

# Exotic plant species in the restoration project area in Ranupani recreation forest, Bromo Tengger Semeru National Park (Indonesia)

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## ABSTRACT

Exotic plant species invasiveness is the crucial issue in mountain forest ecosystems restoration programs. The aim of this research was identifying the diversity of exotic species in Tengger highlands. There are some important exotic plant species in Ranupani restoration area, including *Salvinia molesta* D. S. Mitch., *Acacia decurrens* Willd., *A. mangium* Willd., *Eupatorium inulifolium* Kunth., *E. riparium* Regel, *Solanum pseudocapsicum* Medik., *Zantedeschia aethiopica* (L.) Spreng., *Lantana camara* L., and *Fuchsia magellanica* Lam. Actually, among factors most favorable to exotic plants species invasion there are forest and habitat degradation. Clearing exotic plant species in restoration areas, building community awareness about exotic species and enhancing the capacity of national park management to control and monitor the existence of exotic plant species is extremely important.

## KEY WORDS

Mountain biodiversity; non-native plant; native habitat conservation.

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## INTRODUCTION

Exotic plant species, nowadays, are a significant issue in biodiversity conservation as they significantly contribute to native ecosystems disturbance by triggering biodiversity extinction. Ecologically, exotic plant species are able to alter ecosystem structure and function. Invasion of exotic plant species - particularly high in the degraded lands - is one of the crucial steps in the process of native species extinction. Recently, most of the world's ecosystems have been affected by exotic plant species invasion. Exotic plant species have been the subject of extensive ecological research in many countries,

especially in terms of biodiversity conservation (Stadler et al., 2000; D'Antonio & Meyerson, 2002).

Exotic plants are defined as those species that are naturally not occurring within their biographical ranges. Such plants are introduced from outside mostly due to anthropogenic (i.e. economic, social and cultural) factors. For example, numerous exotic plants are planted in home gardens due to their high economic value, or, some species have been introduced as ornamental plants. However, the contribution of humans in exotic plant species invasion is significant and exotic plants are particularly abundant in human-influenced ecosystems

(Mack & Lonsdale, 2001; Hakim & Nakagoshi, 2007; Dehnen-Schmutz et al., 2007).

A recent survey in Indonesian national park suggested that exotic plant species did contribute to biodiversity decline due to the extinction of several local species, many of which endemics to particular areas (Hakim, 2011; Hakim & Miyakawa, 2014). Hence, restoring tropical mountain forest is very important in mountain biodiversity conservation.

Tropical mountain forest restoration projects, however, exhibit a number of limitations (Hakim & Miyakawa, 2014), one of which certainly is the lack of a scientific comprehensive database of exotic plant species. The aim of this research is to provide basic data of exotic plants in Ranupani forest area in order to contribute to the near-future restoration management projects.

## MATERIAL AND METHODS

### *Study site*

In the end of 2010, the Japan International Cooperation Agency implemented the national restoration program in protected areas known as “Project on Capacity Building for Restoration of

Ecosystems in Conservation Areas in Indonesia”. Bromo Tengger Semeru National Park (BTSNP), particularly the Ranupani forest recreation area (2000–2200 m asl; average temperature 10–20 °C; relative humidity 80–85%), was one of the selected study areas (Fig.1). The project aimed at protecting the Lakes Pani and Regulo and restoring the tropical mountain forest surrounding them. In the past, Ranupani area was characterized by a great diversity in mountain flora species and both lakes were crucial freshwater resources for humans and wildlife. However, recently, the combination of population growth and forest fire led these areas under rapid degradation. Hence, the conflict between biodiversity protection in national park and socio-economic development appears all around Tengger Highland (Hakim, 2011). In Ranupani, human disturbance and natural forest fire damaged systematically the ecosystem, leading to the forest degradation with major consequences for Lake Ranu. Recently, also Lake Pani has been seriously degraded due to increasing population and intensive agricultural practices.

From a geological standpoint, the soil is composed of volcanic ash; the climax vegetation disappeared being replaced by a recent vegetation structure including pioneer to sub-climax species.

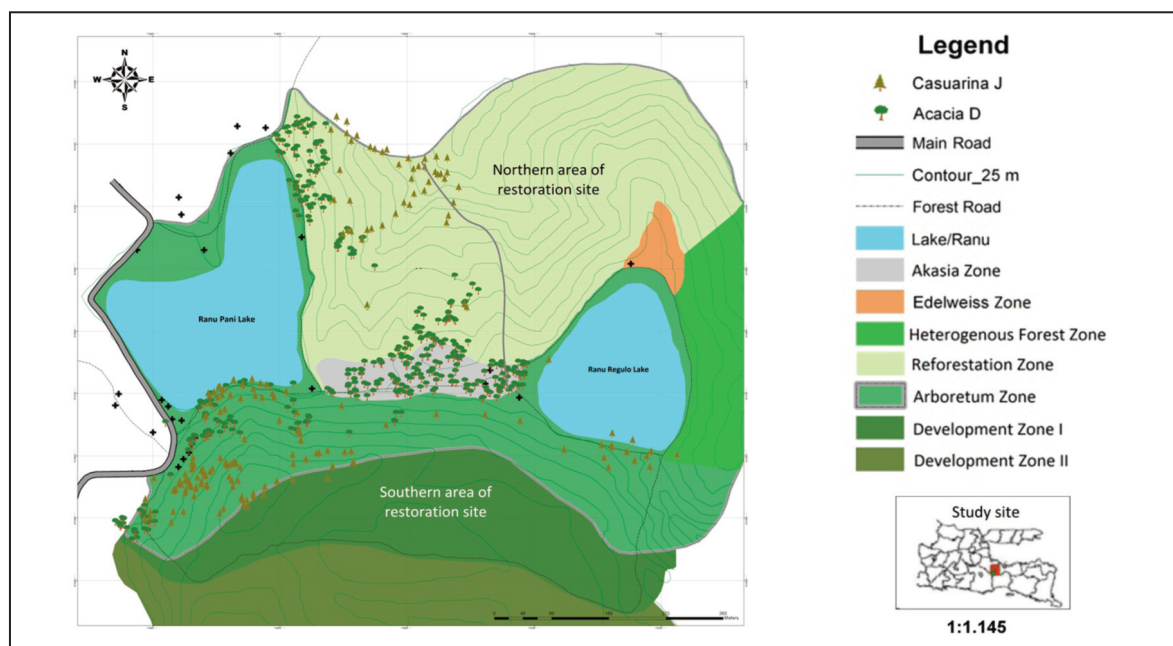


Figure 1. Restoration target area in Ranupani sector of the Bromo Tengger Semeru National Park.

In the eastern part of the lakes, young populations of *Casuarina junghuhniana* (Cemara Gunung) grow as pioneer species and occupy nearly 60% of the area. About 40% of the area was invaded by shrubs and herbs, including *Eupatorium inulifolium* (Kirinyuh), *E. riparium* (Tekelan), *Gonostegia hirta*, and *Imperata cylindrica* (Alang-alang). Original tropical mountain forest with *Acer laurinum* (Dadap putih), *Acmena acuminatissima* (Jambon, Tinggan, Salam badak), *Lithocarpus sundaicus* (Pasang), *Macropanax dispernum* (Pampung, Endog-endogan, Kodokan), *Engelhardia spicata* (Danglu, Kukrup, Morosowo), *Astronia spectabilis* (Kayu Ampet, Gembirung), *Turpinia sphaerocarpa* (Kayu Bangkong), *Cyathea contaminans* (Paku pohon) and *Omalanthus giganteus* (Tutup, kebu, belantih) has been replaced by grassland and barren lands dominated by shrubs.

In the past, the main threats to woody trees species primarily came from illegal logging, firewood collection and forest conversion into settlement and agricultural lands; dwellers of the village depended on firewood as fuel to cook and warm cold rooms (Hakim & Miyakawa, 2014). Many epiphytes orchids have been endangered due to the loss of woody vegetation however, in the eastern part of the area, there still is a woody vegetation with epiphytes orchids. Recently, Ranupani recreation forest has been considered as one of the most important tourism destinations in BTSNP.

### Methods

The study consisted of two fundamental parts. First, an intensive literature survey was done focusing on available references on exotic flora of mountainous regions, including "Flora Pegunungan Jawa" (van Steenis et al., 2006), "The Ecology of Java and Bali" (Whitten et al., 2002) and some other relevant books and scientific reports dealing with the ecology of Bromo Tengger Semeru National Park. All the information related to potential exotic plant species in mountain environments was listed systematically and verified using the Germplasm Resources Information Network or GRIN-USDA databases.

The list was used as guidance in plant species recognition in the field. Second, field surveys were carried out in February and August 2011, March and July 2012 and January and August 2013,

covering both rainy and dry seasons. All suspected exotic species were documented by photographs and some part of the plant species was collected and stored for the herbarium. Species identification was done by examining morphological and flora characters. In order to identify the type of relationship connecting humans and exotic plant species, we also conducted a semi structured interview with national park rangers, national park technicians, and representatives of local people in Ranupani Villages.

## RESULTS AND DISCUSSION

### *Exotic plant species in restoration area*

Ranupani forest is one of the hotspot of exotic plant species in Bromo Tengger Semeru National Park. Some notable important exotic species with high potentiality to hamper restoration programs are listed below.

#### *Salvinia molesta* D.S. Mitch.

Giant salvinia (Ki Ambang). Familia Salvinia-ceae. Native to South America, has been naturalized widely in tropic and subtropic regions. The species was considered as noxious weed (Arthington & Mitchell, 1986). Firstly recorded at Pani Lake in the middle of 2011 as small population in the periphery of lakes, its population grew very fast and covered about 75% of lake surface by the end of the same year (Fig. 2). Little is known of the introduction mechanism of Giant salvinia to Lake Pani. The rapid invasion of *Salvinia* in Pani Lake is one of the most important implications of water eutrophication.

#### *Acacia decurrens* Willd.

Black wattle, Green wattle (Akasia). Familia Fabaceae. Species native to Australia, New Zealand, Ethiopia, Tanzania, South Africa, India. In Mt. Merapi (Yogyakarta), after 1996 eruption, *A. decurrens* is one of the important species in ecosystems succession (Suryanto et al., 2010). In Ranupani, these trees grow to about 10 meter with a very dense crown of foliage; dead and down woody trees are collected as fuel wood. The species is tolerant to frost attack.

***Acacia mangium* Willd.**

Broadleaf salwood. Familia Fabaceae. Native to Australia, Vietnam, and Malaysia. In the past, few elements were introduced in an area adjacent to Ranu and Regulo lakes for reforestation. *Acacia mangium* is one of the rapid-growth species, especially in humid tropical environment. In Sabah, *A. mangium* was introduced and used to reduce forest fire. The species was reported as high competitor with *Imperata cylindrica* (Tsai, 1988). Norisada et al. (2005) reported that *A. mangium* can be used to enhance the survival rate of dipterocarp seedlings in reforestation programs.

***Eupatorium inulifolium* Kunth.**

Familia Asteraceae. Synonym of *Austroeupatorium inulifolium* (Kunth) R. M. King et H. Rob. Locally called Triwulan. The species is native to Central and Southern Americas (Panama, Guyana, Venezuela, Brazil, Bolivia, Ecuador, Peru, Argentina, Paraguay, Uruguay). During the early 1990s, *Eupatorium* was introduced for numerous agricultural purposes, i.e. compost, shading plant and soil conservation plant (van Steenis et al., 2006). It is found wherever there is open habitat. In the absence of forest trees canopy, the population of *E. inulifolium* is large and frequent. Under trees canopy, plants' density is low. The seedlings of *E. inulifolium* survive and grow under moderate to low light levels. Forest clearing in Ranupani area has severely increased *E. inulifolium* habitat over the years. In this area, the species blooms in the dry season, from June to September.

***Eupatorium riparium* Regel**

Familia Asteraceae. Synonym of *Ageratina riparia* (Regel) R. M. King et H. Rob. Native to Mexico but widely naturalized in Africa, Australia, Pacific, Southern America and Tropical Asia (including Indonesia). *Eupatorium riparium* grows on open grasslands and degraded lands (Tripathi et al., 1981). In Ranupani, the distribution and habits of the species is very large, ranging from open area to habitats under forest canopy. Ecologically, *E. riparium* is one of the most adaptive exotic species, which is why it was able to distribute in numerous habitats. The leaves are not resistant to frost attack.

***Solanum pseudocapsicum* Medik.**

Familia Solanaceae. Jerusalem cherry is a shrub up to 1.5 m tall, employed as ornamental plant. *Solanum pseudocapsicum* was found to invade small paths under *Acacia decurrens* canopy in Lake Regulo area. It forms dense patches and prevents the regeneration of native trees. *Solanum pseudocapsicum* is intolerant to drought (Aliero et al., 2006), which might explain its abundance in riparian area of Lake Regulo, but its absence in hills open area. The plant has the capacity to invade and transform areas by displacing existing native species thus allowing the soil erosion.

***Zantedeschia aethiopica* (L.) Spreng.**

White-arum-lily. Familia Araceae. Native to Southern Africa. It grows abundant in riparian zone of Ranupani Lake, but is absent in Ranu Regulo Lake. In Pani Lake, *Z. aethiopica* population grows fast, up to 75 cm with white trumpet-shape flower, spreading by rhizomes. Its density is higher in the semi-open habitat, in the south, whereas there are no populations in the northwest of the lake, which is dominated by sedimentations land and waste. The distribution and invasion of *Z. aethiopica* is limited by water content in soil as the plant is not drought tolerant (Bown, 2000).

***Lantana camara* L.**

Common lantana. Familia Verbenaceae. Locally called Kembang telekan. Van Steenis et al. (2006) note that *L. camara* was introduced in 1850 as ornamental plant. It is one of the most colorful exotic plant species. The species was reported as fire tolerant and has better adaptability and ability compared to the indigenous flora (Gentle & Duggin, 1997; Sharma et al., 2005). The shrubs grow rapidly on degraded lands.

***Fuchsia magellanica* Lam.**

Fuchsia. Locally called Anting-anting. Familia Onagraceae. Native to Argentina and Chile, naturalized in Bolivia, Canary Islands, Kenya, Tanzania, Australia, New Zealand, UK, and Hawaii. At first, it was introduced as ornamental plant (Hakim & Nakagoshi, 2007). When in bloom, *F. magellanica*





Figure 2. The invasion of *Salvinia molesta* in Lake Pani (Ranu Pani).

is a very beautiful decorative species. *Fuchsia magellanica* inhabits grassland and shrubs land, but is absent under forest canopy.

### ***The implication for forest restoration program***

According to national park's ranger and technicians, there has been a rapid increase of the area covered by exotic plant species, which is attributable to several important factors, including forest disturbance, poor public understanding and even less government attention. The open forest structure is usually dominated by exotic plant species, especially *E. inulifolium*.

Intensive forest disturbance was considered to be the greatest factor of exotic plant species abundance as the absence of the canopy provides suitable habitat for exotic plants. Consequently, maintaining forest canopy could be a successful strategy to significantly reduce exotic plants invasion. In such a case, controlling illegal woody tree cutting and harvesting becomes crucial. In Ranupani Village, woody trees are essential resources for human every-day life. For instance, *A. decurrens* and *Casuarina junghuhniana* Miq. (Casuarinaceae) are

widely used as fire wood (Bhatt & Sachan, 2004). Actually, collecting of *A. decurrens* and *C. junghuhniana* as fire wood is prohibited but, according to national park's ranger, there still is illegal harvesting and collecting by local people.

Forest fires, one of the main causes of tropical forest degradation, contribute to the invasion of exotic species, especially *E. inulifolium*. Forest fires occur in dry months (July–August). Although not very frequent, they have serious implications in native vegetation decline. Therefore, a proper forest fire prevention strategy should be involved in restoration and management projects.

Another factor is the poor public understanding about exotic plant species. In Ranupani forest area, *S. pseudocapsicum* and *F. magellanica* have been neglected as potential invasive species. These species were introduced as ornamental plants. According to the informant, seeds were obtained from an European family living in Ranupani in the beginning of 1940. Subsequently, a small pioneering community that settled in the Ranupani village in the early 1960 introduced some ornamental plants from Malang, Pasuruhan and Probolinggo. Increasing of human population in Ranupani Village contributes to the increase of exotic plant species in this area; according to Hakim & Nakagoshi (2007) there are about 154 ornamental plant species from 52 plant families. In particular, local people gardening activities have a direct effect on the introduction and invasion of some exotic plant species, such as *Solanum pseudocapsicum*, *F. magellanica* and *Z. aethiopica*. Therefore, a severe control of exotic ornamental plant seedlings and establishment in restoration areas should be implemented systematically.

The thirds factor is the least government attention to the existence of exotic plant species in protected areas. The existence of *A. mangium* in Ranupani forest is the evidence of such a case. In Indonesia, only limited attention has been paid to invasion of exotic plant species. Overtime, many exotic plant species have gradually expanded, with government institutions generally paying less attention to take any initiative to combat such an invasion (Whitten et al., 2002; Garsetiasih & Siubelan, 2005). According to national park's rangers and staff, funding for restoration programs has been a major uncertainty. Providing significant funding support in order to enhance restoration programs,

based on long-term research and monitoring, is crucial.

## CONCLUSION

The degraded forest in Ranupani area provides habitat for a numerous exotic plants, including aquatic fern, herbs, shrubs and woody trees. Virtually all of the degraded and open forest areas have been invaded by exotic plants. *Acacia decurrens* and *E. inulifolium* are dominant in restoration area. The invasion of exotic plant species, in Ranupani forest area, constitutes one of the most serious threats to the success of forest restoration programs. The main factors governing the distribution and invasion of numerous exotic plant species include habitat disturbance, poor human knowledge/awareness, and lack of ecological monitoring and control by national park authority. In order to enhance the success of restoration programs, clearing exotic plant species in restoration area, building community awareness about exotic species and enhancing the capacity of national park management to control and monitor the existence of exotic plant species are certainly needed.

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