JOURNAL OF DEGRADED AND MINING LANDS MANAGEMENT
ISSN: 2339-076X (p); 2502-2458 (e), Volume 5, Number 3 (April 2018): 1299-1305
DOI:10.15243/jdmlm.2018.053.1299

Research Article

Checklist of flora along tourist trails to Mt. Lamongan, East Java (Indonesia): misconception of restoration and ecotourism programs in mountain region?

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Received 28 February 2018, Accepted 31 March 2018

Abstract: The aim of this research was to evaluate the diversity of plant species along the tourist trails to Mt. Lamongan and combat any misconceptions about ecosystem restoration and the ecotourism development program in Mt. Lamongan. A floristic survey was done through flora identification along the hiking trail from the gate of Mt. Lamongan nature recreation area in Papringan Village to the slopes of Mt. Lamongan. The identified species were listed and their taxonomic status analyzed using information from the GRIN website. This study found that exotic plant species are abundant along the tourist tract. Human activities were identified as contributing to the introduction and establishment of exotic plant species. Result of the research indicate that restoration knowledge and techniques do not exist in the Mt. Lamongan region. A comprehensive evaluation of flora should be implemented to enhance the restoration program and protect forest area, especially the tourist corridor to the peak of Mt. Lamongan. Integrated actions to enhance restoration and promote tourism are needed. It encompasses strengthening the restoration concept and technology, eradication of exotic plant species, and establishing a proper tourism interpretive tract.

Keywords*: exotic plant, invasive plant, mountain restoration, mountain tourism*

To cite this article: Hakim, L., Rahardi, B. and Rachmansyah, A. 2018. Checklist of flora along tourist trails to Mt. Lamongan, East Java (Indonesia): misconception of restoration and ecotourism programs in mountain region? J. Degrade. Min. Land Manage. 5(3): 1299-1305, DOI: 10.15243/jdmlm. 2018.053.1299.

Introduction

Tropical forest in East Java has been suffering from heavy disturbance. In the past decade, the lost of forest on East Java was enormous. Since the 1970s, the forest of East Java has been transformed through rapid and intensive deforestation. By 1999, forest cover in East Java totaled ± 1,357,640 Ha, of which only 578,374 Ha are declared as protected forest (Departemen Kehutanan, 2002). In recent years, remaining forest cover in East Java has increasingly been confined to the mountains and highland ecosystem spreading from Mt. Lawu (3,265 m above sea level), Mt. Wilis (2,460 m asl), Mt. Kelud (1,731 m asl), Mt. Butak (2,868 m asl), Mt. Arjuno (3,339), Mt. Welirang (3,156 m asl), Mt. Penanggungan (1,653 m asl), Mt. Semeru (3,676 m asl), Tengger highland-Mt. Bromo (2,392 m asl), Mt. Lamongan (1,651 m), Iyang highland-Mt. Argopuro (3,088 m asl), Mt. Raung (3,332 m asl) to Mt. Ijen (2.443 m asl). All of the area has been declared as protected area in some manner, including national parks, strict protected areas, wildlife sanctuaries, and grand forest (Smiet, 1992; Whitten et al., 1996; Carn, 2000). Some mountain areas have been designated by

UNESCO as biosphere reserve areas, including Mt. Semeru, Tengger highland, Mt. Bromo, and Mt. Ijen (Hakim and Soemarno, 2017).

Mt. Lamongan is one of the areas with potential geothermal energy, biodiversity and recently has become a popular nature-based tourism destination in East Java (Nasution and Tarmudji, 1981; Whitten et al., 1996; Deon et al., 2015). As with many forest areas on Java Island, rapid degradation of forest in Mt. Lamongan occurred after the economic crisis in 1997. In order to recover the ecosystem of Mt. Lamongan, numerous attempts at mountain forest rehabilitation and restoration programs have been made. Introduction of numerous plant species may be essential and has been practiced by the government and the local community. Interestingly, there are many rehabilitation activity which are linked to the tourism program. Plant introduction in degraded areas has been viewed as part of the effort to increase destination attractiveness. Today, ecotourism in mountain areas has gained momentum for development, and rehabilitation is one of the crucial efforts to improve destination quality. The development of the ecotourism program at Mt. Lamongan is especially relevant with the issues of increased tourism market demand to visit natural areas and programs to conserve biodiversity.

A plant species diversity database is required to establish comprehensive ecotourism planning at Mt. Lamongan. Developing a plant species database would provide crucial information on sustainable use of mountain flora. A plant database would provide information that has a significant value in tourism programs, such as nature interpretation. The descriptive information on flora species diversity would make it possible to design a sustainable tourism destination (Eagles et al., 2002; Hakim and Soemarno, 2017). Ecotourism sites often include attractive areas, containing numerous plants for education program purposes.

The investigation of mountain flora is also important to identify exotic plant species. Exotic plant species specific to the particular regions and ecosystem are often related to the number of programs, including land rehabilitation, ecosystem restoration and tourism site improvement. Exotic plant species has been reported to contribute to environmental degradation and biodiversity extinction (Myers et al., 2000). Aside from the work of van Steenis et al. (1972), to date there are no intensive studies focusing on mountain flora databases, especially on exotic plant species in mountain areas. With the increasing awareness of biodiversity extinction, more attention needs to be paid to the work of providing flora databases. Due to the lack of basic information on flora diversity, field research should be a crucial element in the management, planning and design of mountain areas as ecotourism destinations. The aim of this research is to evaluate the diversity of plant species along the tourist trails to Mt. Lamongan and combat any misconceptions about ecosystem restoration and the ecotourism development program in Mt. Lamongan.

Materials and Methods

Study area

The study was conducted at Mt. Lamongan in East Java Province, Indonesia. The Mt. Lamongan forest area reaches an altitude of between 400 and 1,651 m above the sea level. Mean annual temperature varies between 26-28 ºC. Administratively, the study area is situated in Lumajang Regency in East Java Province. The ecosystem types at Mt. Lamongan are diverse, ranging from primary mountain forest to secondary forest, shrubs-grassland, and plantations. There are fresh water lakes on the slopes of Mt. Lamongan, namely Lake Lading, Lake Klakah, and Lake Pakis. Since the economic crisis of 1997, a dramatic loss of mountain forest occurred, mainly due to the massive illegal harvesting. The degradation of lower mountain forest on Mt. Lamongan was initiated by the exploitation of timber species by local people. Now, there are few primary forest patches left on Mt. Lamongan due to degradation after illegal logging. A major part of the slope area of Mt. Lamongan is covered with shrubs and grassland. The top of the mountain is rocky, and vegetation consists of a mixture of shrubs and grassland. Recently, a large area of the shrubs and grassland have been subject to forest fires. Mt. Lamongan is surrounded by Javanese and Madurese rural settlements, agricultural fields, and state plantations. These villages are located at from 300 to 400 m asl. Farming is the primary economic activity in the majority of the rural area near Mt. Lamongan. The study was restricted to abandoned lands located between 400 m and 700 m elevation southwest of Mt. Lamongan. These areas were selected due to intensive interaction of humans and nature, including animal fed collection, a forest rehabilitation program, and tourism. Historically, this area was covered by lower mountain forest, but most of the forest lands were degraded and abandoned. We studied flora species diversity along the tourist trails covered with shrubs, grassland, and a small patch of secondary forest.

Methods

The study was conducted from January to June 2017. Prior to field observation, a secondary data exploration was carried out to understand the ecology of Mt. Lamongan and the socio-economic circumstances of the local community surrounding Mt. Lamongan, especially in Papringan village. Papringan village is the closest inhabited settlement to Mt. Lamongan. Administratively, the village belongs to Klakah sub-district-Lumajang Regency. The floristic survey was done through flora identification along the tourist hiking trail from the gate of Mt. Lamongan nature recreation area in Papringan Village to the slopes of Mt. Lamongan. This area is the degraded zone of Mt. Lamongan in which a patch of agro-forestry and small secondary forest exists among the dominant shrubs and grassland. Plant species were studied using direct plant identification. The identified species were listed and their taxonomic status was analyzed based on the GRIN website. The local name was generated from informants in the field and verified based on Flora of Java by Backer and Bakhuizen (1965) and Mountain Flora of Java by van Steenis et al. (1972). An interview with ten informants was conducted to gather information regarding the relationship between humans, forest resource exploitation, forest degradation and restoration programs which are implemented in Mt. Lamongan. Data were analyzed descriptively.

Results

Recent land types and plants species

Field observation revealed that the study area has been degraded. Informants stated that timber species were illegally harvested to sell in illegal markets and the forest has declined significantly as a result. Illegal logging and over-exploitation has contributed to the survival of timber species. After rapid forest degradation starting in 1997, in recent years the land has included four ecosystem types: agroforestry, shrubs and grassland, and secondary forest. A total of 224 plant species belonging to 62 families were found along the transects. The families with the highest number of species were Fabaceae (18 species), Asteraceae (12 species), Poaceae (13 species), and Euphorbiaceae (7 species). Mt. Lamongan is of particular significance for east javan rare species, including the pitcher plant. This species was reported in previous studies but not observed during field observation. A number of orchids and epiphyte were absent due to loss of host tree species.

Agroforestry

Agroforestry lands were distributed along the border of protected lowland mountain forest and settlement area. According to informants, the agroforestry area has flourished in some forest patches after the rapid deforestation occurred in 1999. Agroforestry area development was initiated as an effort to increase community participation and involvement in an attempt to improve forest quality. Recently, this area was established and maintained by the local residents through community based forest management practices. The number of native lower mountain plant species was extremely low, and the agroforestry area was dominated by plants with economic value. Informants point out that in the past, native vegetation was destroyed to provide clear lands for cultivation. Recently, the agroforetsry area has been characterized by timber and fruit tree species, including *Tectona grandis*, *Paraserianthus falcataria*, *Swietenia macrophylla*, *Gmelina arborea*, *Pithecellobium jiringa*, *Artocarpus heterophyllus*, *Persea americana*, and *Durio zibethinus*. Plants with potential market value such *Coffea canephora*, *C. excelxa* and *Theobroma cacao* were often planted under *Leucaena leucocephala*, *Parkia speciosa*, and *Pithecellobium jiringa*. Additional species found in the agroforestry area include *Musa* spp. Saplings and seedlings of *Swietenia macrophylla* were very common in the agroforestry area.

Shrubs and grassland

Shrubs and grasses grow everywhere as a result of the combination of rapid forest clearing and poor soil capability to support the growth of native forest vegetation (Figure 1). The shrubs and grassland were dominated by ferns and grasses. About 11 ferns were recorded, including *Drynaria quercifolia*, *Pteris ensiformis*, *Pityrogramma calomelanos*, *Stenochlaena palustris*, *Phyrosia nummularifolia*, *Nephrolepis* sp., *Davallia trichomanoides*, *Selaginella* sp., *Lygodium circinatum*, *L. flexuosum*, *Adiantum* sp., and *Cyathea* sp. The grasses include *Axonopus compressus*, *Eleusine indica*, *Eulalia amaura*, *Paspalum conjugatum*, *Apluda mutica*, *Imperata cylindrica*, *Themeda arguens*, *Sporobolus*, *Cynodon dactylon* and *Setaria palmifolia*. While some species are able to be use as animal feed, only a few species were

collected from the shrubs and grassland area for animal feed.

Secondary forest

The small area of secondary forest in Mt. Lamongan has been scattered, and the large lower mountain forest at the boundary of the rural settlement area has been converted into tree plantations. Recent secondary forest contains a number of lower mountain species, including *Trema orientalis*, *Alstonia scholaris*, *Bischofia javanica*, *Litsea* sp., *Engelhardia spicata* and *Ficus* sp. There are five *Ficus* species that are sparsely distributed in the study area, including *F. septica*, *F. benjamina*, *F. hispida*, *F. padana* and *F. variegata*. In the past, wood plants such as *Trema orientalis*, *Bischofia javanica*, *Litsea* sp. and *Engelhardia spicata* were all harvested illegally to provide wood for numerous civil construction projects. Informants point out that *Alstonia scholaris* was illegally collected as an ornamental tree which was recently planted in urban parks.

Exotic plant species

This survey found numerous non native plant species in the Mt. Lamongan ecosystem. These exotic plant species basically can be classified as valuable plant species and weeds.

Valuable species

The exotic plants in valuable plant species can be classified into fruit, vegetable, wood and other economic trees species.

Fruit trees: Fruit trees were introduced and planted in degraded land in Mt. Lamongan in the early 2000. Most species of fruit trees planted in Mt. Lamongan were edible and marketable. They include *Mangifera indica*, *Nephelium lappaceum*, *Annona muricata*, *Artocarpus heterophyllus*, *Persea americana*, *Durio zibethinus*, *Manilkara zapota*, *Psidium guajava*, *Lansium domesticum*, *Averrhoa carambola* and *Chrysophyllum cainito*. All of these species can be common and economically have played a substantial role in local household earnings**.** Other fruit trees with minor market value are *Anacardium occidentale*, *Syzygium cumini*, *Antidesma bunius*, *Dimocarpus longan* and *Annona reticulata***.**

Vegetables: Several plants are important sources of spices and vegetables, including *Piper nigrum*, *Leucaena leucocephala*, *Parkia speciosa*, *Pithecellobium jiringa*, *Aleurites moluccana* and *Cinnamomum burmanni*.

Wood and other economic tree species: A number of woody plants were introduced and planted in abandoned lands and can have a good market, including *Tectona grandis*, *Paraserianthus falcataria*, *Albizia chinensis*, *Swietenia macrophylla*, and *Gmelina arborea*. The species *Paraserianthus falcataria* dominates the agroforestry and plantation area that now has good prices in market. Important introduced economic plants come from the species *Coffea canephora*, *C. excelxa* and *Theobroma cacao*.

Weeds

Most of the invasive weed species in the Mt. Lamongan area belong to the families Asteraceae, Fabaceae and Poaceae. Senggani (*Melastoma malabathricum*) is considered as a major invasive species in the Mt. Lamongan area. Other invasive plant species have been found on or near Mt. Lamongan, including *Lantana camara* (Figure 2) and *Eupatorium inulifolium*. This species grows widely and occupied the open area on Mt. Lamongan. Another exotic plant is *Acacia mangium*. This species is native to Australasia zones and was introduced to Mt. Lamongan by local people as a fuel wood and soil improver. *Acacia mangium* was widely planted for the reforestation program**.**

Discussion

Mountain degradation in Mt. Lamongan resulted in three main types of ecosystem, namely shrubs-grassland, agroforestry areas and secondary forest. Agroforestry is the result of the governmental re-vegetation programs in degraded areas through the introduction of plant tree species as commodity crops, most commonly coffee. Globally, it is common for coffee to be cultivated in agroforestry systems (Lin, 2007; Jose, 2009). Besides contributing to the effort to improve greenery in degraded areas, this policy often contributes to the socio-economic improvement of local people in surrounding degraded areas. Shrubs-grassland is often established naturally in abandoned area. These ecosystems are widely found in open areas and are adaptive to drought and fire (Maestre et al., 2003; Nano and Clarke, 2011; Blair et al., 2014). Since the area has a high likelihood of forest fires, a control and monitoring area especially during the dry season is important to minimize forest fire risk on Mt. Lamongan. Some recently appearing secondary forest patches along the hiking trail corridor area in the past contained few valuable woody tree species and useful plants. The existence of secondary forest areas, however, is important in natural succession. The existence of secondary forest in degraded

areas is therefore crucial for a restoration program (Parrotta et al., 1997; Kennard, 2002).

The presence of numerous exotic plant species along the tourist tract of Mt. Lamongan indicates that native vegetation is potentially undergoing degradation (Stohlgren et al., 1999). The abundance of exotic and invasive species at Mt. Lamongan also indicates poor understanding of tropical mountain management after rapid degradation. There are two introduction programs which are responsible for the number of exotic plant species on Mt. Lamongan: (1) introducing and planting numerous plant species in the context of forest rehabilitation and restoration programs, and (2) introducing numerous plants as media for conservation education in the context of ecotourism. Globally, restoration of degraded ecosystems is an important environmental program. Science, technology and human skill in restoration is important. Problems in restoration of degraded native forest in developing countries are often related to lack of knowledge and competence in conducting a restoration program (Katz, 1996; Leigh, 2005; Harris et al., 2006; Aronson et al., 2017).

In fact, restoration implementation in Mt. Lamongan is hampered by the lack of data regarding flora for a basic restoration program. By considering the list of plant species, it seems that economic considerations are dominant in selection of species to introduce in degraded areas at Mt. Lamongan. Restoration of degraded mountain area is hampered by poor ecological knowledge and consideration. Numerous exotic plants along the tourist tract in Mt. Lamongan have important economic value. Because a restoration program generally requires active community participation, they often encourage it by permitting plants with economic value (or known as multi purpose tree species) to be grown in the restoration area (Johnson, 1983; Otsamo et al., 1997; Roshetko and Purnomosidhi, 2004). At Mt. Lamongan, the dominant plant species seem to be chosen as part of a strategy to involve local community participation in restoration programs.

Introduction of numerous exotic plant species is also triggered by and in many cases related to tourism development. Numerous plants have probably been planted because they are tourism attractions (Sullivan et al., 2005; Hakim et al., 2017). There are also arguments that three species have a crucial role in biodiversity and environmental education through tourism. This leads to the intensive use and introduction of exotic plant species in tourism area development.

In mountain areas in Java Island, the abundance of exotic plants has been considered one of the ecosystem's problems. As an impact on exotic plant invasions, only a few seedlings of timber species germinated in the soil surface (Hakim and Miyakawa, 2015). In the case of Mt. Lamongan, there are some important strategies to link restoration and tourism programs in degraded mountain area. The crucial programs include (1) strengthening the restoration concept and technology, (2) eradication of exotic plant species, and (3) establishing proper tourism interpretive tracts.

Strengthening the restoration concept and technology

The proper restoration concept and planning are vital in Mt. Lamongan. It is especially important when there are numerous stakeholders and communities paying attention to the restoration program, but there are no scientific restoration guidelines available. The restoration concept should involve abundant biophysical data related to the degraded area as well as a socio-cultural human dependency aspect to the resources. Integrating numerous maps of physical, chemical and biological properties is important (Aronson et al., 2017). Introduction of native plant species should be promoted in degraded land on Mt. Lamongan. In such a case, the technology of geographic information system (GIS) is important to assist restoration program planning and implementation (Rahman, 2014).

Eradication of exotic plant species

Eradication of exotic plant species is crucial in the restoration program (Myers et al., 2000). In order to protect the biodiversity of Mt. Lamongan, extensive efforts to eradicate weed species on Mt. Lamongan are needed. *Eupatorium inulifolium* is the most widespread weed in many mountain areas in Java, including on Mt. Lamongan. Invasion of *Eupatorium inulifolium* consequently led to decreased biodiversity (Tripathi et al., 2006).

Establishing tourism interpretive tracts

One problem faced by conservationist and ecotourism planners working to promote ecotourism on Mt. Lamongan is the lack of basic data about flora and integrating such information into tourism tract design. Education has a significant role in developing tourist knowledge and awareness of mountain biodiversity. Lack of interpretive design and facilities can diminish the ecosystem of natural areas. That was found at Mt Lamongan; interpretive tracts were dominated by exotic plant species. Introducing and strengthening native plant species populations is therefore important to creating and providing an

appropriate interpretive tract. The use of GIS in establishing proper tourism interpretive tracts has been widely recognized.

Figure 1. Grassland along tourist trails to Mt. Lamongan

Figure 2. *Lantana camara*, an exotic plant species with invasiveness potentiality found along tourist trails to Mt. Lamongan

Conclusion

At Mt. Lamongan, lack of comprehensive mountain flora diversity data is probably the main cause of the poor biodiversity and forest management. At Mt. Lamongan, it is shown by misconceptions about restoration and ecotourism development program. Adequate restoration knowledge and techniques do not exist at Mt. Lamongan. It is indicated by introduction of numerous non native plants, particularly three species, in mountain ecosystems. Inventorying plant species along the tourist tract to Mt. Lamongan able to evaluate the restoration and ecotourism destination development program in problems. Problems identified are largely attributable to the introduction of numerous exotic species in natural areas, which contradicts the vision of restoration and ecotourism programs. A comprehensive evaluation should be implemented to enhance restoration programs and protect forest areas, especially the tourist corridor to the peak of Mt. Lamongan. Integrative actions of strengthening restoration concepts and technology, eradication of exotic plant species, and establishing a proper tourism interpretive tract seem to be the crucial components of a strategy to increase the quality of the Mt. Lamongan ecosystem.

Acknowledgements

We thank Mr. Kiswoyo for field assistance and Lab. of Plant Taxonomy Department Biology-Brawijaya University for technical assistance in specimen identification.

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