

A collaborative management model as an effort for the conservation of native plants of Java's mountains in Mount Merbabu National Park

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Abstract. Taman Nasional Gunung Merbabu possesses a diverse flora, encompassing various indigenous plant species crucial for ecosystem equilibrium. The preservation of these native plants is threatened by anthropogenic activities in the surrounding area, including forest fires, high-intensity human activities, illegal actions, and excessive exploitation. This research aims to explore the role of communities in the conservation efforts of indigenous plants in Taman Nasional Gunung Merbabu. Data collection was conducted through in-depth interviews, field observations, and document analysis. The results indicate that a strong synergy between the government and local communities is essential for the conservation of Merbabu's native plants. The government's role involves educating communities about native plant conservation, in addition to its primary function as a policymaker. Communities participate in various activities such as protected area security, plant monitoring, nursery development, planting, and environmental education. These roles contribute positively to the conservation of Gunung Merbabu's indigenous plants. Active community participation not only strengthens conservation efforts but also enhances awareness and concern for the necessity of preserving plant diversity. The findings from this research provide insights into how participatory approaches can improve the effectiveness of conservation programs and suggest models that can be applied to other national parks to address similar challenges.

1 Introduction

Taman Nasional Gunung Merbabu (TNGMb) constitutes a region characterised by exceptional floral diversity and serves as a habitat for various indigenous plant species that play a crucial role in maintaining ecosystem equilibrium. According to data from relevant research, this national park has documented the presence of 135 flora species, comprising 35 tree species, 100 understory plant species, 60 medicinal plant species, and 57 ornamental plant species [1]. Several plant species prioritised for conservation include saninten (*Castanopsis argentea*), edelweiss (*Anaphalis javanica*), kemlandingan gunung

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(*Paraserianthes lophantha*), and kesowo (*Engelhardia serrata*), which possess high ecological and economic value and represent an integral component of Indonesia's biodiversity [2].

Unfortunately, the conservation of native flora in Gunung Merbabu National Park is currently under significant threat due to various anthropogenic activities in the surrounding area. Forest fires represent one of the primary threats, with fire incidents occurring almost annually. Over the past decade, the average burned area has reached 188.5 hectares per year, negatively impacting the abiotic, biotic, and cultural components of the Gunung Merbabu ecosystem [3]. According to Tacconi [4], forest fires constitute one of the principal causes of ecosystem degradation in tropical regions, and their impact can lead to biodiversity loss and disrupt the sustainability of endemic species.

In addition to wildfires, the high intensity of human activities significantly contributes to the ecosystem degradation within Mount Merbabu National Park. Research conducted by Nugraha et al. [5] indicates that grazing activities carried out by local communities have reached 80% over generations, which has led to the thinning of the forest canopy and the destruction of the natural habitats of indigenous plant species. Activities such as firewood collection and uncontrolled tourism hiking frequently result in damage to vegetation and the accumulation of waste within the forest area [6]. Illegal activities and excessive exploitation also pose serious threats to the preservation of native flora in this region. Wibowo [7] reported that illegal hiking through unofficial trails has detrimental effects on habitat integrity, while other researchers have identified issues such as poaching, timber extraction, and moss collection, which could potentially lead to a decline in the populations of native plants [8].

Given these ongoing challenges, efforts to conserve native plant species in Gunung Merbabu National Park have become increasingly urgent. The need for robust conservation strategies is not only critical within the park itself, but also part of a global movement towards integrated and community-based conservation. Globally, there is a growing recognition of the importance of community-based conservation as a means to address the complex environmental and socio-economic factors driving biodiversity loss. Studies have shown that community engagement can significantly enhance the effectiveness and sustainability of conservation initiatives, making local involvement not just beneficial but essential for long-term ecological health. This approach aligns with the global shift towards multi-stakeholder governance, where collaboration between local communities, governments, NGOs, and the private sector has been identified as a key success factor in addressing biodiversity challenges. As Galvin, Beeton, and Luizza [10] emphasised, community involvement strengthens conservation efforts and fosters a sense of ownership and responsibility, crucial for the sustainability of preservation programs.

This research aims to explore the role of local communities in the conservation of native plants in Mount Merbabu National Park and to identify collaborative management strategies that can be implemented in these conservation efforts. Multi-stakeholder support and multidisciplinary approaches are essential to strengthen government policies in biodiversity conservation within this national park [9]. Nature conservation cannot be effectively implemented without the active participation of those who directly interact with these conservation areas, and the lessons drawn from global conservation trends underscore the importance of these strategies in ensuring the success and resilience of local conservation programs. The implications of this research extend beyond the direct involvement of communities; they also emphasise the synergy among government entities, academics, and other parties engaged in conservation efforts. The findings are anticipated to serve as a reference for other national parks in adopting participatory approaches, thereby addressing similar challenges in the preservation of native plants across different regions in Indonesia. Consequently, this research contributes to strengthening a more inclusive and adaptive

conservation management model that meets the national needs for the conservation of native plant species.

2 Materials and methods

2.1 Research design

This study uses a qualitative approach with an exploratory descriptive method, which is appropriate to explore in depth the role of the community in preserving native plants in Mount Merbabu National Park [11]. This qualitative approach allows researchers to understand the phenomenon holistically and identify various factors that influence community participation in conservation efforts [12].

2.2 Research subjects and selection method

The research subjects include local communities, national park officials, and relevant stakeholders such as NGOs, local government representatives, and academics. Purposive sampling was used to select informants based on their knowledge, experience, and direct involvement in native plant conservation efforts, ensuring that participants had practical insights into local conservation activities [13]. A total of 50 informants were involved, including members of nature enthusiast groups, community groups working on nursery development, and representatives from government agencies. This diverse range of informants provided a comprehensive view of conservation practices, combining local knowledge with broader policy perspectives.

2.3 Data collection techniques and instruments utilised

Data were collected through three primary techniques: in-depth interviews, field observations, and document analysis. In-depth interviews were employed to obtain information regarding community roles and participation, as well as government policies in conservation efforts, utilising a semi-structured guide to maintain flexibility in information gathering [14]. Field observations were conducted to directly examine conservation activities undertaken by the community and government in the Mount Merbabu National Park area [15]. Document analysis was performed using various official documents, activity reports, government policies, and literature related to native plant conservation as supplementary data sources [16]. Table 1 below elucidates the interview instrument matrix utilised.

Table 1. Research instrument grid.

Aspect	Indicator	Total
Community Role	- Involvement in area security	10
	- Participation in plant monitoring	8
	- Nursery development and planting activities	7
Participation in Activities	- Involvement in planting programs	6
	- Contribution to environmental education	4
	- Area protection activities	5
Government Support	- Area protection policies	3
	- Education programs on native plant conservation	4
Obstacles to Conservation	- Illegal activities (e.g., illegal logging)	5
	- Lack of community knowledge about conservation	3
	- Impact of tourism and climbing activities	4

2.4 Instrument validity technique

The validity technique employed in this research is data triangulation, encompassing source triangulation, method triangulation, and researcher triangulation. Source triangulation is conducted by comparing information obtained from various informants, while method triangulation is performed by comparing the results of interviews, observations, and document analysis [17]. Researcher triangulation involves discussions between the primary researcher and collaborators to ensure data consistency.

2.5 Data analysis techniques

The collected data are analysed using thematic analysis, which consists of data collection, reduction, presentation, and conclusion-drawing stages [18]. The analysis process begins with data coding to identify the main themes related to community roles, government policies, and factors influencing the conservation of native plants. The data are then categorised into specific themes aligned with the research objectives and critically interpreted to derive valid conclusions regarding the collaborative management model in the conservation efforts of native plants in Gunung Merbabu National Park [19].

3 Results and discussions

The government plays a crucial role in educating the public about native plant conservation and formulating policies that support preservation efforts. This educational initiative encompasses outreach programs regarding the significance of biodiversity, conservation methodologies, and applicable regulations. Implemented policies may include protected area designations, resource utilisation regulations, and incentives for conservation activities. Collaborative efforts ensure that conservation policies and programs developed by the government can be effectively implemented in the field, with active support and participation from local communities.



Fig. 1. Extension activities.

Collaboration ensures that conservation policies and programs formulated by the government can be implemented effectively in the field, with active support and participation from local communities. Local communities can assist in activities such as monitoring,

planting, and area management. Factors influencing community participation in National Park management consist of internal (age, occupation, education, income, length of residence, psychological attachment, community leaders) and external (stakeholders such as NGOs, local government, and private sector) factors. Active community involvement is crucial for conservation as they play a role in area security, plant monitoring, nursery development, planting, and environmental education. This can be elucidated as follows:

- The safeguarding and monitoring of plant life in conservation areas. Local communities play a crucial role in protecting regions from illegal activities, such as deforestation, while also assisting in the assessment of plant health and species diversity.
- Development of nurseries and planting initiatives. Community members are actively engaged in establishing nurseries to cultivate native plant seedlings for rehabilitation efforts, as well as participating in tree planting and land restoration activities.
- Environmental education. Furthermore, local populations contribute significantly to disseminating knowledge about conservation to other communities and future generations through educational activities, workshops, and environmental campaigns. Their involvement is essential for preserving the environment for future generations.

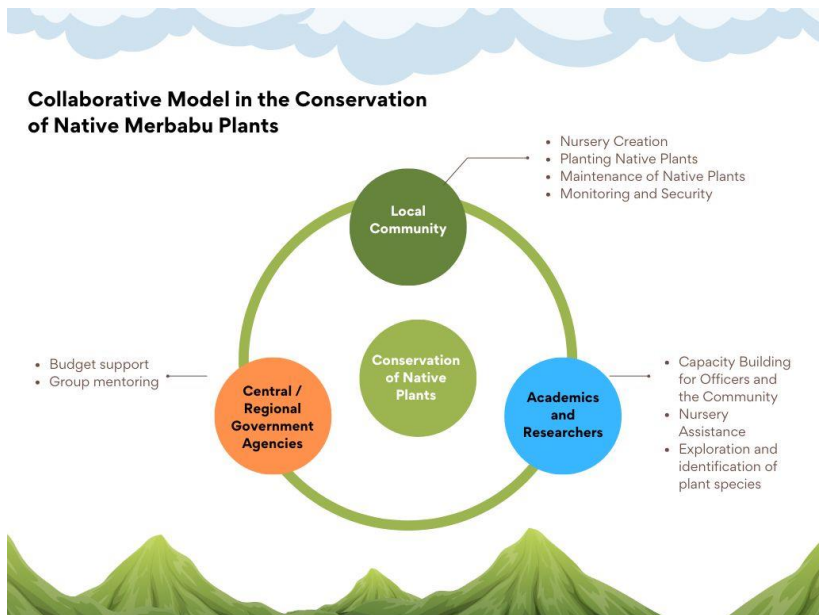


Fig. 2. Illustration of a collaborative model for preserving native Merbabu plants.

3.1 Construction of orchid and native plant greenhouse

Management of Merbabu Orchid Demonstration Plot in Sobleman, Magelang Regency, in collaboration with Community Forest Ranger Partners (MMP) of Wonolelo Resort, Sawangan, Magelang Regency. There are 30 species of native Merbabu orchids, with a total of 192 specimens. The following documentation illustrates orchid conservation activities through the greenhouse.



Fig. 3. Orchid greenhouse.

3.2 Conservation of endangered native plant species in Merbabu

The conservation of endangered native plant species on Mount Merbabu is a primary focus of efforts to preserve biodiversity in this region. Among the plant species included in the conservation program are Tesek (*Dodonea viscosa*), Dempul (*Glochiodon* sp.), Puspa (*Schima wallichii*), Pampung (*Macropanax dispermus*), Picis (*Nauclea lanceolata*), Wilodo (*Ficus fistulosa*), Wuru (*Myrica javanica*), and Bintami. Each species plays a crucial role in maintaining ecosystem balance and represents a natural heritage that must be protected. The conservation initiative engages various stakeholders, including local communities,

government entities, and academic institutions, in efforts to restore native plant populations and ensure their sustainability for the future. Conservation activities encompass planting, nursery development, and ongoing monitoring, thereby safeguarding the ecosystem of Mount Merbabu and supporting the existing biodiversity within it.

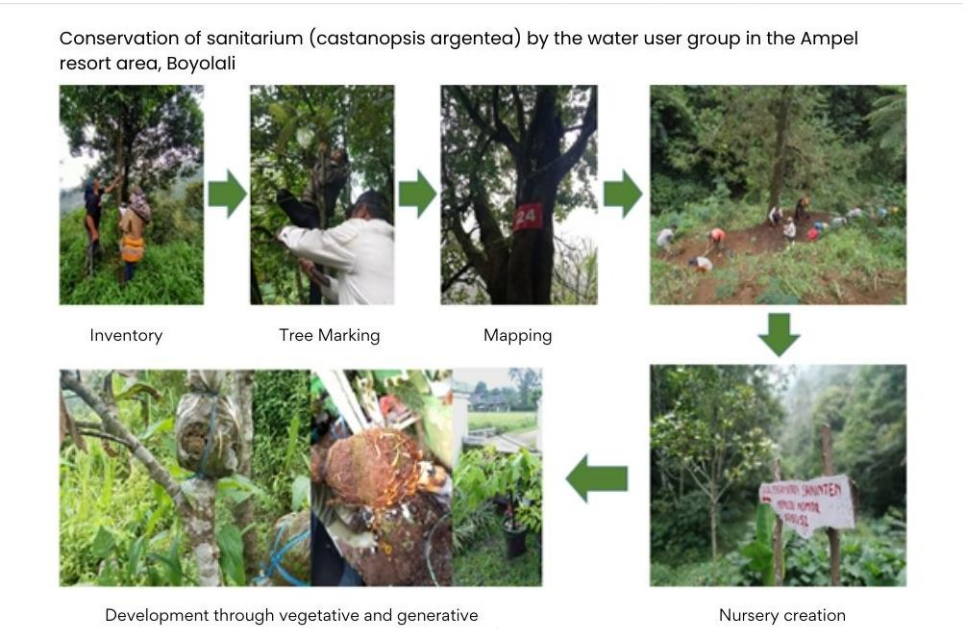


Fig. 4. Documentation of native plant conservation.

The implementation of efforts to preserve native plant species in Mount Merbabu National Park involves various community groups and local institutions that actively participate in conservation activities. Key contributors to this program include the Banyugiri Nature Lovers Group based in Pakis, Magelang; the Panji Kinasih Group located in Selo, Boyolali; and the Youth Empowerment Institution of Genikan Village in Ngablak, Magelang. Each of these groups engages in a range of conservation activities, such as nursery development, planting of native plants, and monitoring and protection of forest areas.

In addition to community involvement, academics and researchers play a crucial role in supporting this conservation program. Academics contribute to enhancing the knowledge of national park staff through in-house training, particularly in plant species identification techniques. For instance, the Faculty of Forestry at UGM participates in joint training and exploration activities, which have resulted in the identification of 56 woody plant species and 166 understory plant species in the Gunung Merbabu National Park area. This collaboration demonstrates the significance of academic involvement in providing the necessary scientific support and technical knowledge for conservation efforts.

Conversely, government agencies also provide substantial support in these preservation endeavours. Several agencies involved include the Pamali Jratun Watershed Management Office, the Brantas Watershed Management Office, the Central Java Provincial Forestry Service Branch, and the local government (through Muspika and the District Environmental Service). Support from government agencies encompasses funding for ecosystem restoration activities, assistance to community groups, and security and protection of the national park area. The synergy between government, community, and academia is key in efforts to

preserve native plants in Gunung Merbabu National Park, ensuring their sustainability as part of Java's biodiversity.



Fig. 5. Documentation of agency roles in collaboration activities.

3.3 Discussion

The community and government collaborate to conserve native plant species in Mount Merbabu National Park through close cooperation in area protection from illegal activities, nursery development, and planting initiatives. According to Oldekop et al. [20], local community participation in conservation efforts plays a crucial role in successfully managing natural resources due to their traditional knowledge and direct connection with the local ecosystem. In this context, local communities serve as primary guardians protecting forest areas from illegal activities such as logging, poaching, and excessive extraction of natural resources. They actively engage in patrols and monitoring alongside national park officials to ensure the area remains protected. As noted by Borrini-Feyerabend et al. [21], the involvement of local communities in conservation area patrols can enhance surveillance effectiveness and reduce the incidence of illegal activities.

Furthermore, communities play a significant role in developing nurseries that produce indigenous plant seedlings, which are subsequently utilised for the rehabilitation of degraded lands. This activity aligns with research conducted by Gebara [22], which demonstrates that conservation efforts involving community participation in nursery development can enhance a sense of ownership and responsibility towards environmental preservation. The government, conversely, provides support in the form of facilities, training, and funding to strengthen these protection and nursery activities. According to Evans et al. [23],

governmental support in the form of training and funding is crucial for enhancing the capacity of local communities to implement conservation initiatives.

In the context of afforestation, the government has initiated reforestation programs that actively engage local communities at every stage, from land preparation to planting and maintaining seedlings. This collaboration illustrates the effectiveness of the synergy between the community and the government in preserving native plant species. As Sterling et al. [24] noted, conservation management models incorporating collaboration between governmental bodies and local populations can foster more adaptive and sustainable approaches to managing conservation areas. This underscores the critical importance of involving all stakeholders in the conservation process to ensure the sustainability of ecosystems.

The government and the community play a crucial role in disseminating knowledge about the significance of conserving native plant species through various educational and environmental outreach activities. Through relevant agencies, the government regularly conducts training and outreach programs to enhance public awareness regarding the importance of preserving biodiversity in Mount Merbabu National Park. These programs include education on conservation methods, understanding endangered native plant species, and the necessity of protecting ecosystems from harmful human activities. According to Sterling et al. [24], government involvement in educational efforts can enhance public understanding of the value of local ecosystems and encourage participation in conservation activities. Conversely, the community also contributes to educational initiatives by organising community-based activities such as workshops, seminars, and environmental campaigns that engage youth and local groups. Jones et al. [25] emphasise that community involvement in educational programs is highly effective in fostering a sense of ownership and responsibility towards the environment. The participation of community leaders, youth, and nature enthusiasts in these activities aids in spreading information and raising awareness about the importance of preserving native plants. This collaboration creates a sustainable impact, where the community not only receives information but also actively participates as agents of change in environmental conservation [26].

Academics and researchers play a crucial role in the conservation efforts of native plants, primarily through knowledge transfer and the development of research-based conservation models. They provide training to national park personnel and local communities on plant identification techniques and effective preservation methods. According to Reed et al. [27], the involvement of academics in knowledge transfer can enhance the capacity of local communities to manage natural resources and promote the implementation of more effective conservation methods. Through scientific exploration and research, academics have successfully identified various native plant species and developed conservation models that can be applied in the field, thus providing practical guidance for preservation efforts in Mount Merbabu National Park. Research findings by Leisher et al. [28] also indicate that community participation in conservation is influenced by internal factors, such as age, occupation, and education level, which determine their understanding and commitment to conservation. External factors, including support from stakeholders, non-governmental organisations, and the government, also significantly encourage community involvement in preservation programs.

Efforts to preserve native plant species face significant challenges, especially from annual forest fires and illegal activities such as logging and poaching. Tacconi et al. [4] emphasise that human activities often trigger these fires, causing severe damage to ecosystems. To address these challenges, preventive measures involving all stakeholders are essential. A collaborative approach has proven effective in combining diverse perspectives and resources to create more sustainable conservation strategies. As Bennett et al. [29] note, cooperation in activities like safeguarding, planting, and education can significantly enhance conservation success.

Furthermore, local community participation plays a crucial role in shaping ecologically sound and socially sustainable policies. Integrating local knowledge with scientific research leads to context-specific solutions that are more likely to be adopted. This participatory approach also contributes to long-term policy development by ensuring that conservation policies are inclusive, adaptive, and address both environmental and socio-economic needs. This model of multi-stakeholder collaboration in Mount Merbabu aligns with global trends in community-based conservation, such as those in the Amazon and Africa, where inclusive approaches have proven effective in promoting sustainable conservation. In conclusion, this research underscores the importance of combining local knowledge and institutional efforts, offering a unique contribution to global conservation strategies aimed at enhancing sustainability and resilience.

This research underscores the significance of collaboration among governmental entities, local communities, and academic institutions in conserving indigenous flora, which may serve as a foundation for developing future conservation policies. The proposed practical recommendations encompass the enhancement of educational and training programs involving community participation, as well as the provision of more adaptive financial support and regulatory frameworks from governmental authorities. These measures are anticipated to ensure the sustainability of conservation efforts in Gunung Merbabu National Park and contribute to conservation practices in other regions.

4 Conclusion

A robust synergy between the government and local communities is essential for conserving native plant species on Mount Merbabu. The government plays a crucial role in educating the public about native plant conservation and its primary function as a policy-making entity. Local communities contribute through various activities, including protected area security, plant monitoring, nursery development, reforestation efforts, and environmental education. These roles have a positive impact on the preservation of native plant species on Mount Merbabu. Active community participation not only strengthens conservation efforts but also enhances awareness and concern for the necessity of preserving plant biodiversity. The findings from this research provide insights into how participatory approaches can improve the effectiveness of conservation programs and suggest models that may be applicable to other national parks facing similar challenges.

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