The Biodiversity of Mount Papandayan and the Threats

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Abstract

Mountain forests in Java play a critical role as biodiversity refuge given that most lowland forests in this island have been converted to other uses. Most mountain forests in Java, however, are not well managed and often suffered from lacking of scientific information necessary for construction of effective management. This study aimed to provide latest information on the biodiversity status of Mount Papandayan and identification of the threats. Biodiversity assessment was conducted for plants and birds in three major natural vegetation types, i.e. craters vegetation, mixed forest and grassland. Socio-economic survey was conducted in the villages surrounding to identify the threats and revealing the underlying causes. This study indicated that the mountain forest of Mount Papandayan possessed fairly high plant diversity and its vegetation exhibited distinct compositional feature. This study also documented the impact of year 2002 eruption on crater vegetation. The bird survey revealed that Mount Papandayan was an important area for bird conservation, given the presence of several protected species. This study found that the major threat to the integrity of Mt. Papandayan ecosystem was forest encroachment to create agricultural fields. Poverty trap was the main underlying cause triggering many destructive activities in this area.

Key words: biodiversity, plants, birds, threats, Mount Papandayan

Introduction

Tropical mountain forests in Java play a critical role as biodiversity refuge given the fact that most lowland tropical rainforests in this island has been converted to other uses (Whitten et al., 1996). Despite their critical role, only a few of them are managed well in a 'secure' status like national park. Mountain forests outside national park are generally not well managed compared to those designated as national park; mainly due to limitation of resources. Limited resources make most forest outside national parks suffering from lacking of scientificinformation particularly on biodiversity status of the areas.

Meanwhile, the ecological roles of these areas are under intense pressures because of land conversion, logging, over-harvesting of forest products and animal poaching. Apart from not knowing what is actually lost, scarcity of particularly up-to-date scientific information could hinder construction of effective measure to eliminate the threats and maintain the ecological roles.

The objective of this project was to provide latest information on the biodiversity status of Mount Papandayan and identification of the threats. Mount Papandayan is a nature reserve in West Java Province with an area of approx. 6,800 hectares. Van Steenis (1972) -- quoting earlier works – suggested that Mount Papandayan was floristically very rich. Since then, however, there has been no major scientific study in this area.

This study was expected to make contribution in updating the scientific information (particularly on plants and birds) on the area and revealing the threats. The findings of this project could then be used by as the basis for improving the management of Mount Papandayan Nature Reserve.

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Study Area

Mount Papandayan is an active volcano located in the southern part of West Java Province. The last major eruption occurred in 2002. Its peak is located at 07o19'42''S and 107o44'00''E with the elevation of 2,675 m asl. Administratively, it belongs to the Garut Regency (eastern part) and Bandung Regency (western part). Almost all forested areas in Mount Papandayan has been designated as nature reserve (6,800 ha). The main authority managing this area is Natural Resource Conservation Bureau of West Java Province (BKSDA JABAR II). The Mount Papandayan Nature Reserve shares borders with production forests planted with pines and *Altingia exelsa* (under the management of a state-owned forestry company, PERHUTANI) as well as tea plantation (under the management of a state-owned plantation company, PTPN VIII). Since the onset of Indonesia's financial crisis in 1997, large scale conversion of forests into agricultural fields has occurred mainly in the areas near the edge of the Nature Reserve. This study was mainly conducted in the forests within the Nature Reserve, near the border to the production forests and tea plantations as well as in several villages surrounding Mount Papandayan (Figure 1).

Methods

Vegetation Survey

Plant diversity assessment was conducted using plot-based sampling on several sites reflecting the variation of ecosystems in the study area, i.e. vegetation near volcanic crater that was affected and un-affected by the 2002 eruption, mixed forest and grassland. Measurements were conducted for all species of the following life forms: tree, shrub, herb and climber. The sampling plots were nested in which size of the outermost plot was 20 x 20 m2 (for trees with DBH >= 10 cm) enclosing four 5 x 5 m2 plots (for trees with DBH < 10 cm, shrubs and climbers). Within each of the 5 x 5 m2 plots, four 1 x 1 m2 plots were set for measuring herbs. The number of plots in each site was 10 for the crater vegetation, nine for the mixed forest and 22 for the grassland. The main parameter measured in each plot was species abundance, presented as the number of individual per plot for tree. For the herbs in the grassland, the abundance was presented as percent coverage. The data was subsequently analyzed to calculate relative abundance and Shannon's Diversity Index (Stiling, 1999). The major fieldwork was conducted during the period of June – September 2004. Additional qualitative survey was conducted recently, i.e. April and June 2006.

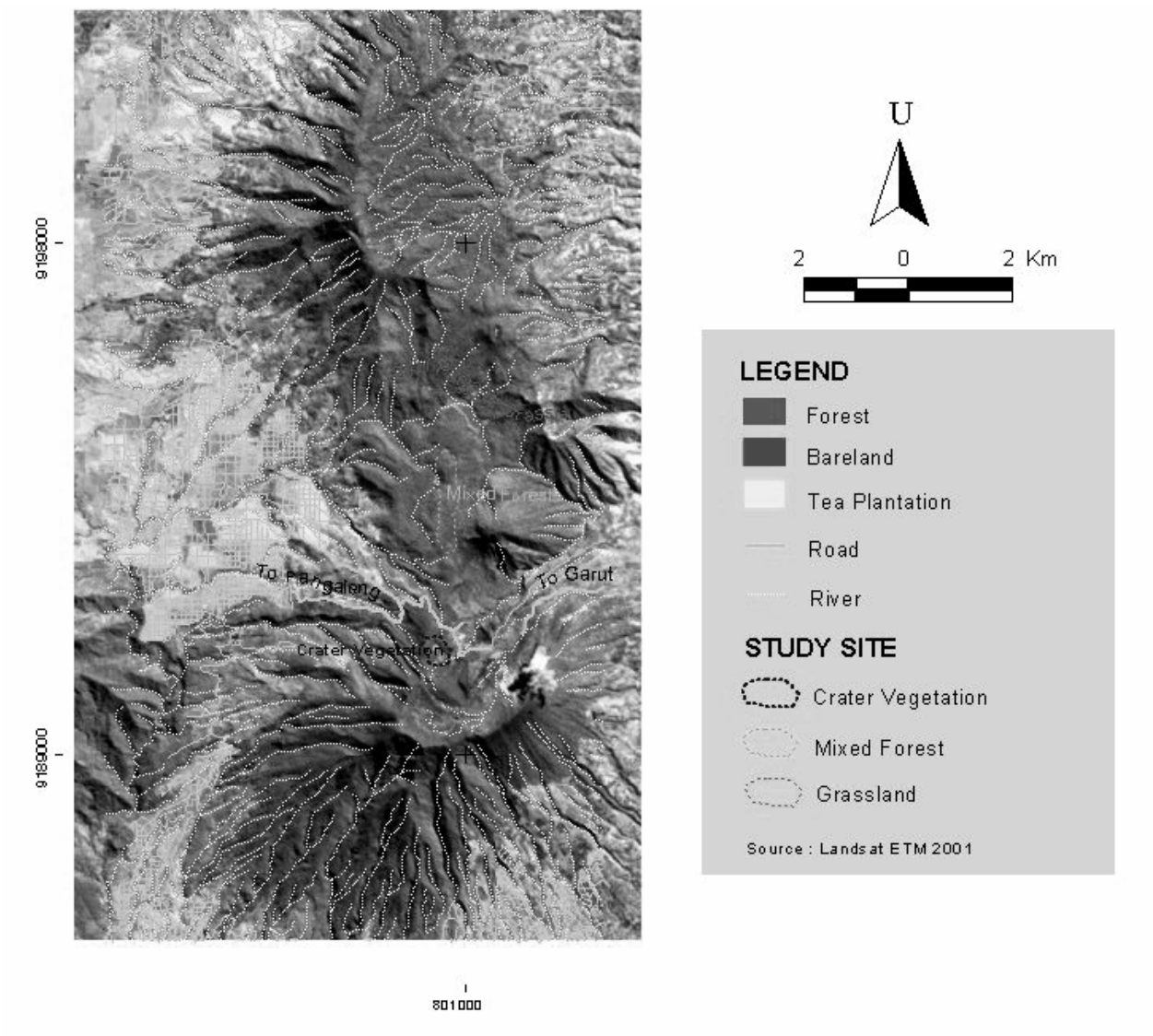

Figure 1. Mount Papandayan region. The study sites are marked with dotted circles.

Bird Survey

Bird survey was conducted in the crater vegetation, the mixed forests and forest areas near the edge of the Nature Reserve bordering with agricultural fields. Bird diversity assessment was conducted using a modified transect method. In this survey, the distance along transect was ignored; instead, the counting of the bird was recorded on 2 hours interval. The total length of observation time was (± 38 hours). This paper only presents the qualitative result, i.e. the number of species and conservation status, while the data on the abundance of each species can be found in Sulistyawati *et al.* (2005a). The fieldwork was conducted during the period of June – September 2006.

Socio-economic Survey

The socio economic survey was focused on four villages, i.e. Sirnajaya and Kramat Wangi belonging to Garut Regency, and Sukamanah and Santosa belonging to Bandung Regency. We conducted direct observation to identify the threats. In addition, a number of indepth interviews and focused group discussion (FGD) were also conducted to reveal the underlying causes of presently-occurring destructive activities. The respondents of this socioeconomic survey included local government officers, the nature reserve officers and PERHUTANI officers, farmers, petty-traders, local NGOs and visitors.

Results and Discussions

Plant diversity and vegetation composition

During the vegetation survey, we found 42 species of trees, 14 species of shrubs, 106 species of herbs and 23 species of climbers. The complete list of species can be found in Sulistyawati *et al*. (2005b). There was variation on the level of plant diversity of among the study sites, as measured by both the species richness and the Shannon Index (Table 1). For almost all life forms, the plant diversity of the mixed forest was higher than that of the crater vegetations and grassland. Meanwhile, the diversity on the crater vegetation unaffected by the 2002 eruption was higher than on the site affected by the eruption. Comparison with other mountain forests of comparable altitude, i.e. in Mount Pangrago (Yamada, 1977) and Mount Tangkubanparahu (Susanti, 2004) suggests that the mountain forest of Mount Papandayan
possessed fairly high plant diversity.

Table 1. The level of plant diversity as measured by species richness (S) and Shannon Index (H')

Sites	Trees d>=10cm		Trees d<10cm		Shrubs		Herbs		Climbers	
	S	H'	S	H'	S	H'	S	H'	S	H'
Crater Veg. -Affected	-	-	-	-	3	0.28	7	1.65	-	-
Crater Veg. -Unaffected			8	1.54	5	1.34	10	1.75	3	0.6
Grassland	-	-	-	-	-	-	26	1.97	-	-
Mixed forest	35	2.9	28	2.9	11	0,63	53	2.32	15	2.19

Variation on the vegetation composition among study sites can be seen from the dominant species presented in Table 2. In both sites of the crater vegetation, *Vaccinium varingiaefolium* (shrub) was dominant. However, the site affected by year 2002 eruption differed from the unaffected site in that it had less shrubs and herbs as well as had no tree, climber and epiphyte. *Anaphalis javanica* (Javan eidelweiss), which was previously abundant in the affected site, was not found during the 2002 fieldwork. The dominance of *Vaccinium varingiaefolium* indicates that this species is able to withstand the environmental changes caused by volcanic eruption. This study also shows that the recovery of understorey vegetation (herb layer) after the volcanic eruption has occurred considerably quickly. After two years, grasses and ferns were abundant with significant coverage. A recent visit to the effected site

in June 2006 found that the diversity and coverage of herbs has increased since our fieldwork in 2004. We also noticed that the quick recovery of understorey vegetation has also occurred on many other parts of crater vegetation affected by the 2002 eruption.

Table 2: The dominant species presented as up to four species with the highest relative abundance.

Life Forms	Sites			
	Crater Veg - Affected	Crater Veg - Unaffected	Mixed Forest	Grassland
Trees, d>= 10 cm			*Distylium stellare (19,6)*	
			Cyathea latebrosa (10,3)	
			Engelhardia spicata (10,3)	
			Macropanax dispermus (6,1)	
Trees, d< 10 cm		*Myrsine affinis (31,2)*	*Neolitsea javanica (14,7)*	
		Schefflera lucescens (18,9)	*Syzygium glomeruliferum (10,3)*	
		Acronodia punctata (12,5)	*Distylium stellare (9,6)*	
		Helicia serrata (12,5)	*Ardisia javanica (8,0)*	
Shrubs	*Vaccinium varingiaefolium (93,6)*	*Vaccinium varingiaefolium (44,4)*	*Strobilanthes spp (86,64)*	
	Melastoma malabathricum (3,2)	*Melastoma malabathricum (28,4)*	*Piper sulcatum (5,27)*	
	Myryca javanica (3,2)	*Anaphalis javanica (14,8)*	*Dichroa febrifuga (2,46)*	
		Eupathorium inulifolium (6,2)	*Eupathorium inulifolium (1,93)*	
Herbs	*Carex myosurus (31,5)*	*Dicranopteris linearis (33,2)*	*Elatostema eurhynchum (33,4)*	*Imperata cylindrica (51,2)*
	Pteridium aquilinum (20,5)	*Carex phacota (29,0)*	*Elatostema rostratum (23,9)*	*Bacopa sp. (7,7)*
	Polypodium feei (15,8)	*Imperata cylindrica (13,8)*	*Strophacanthus membranifolius (7,6)*	*Gonostegia hirta (5,9)*
	Carex phacota (15,0)	*Histiopteris incisa (9,5)*	*Eupatorium riparium (4,9)*	*Eupatorium riparium (5,4)*
Climbers		*Gaultheria leucocarpa (81,3)*	*Rubus moluccanus (22,8)*	
		Polygonum chinense (12,5)	*Melothria pentaphylla (20,5)*	
		Smilax sp. (6,25)	*Rubia cordifolia (13,4)*	
			Heterosmilax sp. (9,4)	

In the mixed forest, the "big trees" were dominated by, among others, *Distylium stellare*. The dominance of *Distylium stellare* presents a distinct feature of the forest of Mount Papandayan compared to other mountain forests in West Java. To our knowledge, this species was never reported to be dominant in the mountain forests of comparable altitude in West Java (see for example Susanti, 2004 for Mt. Tangkubaparahu and Yamada, 1977 for Mt. Pangrango). Another characteristic of the mixed forest of Mt. Papandayan is that the forest understorey was noticeably covered by genus of *Strobilathes* spp. Several species in this genus have unique characteristic as being monocarpic plant, which flowers only once in its life time and dies soon after flowering. Interestingly, the flowering and dying often occurs almost synchronously in a nine-year cycle for *Strobilathes cernua* (van Steenis, 1972). While none of this species flowered during the 2004 fieldwork, we witnessed a rare moment of synchronous flowering of *Strobilanthes cernua*, *S. paniculata* and *S. involucrata* during our recent visit in April 2006. We did not have information on the exact time of the last flowering, but our local guide mentioned that it was more than five year ago.

The grassland site of "Tegal Panjang" occurs in a unique setting, i.e. it is a small patch of grassland surrounded by wet and luxurious forest. Van Steenis (1972) suggested that the formation of this grassland was to large extent caused by recurrent burning intentionally orunintentionally started by humans probably since 1800an. The dominance of a phyrogenic (fire-lover) species of *Imperata cylindrica* indicates the role of fire in the formation and maintenance of such form of vegetation. In the grassland, one endemic herb species was found, i.e. *Alchemilla villosa*.

Bird diversity and conservation status

This study found 73 bird species belonging to 26 families. The complete list of species can be found in Sulistyawati *et al.* (2005a). The number of species found in the mixed forest (41) was higher than in the crater vegetation (16 species). The high diversity of plants and the structural complexity certainly contributes to the high bird diversity in the mixed forest.

Comparison with Hoogerwerf's data (1948), who conducted bird survey in this region, will illustrate the magnitude of environmental changes in this region. The number of species in this study was lower than Hoogerwerf's finding, i.e. 115 species belonging to 35 families. Of the species reported by Hoogerwerf, 51 were found in this study, thus 64 species were not re-found. In addition, this study found 22 species not reported by Hoogerwerf. The discrepancy between the current and Hoogerwerf's findings could possibly be attributed to the short survey time in this study. However, conversion of forests in the buffer zone into agricultural fields and poaching were likely to play a role in the disappearance of such large number of species.

This study also suggested the importance of Mount Papandayan for bird conservation. According to Birdlife International (2005), Mount Papandayan was an Important Bird Area (IBA) judged by the presence of 2 endangered species (EN), i.e. Javan hawk-eagle (*Spizaetus bartelsi*) and Blue-tailed trogon (*Harpactes reinwardtii*) as shown in Table 3. This study also found 16 restricted-range (RR) species, which covers 47% of the total restricted-range species living in Java. Of the total species found in this study, fifteen were protected by Indonesian regulations.

Table 3. Bird species having particular conservation status

Species		Status			
Indonesian	**Latin**	**RR**	**REG**	**EN**	**NT**
Elang-ular Bido	*Spilornis cheela*		*		
Elang hitam	*Igtinaetus malayensis*		*		
Elang Jawa	*Spizaetus bartelsi*	*	*	*	
Alap-alap capung	*Microchierax fringillarius*		*		
Alap-alap sapi	*Falco moluccencis*		*		
Alap-alap macan	*Falco severus*		*		
Puyuh-gonggong Jawa	*Arborophila javanica*	*			
Ayam-hutan merah	*Gallus gallus*		*		
Walik kepala ungu	*Ptilonopus porphyreus*	*			
Walet gunung	*Collocalia vulcanorum*	*			*
Luntur gunung	*Harpectes reinwardtii*	*	*	*	
Luntur harimau	*Harpectes oreskios*		*		
Sepah gunung	*Pericrocotus miniatus*	*			
Cucak gunung	*Pycnonotus bimaculatus*	*			
Berkecet biru tua	*Cinclidium diana*	*			
Tepus pipi-perak	*Stachyris melanothorax*	*			
Wergan Jawa	*Alcippe pyrrhoptera*	*	*		
Cica matahari	*Crocias albonatus*	*	*		*
Tesia	*Tesia superciliaris*	*			
Cikrak muda	*Seicercus gramiceps*	*			
Kipasan ekor-merah	*Rhipidura phoenicura*	*	*		
Burung-madu gunung	*Aethopyga eximia*	*	*		
Pijantung kecil	*Arachnotera longirostra*		*		
Opior Jawa	*Lophozosterops javanicus*	*	*		

RR : restricted range; REG : protected by Indonesian regulations; EN : endanger; NT : near threathened

Threats to the biodiversity

This study suggested that the forest encroachment for creating agricultural fields in the buffer zone was the major threat to biodiversity of Mount Papandayan and integrity of ecosystem as a whole. Establishment of agricultural fields in the forest edge could widen the access to many parts of the reserve, which in turn would increase the risk of occurrence of other destructive activities. Other important threats included wildlife poaching especially birds, burning in the grassland and channeling water from the springs inside the reserve to the agricultural fields. Destructive activities associated with tourism such as collecting fire-wood by campers, littering and vandalism were also observed.

Poverty was the main underlying cause triggering many destructive activities in this area. Many farmers in the surrounding villages were in fact poor and landless. These farmers have been exploited by city-based merchants having big capital through money lending contracts. With the capital borrowed from the merchants, the landless farmers cleared forests to grow crops (e.g. cabbage, potato and tomatoes). Upon the harvest, they were compelled to sell the products to those merchants. In general, the terms of the contract were disadvantaging the farmers. This eventually put the farmers in big debt and created condition such that the farmers were unable to stop growing crops in the formerly forested lands. In other words, no matter how hard the farmer works, they will still be in poverty. The poverty is then inherited to their children creating what may be called sustained poverty. Apart from poverty, lack of awareness among the locals on the importance of conserving forests for future generations were also contributing to the occurrence of many destructive activities.

Another important cause is the weakness in the management of the Nature Reserve. Inadequacy in the number and quality of the staffs, limited equipments and lack of law enforcement to punish the actors of forest encroachment and poaching seemed to make the occurrence of destructive activities in the Nature Reserve hard to control. Adding to the problem on the management aspect is the un-ideal shape of the Reserve (see Figure 1), which is elongated and convoluted. An area having such a shape, compared to the one with compact and rounded shape, will have higher edge-to-interior ratio. Destructive activities, particularly in the form of land conversion, are usually started on the forest edge. Consequently, as the area has longer edge, the interior area will be more exposed to the risk of being disturbed.

Conclusions

This study has shown that the mountain forest of Mount Papandayan possessed fairly high plant diversity and its vegetation exhibited distinct compositional feature. The plant diversity as well as bird diversity in the mixed forest was higher than those found in other vegetation types. Mount Papandayan was an important area for bird conservation, judged by the presence of several protected species. However, comparison with historical data suggested that there has been significant reduction on the bird species, presumably linked to the conversion of forests into agricultural fields in some part of Mount Papandayan. This study found that the major threat to the biodiversity of Mount Papandayan and integrity of ecosystem as a whole. Poverty trap was the main underlying cause triggering many destructive activities in this area. Unless necessary actions are taken, the currently occurring destructive activities would lead to environmental degradation on Mount Papandayan ecosystem. Expression of some local people from a village nearby about the decreasing water availability may illustrate a negative impact started to be felt. Apart from causing environment degradation, the destructive activities would eventually exert impacts on the life of people living on the nearby on many aspects including social, economics and politics.

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