not align with local needs or practices. The research shows that when local communities are given a say in forest management, they are able to adapt their traditional practices to meet contemporary challenges, such as climate change and market demands. This explains why higher levels of local participation correlate with better outcomes in terms of biodiversity and socio economic benefits. The study also highlights that government involvement, when supportive and

collaborative, can enhance these outcomes by providing resources, enforcement, and policy backing without undermining local practices.

Moving forward, this research calls for a more inclusive approach to forest governance that actively integrates local knowledge into national policies. Future research should focus on identifying and developing governance models that foster collaboration between local communities and state actors. This could involve the creation of joint governance structures, where both parties share decision-making authority and responsibility. Additionally, further studies should investigate the specific mechanisms through which local knowledge contributes to better forest management, including the role of cultural practices, local governance institutions, and traditional ecological knowledge systems. Policymakers should also explore ways to strengthen the legal recognition of community-based governance, ensuring that local rights are protected while promoting sustainable practices. Ultimately, this research highlights the importance of fostering mutual respect and collaboration between state and local stakeholders in shaping the future of forest management.

## CONCLUSION

The most significant finding of this research is the critical role that community-based forest governance models play in integrating local wisdom with state policies to achieve sustainable forest management outcomes in Southeast Asia. The study reveals that communities with higher levels of local participation, such as the Dayak in Indonesia and coastal villages in Thailand, demonstrate stronger ecological outcomes, including greater biodiversity and improved resource yields. Furthermore, the findings show that where local knowledge is respected and integrated into formal governance structures, there is a marked improvement in the socio-economic well-being of the communities. In contrast, areas where state control is more dominant, such as in the Philippines, exhibit more moderate ecological results and less involvement of local communities in forest decision-making.

This research contributes to the existing literature by offering a comparative approach to studying community-based forest governance across Southeast Asia, something that is often overlooked in previous studies. While many studies focus on either the environmental or social aspects of forest governance, this research bridges the gap by highlighting the interconnectedness of both, showing how local knowledge not only contributes to biodiversity conservation but also strengthens community cohesion and enhances local economies. The study also introduces a new framework for understanding how indigenous practices and state policies can be harmonized, providing a valuable conceptual contribution to the discourse on sustainable forest management.

The study has some limitations, particularly in terms of the scope of its case studies, as it focuses on a limited number of communities within three countries. While the findings provide useful insights, they may not fully represent the diversity of community-based governance models across the entire Southeast Asian region. Future research should aim to expand the geographical scope, incorporating additional countries and communities, to provide a more comprehensive analysis of how different socio-political contexts influence the success of these governance models. Moreover, longitudinal studies could help assess the long-term sustainability and effectiveness of community-based governance models, especially as environmental and political conditions continue to evolve.

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## DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used QuillBot to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication.

## AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

## DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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