

### The Role of Biodiversity Potential in Sustainable Ecotourism Development Strategy: A Case Study of Mount Sigogor Nature Reserve and Mount Picis Nature Reserve

Nur Patria Kurniawan<sup>1\*</sup>, and Liris Lis Komara<sup>2</sup>

<sup>1</sup> Ministry Forestry Juanda Airport Highway, Indonesia

<sup>2</sup> East Kutai Agricultural College School, Indonesia

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#### CORRESPONDING AUTHOR

[nurpatriakurniawan81@gmail.com](mailto:nurpatriakurniawan81@gmail.com)

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#### ABSTRACT

The Mount Picis and Mount Sigogor Nature Reserves in Ponorogo Regency, East Java, are conservation areas with significant potential for high biodiversity, including habitats for protected species such as the Javan Hawk-eagle and the Javan Leopard, as well as vital environmental services. This study aims to formulate a strategy for developing sustainable ecotourism-based nature tourism in the Mount Picis and Mount Sigogor Nature Reserves, Ponorogo Regency. The data from this study were analyzed using the SWOT method, identifying internal and external factors. The area's main strengths include its ecosystem integrity and rich flora and fauna diversity, while opportunities came from local government support and the participation of buffer communities. However, significant weaknesses include limited management facilities and infrastructure, suboptimal area data, and external threats such as low community well-being and the risk of forest fires. Based on this analysis, two main strategic objectives were formulated: (1) Increasing research and education based on biological potential, and (2) Maintaining the security and integrity of the area. The implementation strategy includes developing a potential database, adding infrastructure, improving human resources, and securing the area integrated with the economic empowerment of communities in the buffer zone. The conclusion of this study is that ecotourism development in the Picis mount and Gunung mount Nature Reserve must be carried out adaptively, prioritizing conservation, and involving the active participation of local communities to ensure the sustainability of the ecological and social functions of the area.

#### ABSTRAK

Cagar Alam Gunung Picis dan Cagar Alam Gunung Sigogor di Kabupaten Ponorogo Jawa Timur merupakan kawasan konservasi ini memiliki potensi besar dengan keanekaragaman hayati yang tinggi, termasuk sebagai habitat kritis bagi satwa dilindungi seperti Elang Jawa dan Macan Tutul Jawa, serta memiliki fungsi jasa lingkungan yang vital. Penelitian ini bertujuan merumuskan strategi pengembangan wisata alam berbasis ekowisata yang berkelanjutan di Cagar Alam Gunung Picis dan Cagar Alam Gunung Sigogor, Kabupaten Ponorogo. Data dari hasil penelitian ini dianalisis menggunakan metode SWOT dengan mengidentifikasi faktor-faktor internal dan eksternal. Kekuatan utama kawasan meliputi keutuhan ekosistem dan keanekaragaman flora/fauna yang kaya, sementara peluang datang dari dukungan Pemerintah Daerah dan partisipasi masyarakat penyangga (KTH dan MPA). Namun, terdapat kelemahan signifikan berupa sarana dan prasarana pengelolaan yang terbatas, data kawasan yang belum optimal, serta ancaman eksternal dari rendahnya kesejahteraan masyarakat sekitar dan risiko kebakaran hutan. Berdasarkan analisis tersebut, dirumuskan dua tujuan strategis utama: (1) Peningkatan penelitian dan pendidikan berbasis potensi hayati, dan (2) Mempertahankan keamanan dan keutuhan kawasan. Strategi implementasi mencakup pembangunan *database* potensi, penambahan infrastruktur, peningkatan SDM, serta pengamanan kawasan yang terintegrasi dengan pemberdayaan ekonomi masyarakat di daerah penyangga. Kesimpulan dari penelitian ini adalah bahwa pengembangan ekowisata di CA Gunung Picis dan Gunung Sigogor harus dilakukan secara adaptif, mengutamakan konservasi, dan melibatkan partisipasi aktif masyarakat lokal untuk menjamin keberlanjutan fungsi ekologis dan sosial kawasan.

## 1. Introduction

The tourism sector is a crucial pillar of global and regional economic development [1], [2]. In Indonesia, its extraordinary natural resources have positioned tourism as a priority sector [3], expected to boost domestic revenue and create jobs [4]. East Java Province, with its geographical diversity, offers a wide spectrum of tourist destinations, from marine tourism to captivating mountain landscapes [5]. Among the regencies in East Java, Ponorogo Regency is widely known for its cultural icon, the Reog Ponorogo [6]. However, this regency also holds hidden natural tourism potential that requires strategic development.

Ponorogo Regency has a rich biodiversity and beautiful natural scenery of highland and mountainous areas [7]. Two particularly ecologically significant mountain areas are Mount Picis and Mount Sigogor. These areas have been designated as Nature Reserves (NR), a conservation status that emphasizes the importance of protecting their ecosystems. The Mount Picis and Mount Sigogor NR are home to a variety of endemic flora and fauna, including tropical mountain rainforest vegetation, and serve as important habitats for protected species such as the Javan Hawk-eagle [8]. The natural beauty they offer, including lush forests, cool air, and the potential for panoramic views from above, makes them a strong foundation for tourism development.

Despite its potential for immense natural beauty, the conservation status of the Nature Reserve limits the tourism development models that can be implemented. The concept of mass tourism or massive infrastructure development is inconsistent with conservation principles [9]. Therefore, the most relevant and responsible model for this area is ecotourism. Ecotourism is defined as responsible travel to natural areas that conserves the environment and improves the well-being of local communities [10]. Ecotourism development in conservation areas such as Mount Picis and Mount Sigogor must be based on the principles of environmental carrying capacity, minimizing negative impacts, and maximizing educational and conservation value.

Currently, the focus of tourism development in Ponorogo Regency is still dominated by established attractions such as Ngebel Lake, which is the largest contributor to Regional Original Income from the tourism sector [11]. Meanwhile, conservation areas such as Mount Picis and Mount Sigogor NR are more frequently accessed for patrols, ecosystem restoration, and biodiversity research by the East Java Natural Resources Conservation Centre, indicating that the utilization of their potential for ecotourism is still in its infancy and has not been holistically integrated into the regional tourism master plan. This lack of strategic development has resulted in the economic and

educational potential of these two mountains being unrealized, and the surrounding community has not fully felt the positive impacts of the existence of these conservation areas [12].

The Successful ecotourism development in the Gunung Picis and Gunung Sigogor NR requires a comprehensive, integrated strategy involving various stakeholders. This strategy encompasses not only physical development (such as interpretation trails or information centers) but also institutional aspects, regulations, marketing, and capacity building for local human resources (HR) [13]. Active participation from buffer village communities (e.g., Gondowido or Pupus Villages) is crucial, as they are at the forefront of preserving nature and are key players in tourism services. Stakeholder analysis such as Natural Resources Conservation Centre (BBKSDA), State Forestry Public Corporation (Perhutani), local government, and the community) is essential for aligning the vision and mission of sustainable development.

Therefore, this research is very relevant and urgent to be conducted. An in-depth analysis is needed to formulate the most effective, adaptive, and sustainable Nature Tourism Development Strategy (Ecotourism) for the Mount Picis and Mount Sigogor areas. This strategy must be able to balance the conservation demands of the Nature Reserve area with opportunities for wise utilization, so that these two mountains can become models for successful conservation-based ecotourism development in East Java [14]. The strategy to be formulated will be an important reference for local governments and managers in optimizing the existing natural potential without sacrificing the ecological function of the conservation area. This study aims to formulate a strategy for developing sustainable ecotourism-based nature tourism in the Mount Picis and Mount Sigogor Nature Reserves, Ponorogo Regency.

## 2. Research Method

### 2.1. Research Location and Time

This research was conducted in the Mount Picis and Mount Sigogor Nature Reserves, located in Pasuruan Regency, East Java Province, which can be seen on Figure 1, from January to July 2025. The selection of locations was based on the research objectives and specific considerations/criteria (purposive sampling). The criteria for the selected villages were those directly adjacent to, or partially within, the Gunung Picis and Gunung Sigogor Nature Reserves, or those residing within the Gunung Picis and Gunung Sigogor Nature Reserves. Some of the residents have developed and utilized agricultural land within the Ndeti Kelikima Nature Reserve as a source of income to meet their living needs.

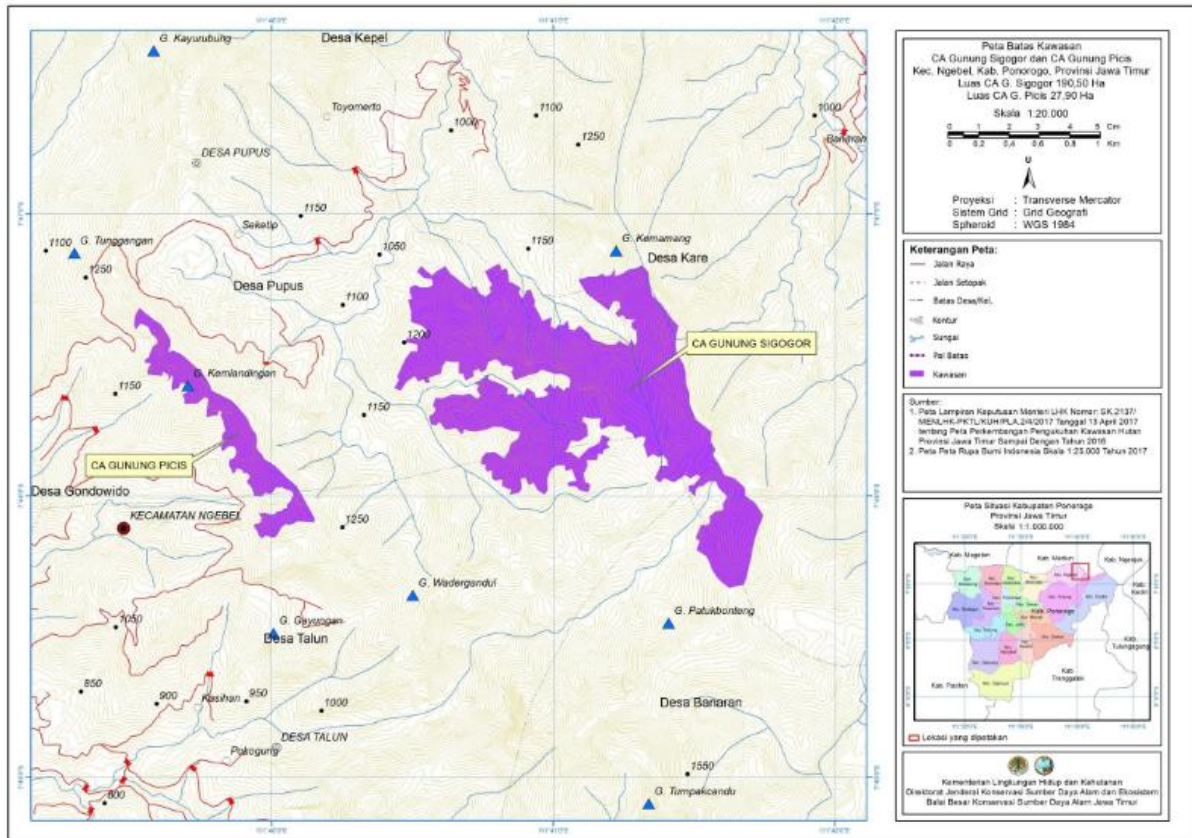


Figure 1. Mount Sigogor and Mount Picis Nature Reserve

2.2. Data Collection Techniques

The data collected consisted of primary data in the form of interviews with the Nature Reserve managers and secondary data, including the general condition of the Nature Reserve, potential flora and fauna, and other factors. The SWOT analysis method was used to analyze the data. This method compares external factors such as opportunities and threats with internal factors such as strengths and weaknesses. The results

of this analysis were then used to design a strategy for developing ecotourism businesses in the area [15].

2.3. Data Analysis

The data analysis used SWOT analysis. This analysis is based on the logic of maximizing strengths and opportunities while simultaneously minimizing weaknesses and threats. A SWOT analysis diagram can be seen in Figure 2.

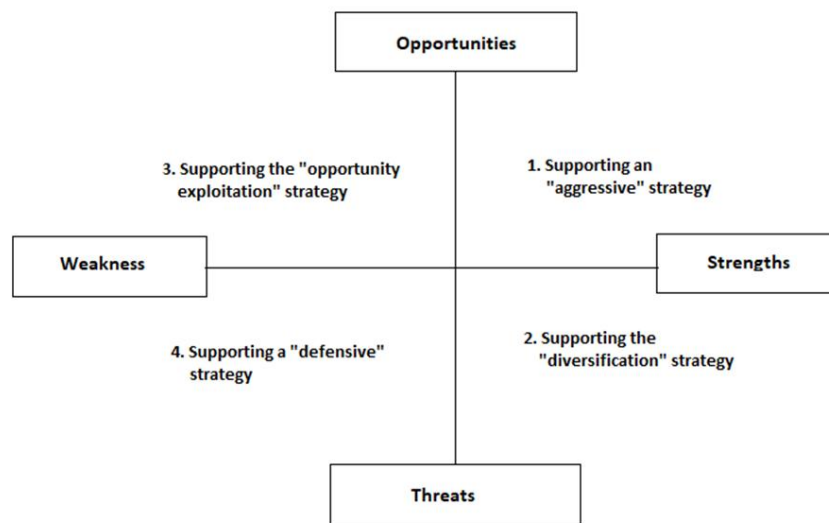


Figure 2. Diagram of SWOT Analysis

Figure 2 caption:

- a. Quadrant 1: This is a favorable situation. It has opportunities and strengths, allowing it to capitalize on existing opportunities. The strategy to implement in this situation is to support an aggressive growth policy.
- b. Quadrant 2: Despite facing various threats, it still possesses internal strengths. The strategy that must be implemented is to use these strengths to capitalize on long-term opportunities through diversification.
- c. Quadrant 3: It faces significant market opportunities, but also faces several internal weaknesses. The strategy is to minimize internal problems to seize better market opportunities.
- d. Quadrant 4: A very unfavorable situation, it faces various threats and internal weaknesses.

SWOT analysis produces 4 (four) possible alternative strategies, namely SO (Strength-Opportunities) strategy, WO (Weakness-Opportunities) strategy, ST (Strength-Threats) strategy, and WT (Weakness-Threats) strategy, as matrix, which can be seen on Table 1 [16].

Table 1. SWOT Matrix [9].

	Strength Determine 5-10 Strength Factor	Weakness Determine 5-10 Weakness Factors
Opportunities Determine 5-10 Opportunity Factors	SO Strategy Create a strategy that uses strengths to take advantage of opportunities	WO Strategy Create a strategy that minimizes weaknesses to take advantage of opportunities
Threat Determine 5-10 Threat Factors	ST Strategy Create a strategy that uses strengths to overcome threats	WT Strategy Create a strategy that minimizes weaknesses and avoids threats

### 3. Result and Discussion

#### 3.1. The Community Socioeconomic Characteristics

The Mount Picis Nature Reserve and Mount Sigogor Nature Reserve are administratively located in Ngebel District, Ponorogo Regency, East Java Province. The buffer villages for the Mount Picis Nature Reserve are Pupus, Gondowido, and Talun, while the buffer village for the Mount Sigogor Nature Reserve is Pupus. The population of these three buffer villages is presented in

Table 2, while type of livelihoods can be seen on Table 3, and the community education level on Table 4.

Table 2. Population in the Buffer Villages of the Mount Picis Nature Reserve and Mount Sigogor Nature Reserve

No	Village	Large (km2)	Gender		
			Male	Female	Total
1	Pupus	960	879	840	1719
2	Gondowido	882	1227	1181	2408
3	Talun	1632	2023	1975	3998

Table 3. Types of Livelihoods

No	Level of Education	Number (of people)		
		Talun Village	Pupus Village	Gondowido Village
1	State Civil Apparatus	6	2	6
2	Farm Owners	2359	692	267
3	Plantation Business Owners			392
4	Farm Laborers		150	15
5	Plantation Laborer	217		15
6	Plantation Employee			5
7	Farm Business Owner			125
8	Farm Worker			5
9	Individual Farm Owner			65
10	Forest Product Processing Business Owner			45
11	Company Employee			26
12	Agricultural Trade Employees			15
13	Agricultural Trade Workers			1
14	Trade Entrepreneurs			115
15	Agricultural Products Entrepreneurs			9
16	Transportation Entrepreneurs			12
17	Hotel & Lodging Entrepreneurs			19
18	Food stall/restaurant owner			22
19	Indonesian National Armed Forces (TNI)			2
20	Retiree		1	
21	Artist			1
22	Domestic Helper			32
23	Driver			24
24	Other Private Sector	622	355	717
25	Trader		23	
26	Not Yet. Not Working		257	

Table 4. Community Education Level

No	Education Level	Total (People)		
		Talun Village	Pupus Village	Gondowido Village
1	Not in School/Illiterate	12	32	2
2	Playgroup and Kindergarten	-	-	50
3	Not Completed Elementary School/Islamic	-	359	155
4	Elementary School/Equivalent	785	720	452
5	Not yet graduated from junior high school/Islamic junior high school/equivalent	-	-	57
6	Graduated from junior high school/Islamic junior high school/equivalent	489	278	525
7	Not yet graduated from high school/vocational school/Islamic high school/equivalent	-	-	19
8	High School/Vocational School/Islamic High School/Equivalent	358	113	179
9	Diploma	-	-	10
10	Bachelor's Degree	25	25	7
11	Postgraduate Master's Degree	-	1	-

### 3.2. Culture

The culture of mutual cooperation (gotong royong) in development remains deeply embedded in the lives of the people of Pupus Village, Gondowido Village, and Talun Village. For example, building bridges and constructing houses is all carried out through mutual cooperation, or "sambatan" (community work), as the villagers call it. Javanese cultural nuances are strongly felt in the three buffer villages of the Mount Picis Nature Reserve and the Mount Sigogor Nature Reserve. Islamic religious activities are strongly influenced by Javanese cultural and social aspects. This is reflected in the use of the Javanese/Islamic calendar, the continued existence of the *Nyadran* (prayer gathering), *slametan* (sacred gathering), *tahlilan* (prayer gathering), *mithoni* (prayer gathering), and other traditions, all of which reflect Islamic and Javanese culture.

### 3.3. Community Empowerment

Currently, there are three community groups supported in each of the buffer zones of the Mount Picis Nature Reserve and Mount Sigogor Nature Reserve. These three groups are:

- a. Wana Husada Forest Farmers Group in Pupus Village. The Wana Husada Forest Farmers Group was established in 2019 and has 16 members. The focus of the Wana Husada Forest Farmers Group's community empowerment activities is the cultivation of Porang (Porang) and Family Medicinal Plants (TOGA).
- b. Picis Makmur Community Group in Gondowido Village. The Picis Makmur Community Group (KTH) was established in 2017, and in 2018, the group's management changed. Currently, the Picis Makmur Community Group has 32 members. The community empowerment activities for the Picis Makmur Community Group are Joper chicken cultivation.
- c. Karangringin Mulyo Community Group in Talun Village. The Karangringin Mulyo Community

Group (KTH) was established in April 2021 with 30 members. Based on an internal meeting, the group agreed to focus its community empowerment activities on catfish and klanceng cultivation.

### 3.4. Biological Potential

#### 3.4.1. Flora

The vegetation species of the Gunung Picis Nature Reserve and Gunung Sigogor Nature Reserve are almost identical. Based on the results of the 2020 biodiversity protection area verification, the flora of the Gunung Picis and Gunung Sigogor Nature Reserves include: Nyampuh (*Pygeum parviflorum*), Pasang (*Lithocarpus elegans*), Morosowa (*Engelhardtia spicata*), Talesan (*Persea odoratissima*), Dali (*Radermachera gigantea*), Suren (*Toona sureni*), Wesen (*Dodonaea viscosa*), Apak (*Casuarina junghuhniana*), Tutup (*Macaranga* sp), Gondang (*Ficus variegata*), Tlitih, Bawangan, Bendo (*Artocarpus elastica*), Gentungan, Ipik (*Fcus retusa* L.), Gitri (*Elaeocarpus sphaericus*), Gempong, Pasang rebung (*Castanopsis acuminatissima*). Kedoya (*Dysoxylum gaudichaudianum*), Puspa (*Schima wallichii*). Some of the dominant flora species in both nature reserves include Pasang (*Lithocarpus elegans*), Nyampuh (*Pygeum parviflorum*), Telesan (*Persea odoratissima*), Wesen (*Dodonaea viscosa*), and several orchid species, including *Vandopsis* sp., *Vanda* sp., *Calanthe triplitaca*, *Spathoglottis plicata*, and others. Some flora species with potential medicinal properties include Bendo (*Artocarpus elasticus*), Pasang (*Lithocarpus elegans*), Gotu Kola (*Centella asiatica*), Puspa (*Schima wallicii*), and Telesan (*Persea odoratissima*).



Figure 3. Flora Potential of the Mount Picis Nature Reserve and Mount Sigogor Nature Reserve

### 3.4.2. Fauna Potential

The fauna potential in the Mount Picis and Mount Sigogor Nature Reserves includes: Javan Hawk-eagle (*Nisaetus bartelsi*), Javan Leopard (*Panthera pardus melas*), Green Peacock (*Pavo muticus*), Red Junglefowl (*Gallus gallus*), Rice-crested Javan (*Cisticola juncidis*), Striped Javan (*Turnix suscitator*), Sriganti Sunbird (*Cinnyris jugularis*), Javan White-rumped Shama (*Ratufa bicolor*), River Kingfisher (*Todirahus chloris*), Javan Opor (*Losphozsterops javanicus*), Five-colored Pitta (*Hydrornis guajanus*), White-rumped Shama (*Psilopogon armillaris*), Beetle-billed Parrot (*Aplonis panayensis*), Green Junglefowl (*Gallus varius*), Coconut Squirrel (*Callosciurus notatus*), Civet Civet (*Paradoxurus hermaphrodites*), Long-tailed Macaque (*Macaca fascicularis*), pearl frog, Javan White-rumped Shama (*Ratufa bicolor*), porcupine (*Hystrix javanica*), Black Eagle (*Ictinaetus malayensis*), Bido Eagle (*Spilornis cheela*), Hornbill, Bodo Python (*Python molurus*), Tiger Bandotan (*Vipera russelli*), Lizard (*Lacerta agilis*), Chameleon (*Bronchocela jubata*), Gecko (*Gecko gekko*), Gecko (*Hemidactylus platyurus*), Dumung/cobra (*Naja sputatrix*).



Figure 4. Fauna Potential of the Mount Picis Nature Reserve and the Reserve

## 3.5. Non-Biological Potential

### 3.5.1. Water Environmental Services

Based on the identification and inventory of potential environmental services in the Mount Sigogor Nature Reserve in 2011, at least five water sources were identified, flowing from the conservation area into the Toyomerto River. The presence of these water sources within the conservation area plays a crucial role in maintaining biodiversity and ensuring the continuity of bioecological processes in the Mount Picis and Mount Sigogor Nature Reserves and their surrounding areas. In addition to providing water environmental services, the Mount Picis and Sigogor Nature Reserves also serve a hydrological function as water catchment areas for villages in the buffer zone.



Figure 5. One of the rivers in the Mount Sigogor Nature Reserve

### 3.5.2. Natural Laboratory

The mandate for designating the Mount Picis and Mount Sigogor areas as Nature Reserves is to protect the diversity of plants and wildlife. This biodiversity is one of the potentials of the Mount Picis and Mount Sigogor Nature Reserves. Through educational and research activities, the Mount Picis and Mount Sigogor Nature Reserves serve as natural laboratories that can serve as sources of scientific knowledge.



Figure 6. Potential survey activities in the Mount Picis Nature Reserve and Mount Sigogor Nature Reserve

### 3.5.3. Carbon Sequestration Services

The Mount Picis Nature Reserve and Mount Sigogor Nature Reserve provide valuable carbon sequestration services. Total biomass stock at the tree level with a diameter of >30 cm is 0.21 tons/ha and at the tree with a diameter of 5-30 cm is 0.02 tons/ha [17]. Understory biomass is 5.88 tons/ha, and total litter yield is 8.47 tons/ha. The total aboveground biomass stock of the 190.5-ha Mount Sigogor Nature Reserve is 1,438.78 tons. The predicted carbon stock in the Mount Sigogor Nature Reserve is 426.05 tons, capable of sequestering 1,601.93 tons of carbon dioxide.

### 3.6. History of the Area

The protected status of the Mount Picis and Mount Sigogor forest areas began during the Dutch colonial era in 1936, establishing a 218.4-hectare Natural Monument (Mount Picis 27.9 hectares and Sigogor 190.5 hectares). This was outlined in Decree of the Governor-General of the Dutch East Indies No. 23 Stbl 471 dated September 4, 1936, taking into account the diversity of plant species. In 2011, the Ministry of Forestry designated the Mount Picis and Mount Sigogor Nature Reserves as part of the East Java Provincial Forest area, as stipulated in Decree of the Minister of Forestry No. SK.395/KPts-II/2011 dated July 21, 2011.

Furthermore, the status of the Mount Picis Nature Reserve and the Mount Sigogor Nature Reserve was strengthened based on the Decree of the Minister of Environment and Forestry Number: 2137/MENLHK-PKTL/KUH/PLA.2/4/2017 Concerning the Map of the Development of the Confirmation of Forest Areas of East Java Province until 2016. In the 2012-2032 Ponorogo Regency Spatial Planning, the Mount Sigogor Nature Reserve is included in the protected

area whose utilization is to maintain the sustainability and/or improve the elements that support the strengthening of its protective function which is based on a mutually beneficial mechanism between the external environment and the living creatures in it. In 2012, the Long-Term Management Plan for the Mount Picis Nature Reserve and the Mount Sigogor Nature Reserve for the period 2012-2021 was prepared and ratified. The arrangement of the Mount Picis Nature Reserve and Mount Sigogor Nature Reserve area blocks was ratified in 2018 based on the Decree of the Director General of KSDAE Number: SK.190/KSDAE/SET/KSA.2/4/2018 and the Decree of the Director General of KSDAE Number: SK.191/KSDAE/SET/KSA.0/4/2018

### 3.7. Physical Conditions

#### 3.7.1. Climate, Topography, Soil Type, Geology, and Hydrology of Mount Picis Nature Reserve

Topographically from the west to the east of the Mount Picis Nature Reserve area is moderately undulating, from north to south the topography is steep, with a slope between 450-600. The altitude is  $\pm 1200$  meters above sea level. Based on the Geological map of East Java Province I scale 1: 500,000 issued by the Forest Inventory and Use Agency in 1977, the Mount Picis Nature Reserve area consists of Volcanic Rocks. Meanwhile, based on the Land map of East Java Province I scale 1: 500,000 issued by the Forest Inventory and Use Agency in 1977, the soil conditions in the Mount Picis Nature Reserve area consist of the Red Yellow Mediterranean Complex, Grumosol, Latosol, and basic and intermediate rocks. The Mount Picis Nature Reserve has a Type C climate with a Q value of 57.4% (Schmidt and Ferguson); The average annual rainfall is 2647 mm with an average of 147 rainy days; the rainy season occurs from November to May while the dry season occurs from June to October.

#### 3.7.2. Climate, Topography, Soil Type, Geology, and Hydrology of of Mount Sigogor Nature Reserve

The topography of the Mount Sigogor Nature Reserve area is hilly (located on the western slopes of Mt. Wilis) with moderate to steep slopes at elevations of 100-1,700 meters above sea level. The highest peaks are located in the southern part (Patak Banteng and Batu Blandar areas) and in the eastern part (Cengger area). According to the 1977 Geological Map of East Java Province, scale 1:500,000, issued by the Forest Inventory and Land Use Agency, the Sigogor Nature Reserve area consists of volcanic rocks. Meanwhile, according to the 1977 Soil Map of East Java Province, scale 1:500,000, issued by the Forest Inventory and Land Use Agency, the soil conditions within the Mount Sigogor Nature Reserve area consist of the Red-Yellow Mediterranean Complex, Grumosol, Latosol, and basic and intermediate rocks. The climate in CA Gunung Sigogor is type C with a Q value of 57% (Schmidt and

Ferguson); Average annual rainfall is 2582 mm with 142 rainy days; The rainy season occurs from November to May. Air temperatures at night range between 15-20°C and during the day between 30-35°C.

### 3.8. Current Condition (Area Importance)

#### 3.8.1. Area Importance

Mount Sigogor Nature Reserve and Mount Picis Nature Reserve as Habitat for the Javan Hawk-Eagle (*Nisaetus bartelsi*). Since 2012, the Mount Picis Nature Reserve has been designated as a monitoring site for the Javan Hawk-Eagle. Observations conducted in the Mount Picis Nature Reserve and Mount Sigogor Nature Reserve for seven days each year in July-August from 2013 to 2018 showed that the Javan Hawk-Eagle population in the area experienced an increase, indicated by the presence of young individuals and encounters at new locations [18].



Figure 7. Javan Hawk-eagle in the Mount Sigogor Nature Reserve

The diverse composition and structure of the vegetation, from seedling to tree stage, and the higher availability of seedling and sapling regeneration compared to tree vegetation, enable the regeneration/succession process of the forest ecosystems of the Mount Sigogor Nature Reserve and Mount Picis Nature Reserve, which serve as habitats for the Javan Hawk-eagle, to proceed stably and sustainably, thus ensuring the preservation of the species.

Mount Sigogor Nature Reserve as a Habitat for the Javan Leopard (*Panthera pardus melas*). Based on data collected by the Javan Carnivore Care (JCC), the distribution of the Javan leopard in East Java includes Alas Purwo National Park, Meru Betiri National Park, Baluran National Park, Bromo-Tengger-Semeru National Park, Ijen Crater National Park, Yang Highlands, Mount Arjuna, Mount Kawi-Kelud, Tuban, Ponorogo, Padangan, Saradan, Jember, Blitar, Jatirogo, Madiun, and Gundih (Ministry of Environment and Forestry, 2016). Although no data series is available yet, in 2020 the East Java Natural Resources Conservation Agency (BBKSDA) monitored the presence of the Javan leopard in the Mount Sigogor Nature Reserve through a verification activity for the

Javan leopard (*Panthera pardus melas*) biodiversity protection area in the Sigogor Nature Reserve. Monitoring results show that encounters only occurred in the eastern part of the area with a leopard encounter frequency of 20%.



Figure 8: Animal Carcasses Indicated by Food Remains (left) and Claw Marks (right) of a Leopard in the Mount Sigogor Nature Reserve

#### 3.8.2. Medicinal Plants in the Mount Picis and Mount Sigogor Nature Reserves.

Based on certain research about the Mount Picis and Mount Sigogor Nature Reserves, 12 tree species with known medicinal properties were identified: suren (*Toona sinensis*), puspa (*Schima wallichii*), morosowo (*Engelhardtia spicata*), talesan (*Persea odoratissima*), gitri (*Elaeocarpus sphaericus*), mangir (*Ganophyllum falcatum*), cempaka (*Turpinia sphaerocarpacea*), trawas (*Litseaodorifera*), nyampuh (*Pygeum parviflorum*), and red wood (*Payena lerii*) [19]. In 2018, the East Java Natural Resources Conservation Centre (KSDA) identified at least 65 species of medicinal plants in the Mount Sigogor Nature Reserve. Medicinal plant exploration activities in the Sigogor Nature Reserve resulted in the discovery and identification of 43 species of medicinal plants from 33 families [20]. These include *Persea odoratissima*; *Disporum cantoense*; and *Codonopsis javanica*.

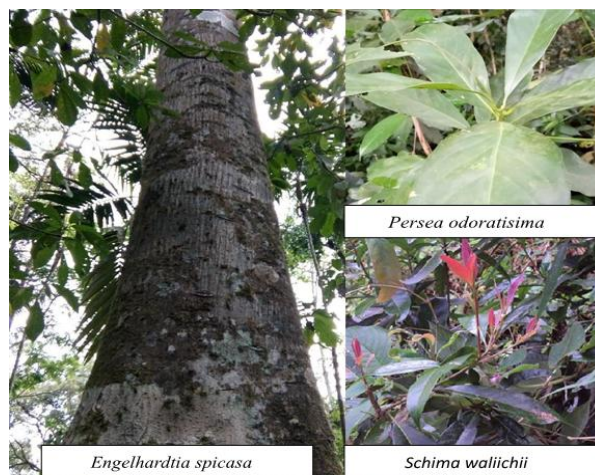


Figure 9. medicinal plants in Mount Sigogor and Mount Picis Nature reserve

### 3.9. Strategic Management Issues

#### 3.9.1. The Position of the Mount Picis Nature Reserve and Mount Sigogor Nature Reserve in the Ponorogo Regency Spatial Planning

Based on Regional Regulation Number 1 of 2012 concerning the Ponorogo Regency Spatial Planning Plan for 2012-2032, the Ponorogo Regency spatial planning includes protected areas; and cultivated areas.

Article 24 explains that the spatial planning for protected areas in Ponorogo Regency includes: 1) protected forest areas; 2) areas that provide protection for subordinate areas; 3) local protected areas; 4) nature reserves, cultural heritage, and nature conservation areas; 5) natural disaster areas; 6) geological protected areas; and 7) other protected areas.

Regional Regulation Number 1 of 2012 states that the Mount Picis Nature Reserve and the Mount Sigogor Nature Reserve are strategic areas of Ponorogo Regency from the perspective of their function and environmental carrying capacity. Therefore, this Regional Regulation serves as the basis for the Ponorogo Regency Government's support in optimizing the management of these two Nature Reserves.

#### 3.9.2. Legality of the Areas

The 27.90-hectare Mount Picis Nature Reserve and the 190.5-hectare Mount Sigogor Nature Reserve were designated based on Decree of the Governor-General of the Dutch East Indies Number 23 Stbl 471 dated September 4, 1936, and Decree of the Minister of Forestry and Plantations Number SK.417/KPtsII/1999 concerning the Designation of Forest and Water Areas in East Java Province. Subsequently, the status of the Mount Picis and Mount Sigogor Nature Reserves was confirmed by Decree of the Minister of Environment and Forestry Number 2137/MENLHK-PKTL/KUH/PLA.2/4/2017 concerning the Map of the Development of Forest Area Designation in East Java Province as of 2016. The absence of a Decree establishing the Mount Picis and Mount Sigogor Nature Reserves is feared to have resulted in suboptimal management of the areas.

#### 3.9.3. Boundary Markers

The Gunung Picis Nature Reserve has 196 boundary markers. Field observations indicate that the boundary markers are in good condition, with only two missing markers: markers 193 and 21. This was caused by natural factors, such as landslides. Meanwhile, the Gunung Sigogor Nature Reserve has 364 boundary markers. Field observations indicate that some require maintenance, as some marker numbers have been lost or erased. Furthermore, several duplicate markers exist, making it difficult for officers to determine the area's functional boundaries.

#### 3.9.4. Mismatch between Boundary Marker Position and Map

Development of Area Establishment. Based on the results of checking the position of boundary markers in the Gunung Picis Nature Reserve and Gunung Sigogor Nature Reserve, there is a discrepancy between the existing conditions in the field and the map attached to the Decree of the Minister of Environment and Forestry Number: 2137/MENLHK-PKTL/KUH/PLA.2/4/2017 concerning the Map of Development of Forest Area Establishment in East Java Province up to 2016.

#### 3.9.5. Forest Fires

Forest fires are extremely rare. However, they also pose a threat to the integrity of the area, as the Gunung Picis and Gunung Sigogor Nature Reserves border Perum Perhutani's production forests, which are prone to fires that could spread into the nature reserves. In 2015, a forest fire burned 3.07 hectares in the Gunung Sigogor Nature Reserve, and the area has since been rehabilitated.



Figure 10. Forest Fire in the Cengger Block, Gunung Sigogor Nature Reserve, 2015

#### 3.9.6. Community Interactions That Potentially Disrupt the Integrity of the Area

The presence of the Kandangan coffee plantation directly bordering the Gunung Sigogor Nature Reserve poses a threat that management must be vigilant about. The remoteness of access to the border and the difficult terrain present challenges for officers. In addition to the coffee plantation, the activities of the surrounding community, such as water and animal feed extraction, also require attention. Through routine patrols and social approaches, it is hoped that these community activities will not spill over into the nature reserve.



Figure 11. Routine patrols and community outreach around the Mount Picis and Sigogor Nature Reserves.

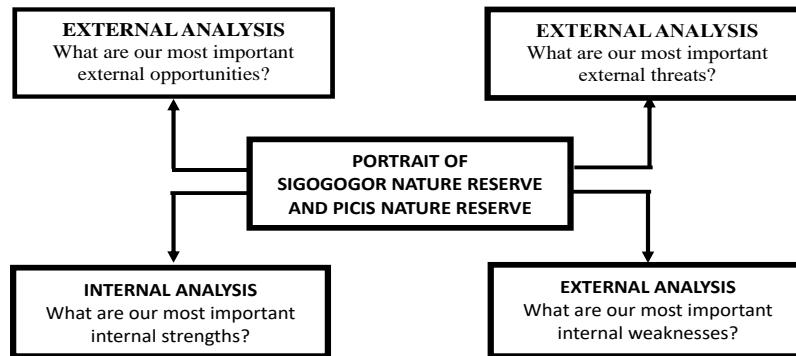


Figure 12. External and Internal Analysis Model

Table 5. Identification of Internal and External Conditions

Strengths	
1	Regional integrity
2	High diversity of flora and fauna
3	Potential for providing environmental services (carbon and water)
4	Habitat for important wildlife (tiger, Javan hawk-eagle)
5	Clear regulations regarding the management of Nature Reserves and Nature Tourism Parks
Weaknesses	
1	The area has not been designated
2	Infrastructure is inadequate
3	Human Resources are inadequate
4	Data on areas that have not been optimally managed
Opportunities	
1	Local government support for the preservation and management of the area
2	The presence of universities and research institutions that support research and development activities in the area
3	Support from the government and surrounding communities
4	Establishment of Agro Forestry Community Group in 3 Buffer Villages
5	Establishment of Fire-Awareness Community Groups in 3 Buffer Villages
Threats	
1	Low levels of education and welfare of the surrounding community
2	Natural disasters, especially forest fires, are common due to the border with the Perhutani forest area
3	The presence of a Kandangan coffee plantation bordering the Nature Reserve
4	Community water and animal feed extraction from the surrounding Nature Reserve area

SWOT analysis can be applied by analyzing and sorting out various things that influence the four factors, then applying them in a SWOT matrix image, where the application is how the strengths in the management of the Nature Reserve are able to take advantage of the opportunities that exist, how to

### 3.9.7. Identifying Internal and External Factors

To achieve the desired conditions, it is necessary to identify internal and external conditions and develop a management strategy, as can be seen on Figure 12 and Table 5. One approach is through a SWOT (strengths, weaknesses, opportunities, and threats) analysis. The SWOT analysis process involves determining specific objectives from various management options and identifying internal and external factors that support and hinder the achievement of these management objectives.

overcome the weaknesses in management that prevent the advantages of the opportunities that exist, then how the strengths of management are able to face the threats that exist, and finally how to overcome the weaknesses in management that are able to make threats become real or create a new threat [21]. The SWOT analysis applied can be seen on Table 6.

Table 6. SWOT Analysis

Internal External	Strengths (S)	Weaknesses (W)
Opportunity (O)	SO Strategy: Collaboration in area management with other institutions Development of a database of area potential Community-based area security	WO Strategy: Database development Improving the quality and quantity of human resources in the field Collaborative area management planning Adding management facilities and infrastructure
	ST Strategy: Empowering communities in buffer zones Involving surrounding communities in disaster response	WT Strategy: Community-based area security Area strengthening
Threat (T)		

### 3.10. Ecotourism Potential Development Strategy for Sigogor and Picis National Parks

#### 3.10.1. Strategy 1: Developing a Regional Potential Database

The Mount Picis and Mount Sigogor National Parks have unique biodiversity potential, including being the habitat of the Javan hawk-eagle. This is one reason why researchers frequently visit these areas for

research. However, these research activities often fall short of management objectives due to suboptimal data management. To provide regional information and research services, a regional database needs to be developed.

The action plan is as follows:

- a. Procurement of a digital-based database application,
- b. Training on the operation of the digital-based database application,
- c. Routine operation of the digital-based database,
- d. Monitoring of regional potential,
- e. Procurement of digital-based database equipment,
- f. Compilation of regional information books, and
- g. Establishment of an Information Center.

#### 3.10.2. Strategy 2: Adding Management Infrastructure

Given the number of existing infrastructure facilities, several in Gunung Picis and Gunung Sigogor National Parks are ineffective and poorly managed. To implement these additional management facilities and infrastructure, the following action plan has been developed:

- a. Procurement of a Community Conservation Area Office,
- b. Procurement of signage and area information boards,
- c. Procurement of GPS,
- d. Procurement of Camera Traps,
- e. Procurement of two-wheeled vehicles,
- f. Procurement of computers, and
- g. Procurement of printers.

#### 3.10.3. Strategy 3: Developing Collaborative Area Management

The numerous parties concerned about area management provide an opportunity to collaborate with them on various activities to implement the strategy for developing collaborative management. The Action Plan is as follows:

- a. Coordination/socialization/collaboration on biodiversity management with the Indonesian Institute of Sciences, universities, and the Research Institute for Medicinal Plants and Traditional Medicines,
- b. Coordination/socialization/collaboration on area security management with Perum Perhutani and Plantations,

- c. Coordination/socialization/research collaboration with universities/research institutions.

#### 3.10.4. Strategy 4: Improving the Quality of Human Resources for Management

A fundamental problem in the management of the Gunung Picis and Gunung Sigogor National Parks is the lack of management personnel and their competency. Therefore, strategies to improve the quality and quantity of human resources are essential. To implement this strategy, the action plan includes:

- a. Training on area potential inventory,
- b. Training on endemic plant nurseries,
- c. Training on Geographic Information System management

#### 3.10.5. Strategy 5: Community-Based Area Security

The Gunung Picis and Gunung Sigogor protected areas remain vulnerable to disturbances, particularly through livestock forage collection and forest fires. These violations can be caused by ignorance/lack of information, negligence, or deliberate action. With protected areas, the management objectives of enhancing flora and fauna-based research and education and improving the quality of beneficial area management can be achieved.

To implement the community-based area security strategy, the following action plan has been formulated:

- a. Routine area patrols/fire patrols,
- b. Publicizing area functions and fire prevention,
- c. Installing prohibition signs/warning signs,
- d. Developing MMPs and MPAs,
- e. Adding MMPs,
- f. Building firebreaks,
- g. Extinguishing fires,
- h. Post-fire monitoring,
- i. Area security operations,
- j. Maintaining boundary markers,
- k. Procuring firefighting infrastructure: Firefighting equipment and Personal use extinguishers.

#### 3.10.6. Strategy 6: Community Empowerment in Buffer Zones

The existence of conservation areas must provide benefits to the community. One strategy to increase the value of the area's benefits to the community is community empowerment activities. In addition to improving the community's economy, empowerment activities also aim to reduce community pressure on the

area. To implement the community empowerment strategy, the action plan developed is:

- a. Formation/guidance of community groups,
- b. Capacity building of groups,
- c. Providing assistance for productive economic enterprises,
- d. Evaluation and monitoring.

### 3.10.7. Strategy 7: Community Involvement in Disaster Response Activities

To date, the disasters that have occurred in the Gung Picis and Gunung Sigogor Conservation Areas have been forest fires. These conditions are caused by a very long dry season, which causes the grass bordering the area to burn. The community's role in disasters includes assisting in extinguishing fires in the surrounding areas. Besides fires, other potential hazards in the surrounding areas include landslides and flooding. To realize the role of the community in disaster response, the proposed action plan is:

- a. Disseminating prevention information to the community,
- b. Coordinating/disseminating/collaborating on SAR/disaster management with the Regional Disaster Management Agency (BPBD)/Basarnas, and
- c. Conducting independent evacuation training.

## 4. Conclusion

The SWOT analysis identified several key factors: Key strengths include the area's integrity and biodiversity. Opportunities include local government support and the establishment of Forest Farmer Groups (KTH) in three buffer villages. Meanwhile, significant internal weaknesses include the area's lack of definitive designation, inadequate infrastructure, and suboptimal area data. The main external threats are the low level of education and well-being of the surrounding community, as well as the threat of forest fires due to its border with Perum Perhutani's production forest. The formulated management strategy seeks to maximize strengths to capitalize on opportunities, while minimizing weaknesses and avoiding threats. The strategy's primary objectives are to enhance area-based research and education, and to maintain area integrity through community-based security and local economic empowerment. This emphasizes that ecotourism development must be adaptive, sustainable, and integrate conservation interests with the well-being of surrounding communities.

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