International Conference on Biological Science
Faculty of Biology Universitas Gadjah Mada 2013
(ICBS BIO-UGM 2013)

“Advances in Biological Science: Biological Approach for Sustainable Development of Tropical Biodiversity for Human Prosperity”


Faculty of Biology
Universitas Gadjah Mada
Yogyakarta, Indonesia

September 20 – 21, 2013
INTERNATIONAL CONFERENCE ON BIOLOGICAL SCIENCE

Advances in Biological Science: Biological Approach for Sustainable Development of Tropical Biodiversity for Human Prosperity

PROCEEDING


Organized by:

FACULTY OF BIOLOGY
UNIVERSITAS GADJAH MADA
YOGYAKARTA
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TROPICAL RAINFOREST DEGRADATION IN INDONESIA: THREAT AND HOPE IN THE LANDSCAPE OF MOUNTAIN FOREST TO MANGROVE SWAMP

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ABSTRACT

Indonesia is one of the countries has extensive forest cover, but has the highest rates of deforestation. The deforestation occurred from watershed to the swamp areas in the landscape. Large areas of the tropical peat swamp-forest in Riau were changed to Acasia spp. and to oil palm, Elaeis guineensis, plantations. Similarly, the forest cover changed into the plantations were also occurred in Kalimantan and many places in Indonesia. In 1996-1997, large area of mangrove forest in Segara Anakan Cilacap was also converted into the intensive shrimp-ponds, which were failed and abandoned, then these abandoned shrimp-ponds were colonized by mangrove shrubs. The lost of the forest due the forest use changes and logging in the mountain forest also left a big gap in the forest. These forest gaps were also invaded by the invasive species, Eupatorium odoratum, and Lantana camara. Their present out-competed the seedlings of both the natural and planted trees. The deforestation also threatened the native animal biodiversities. To over come the deforestation, so far many conservation efforts were implemented through many conservation projects, but were not succeed. However, recently there is a hope, a program reforestation in the degraded land through the corporate social responsibility (CSR) program is established. However, the success of replanting the native trees is also depended on to the involvement of the local community. Thus the local should be part of the programs. The incentive for the local should be based on the survival of the planted tree seedlings, which grow up to reproduce their new generations.

Key words: deforestation, peat-swamp forest, invasive species, oil palm, Acasia

INTRODUCTION

This paper will discuss the tropical rain forest degradation, climate change, tropical fire, invasive species and colonization of shrubs as threats to tropical biodiversity, and also there is a hope from Corporate Social Responsibility (CSR) in the tropical landscape setting of the rainforest in Indonesia. The discussion of this talk based on the case studies in the landscape ecology from lowland of peat-swamp forest of Riau, Sumatra and Central Kalimantan, and mangrove of Segara Anakan, Cilacap Central Java and to upland of the mountain forest of Kamojang Area. Indonesia is a country of thousand islands. As islands, the watershed areas at the headwaters of rivers are so close with the coastal areas. Therefore, the lost of forest in up-lands, in the watershed areas, due to the land use change are also detrimental to especially tropical estuarine forest, mangrove ecosystems, sea grasses, and coral-reef ecosystems in the coastal areas. The lost of tropical rainforest are also caused the climate change, and the animal biodiversity lost their habitat.

Indonesia has the extensive tropical rainforest cover, but ironically has one of the highest rates of deforestation. The deforestation has significant impact on the globe carbon balance and loss of biodiversity. Even though the rate of tropical deforestation decreased from 0.16 Mkm² per year in the 1990s to 0.13 Mkm² per year, but the destruction of natural forest was a still major source of CO₂ emission. It was estimated 16% emission came from anthropogenic activities. The current deforestation rate of Indonesia was 3.4% per year was second only to Brazil among the countries with tropical rainforest (Whittle et al. 2012).
The Tessonilo National Park in Riau lost their forest to oil palm plantation was almost 75% of the 80 ha. The change of the forest cover just as an example how the tropical forest lost to these oil palm plantations occurred almost all over Indonesia at highest rate. Even more at present people started to plant the seedling oil palm at the levee of the abandon shrimp-ponds in the Segara Anakan Mangrove. It was reported from many sources, during the 2009-2012, the forest land used change to: 1. Illegal logging 29.7 Mha; 2. Permission logging (HPH & HTI) 21.2 Mha; 3. Mining 15 Mha, and; 4. Plantation 9.2 Mha. Thus total of the tropical rainforest lost was about 75.1 Mha. This also means the lost of habitats for biodiversity of many endemic organisms.

Similarly, most of the mangrove forests are also as endangered ecosystem due to the forest reclamation to the intensive shrimp-ponds in a large scale, logging, and also have high siltation rate due to bad watershed management. These intensive shrimp-ponds were failed and abandon and leaved the scars on the mangrove ecosystem, which were no mangrove trees anymore. Most of the mangrove ecosystems were colonized by mangrove shrubs *Acanthus ilicifolius* and *Derrys heterophylla* (Napitupulu & Ramu 1982; Djohan 2007; Djohan 2012).

Stibig & Malingreau (2003) reported that the tropical forest in Sumatra was only 30% left. Eighty percentage of 30% left-over forest was in Aceh Province. Mostly the forests in Sumatra and Kalimantan were changed to the oil palm plantations. In addition at Riau Province, the forest also was changed to *Acasia* plantations. The land used change from tropical rainforest and peat-swamp forest has threatened wildlife due to the lost of their habitats. Moreover, these tropical forests cannot give their ecosystem services anymore. The combination between the lost of the forest due to land use change and the global climate change make the threats to the tropical biodiversity become worst. However, recently there is a hope though Corporate Social Responsibility (CSR). One of the CSR activities is to return the forest in degraded land. But these efforts should be implemented with precautions, and the question is why? As mention earlier, the purpose of this paper was to discus the tropical rain forest degradation, climate change, tropical fire, invasive species and colonization of shrubs as threats to tropical biodiversity. Between those threats, there was also a hope from Corporate Social Responsibility (CSR) in returning the forest to the land degradations. The discussion was on the tropical landscape setting of the rainforest in Indonesia from mountain forest to the mangrove swamp.

**MATERIALS AND METHODS**

The discussion of this talk was based on synthesizes and analyses from research reports as a case studies of Djohan *et al.* (2005); Djohan (2012); Djohan & Suhesthiningsih (2013), and also field experiences. Her research was carried out from the mangrove swamps forest in Central Java to the mountain forest in west Java. The discussions of the forest degradations were compared with some issues from several authors who did their research in Sumatera and Kalimantan (Chokkalingam *et al.* 2005; Napitupulu & Ramu 1982; Page *et al.* 2011; Page *et al.* 2002; Stiebig & Malingreau 2003; Whittle *et al.* 2012). These articles were as a case studies on this talk. In elaboration the discussion, I also discussed the forest degradation and forest rehabilitation based on analyses from Dale (1997); and Krebs (2009).
RESULTS AND DISCUSSIONS

Whittle et al. (2012) reported that Sumatra had the most intense recent large-scale forest clearance in Indonesia. Riau Province recorded the highest change of forest cover. Deforestation was defined as conversion of natural forest such as original, as opposed to anthropogenic, vegetation, dominated by trees with a crown cover of more than 10% to another land cover or use. There were two types of deforestation or forest clearance in this province: 1. To produce pulp and paper by establishing *Acasia* plantations. These usually involved extensive networks-infrastructure, such as networks of roads and drainage canals in the peat-swamps for wood extractions and planting preparations. The drainage canals caused the water level in the peat-swamp forest decreased (Djohan et al. 2005); 2. For small-scale agriculture, mainly in many cases the ground conditions were chaotic, with trees left on the ground or burned, and encroachment by shrubs or grassland.

**Forest condition and endangered species, a case study from Riau Province, Sumatra** – Djohan et al. (2005) evaluated with a rapid assessment of high conservation values (HCVs) of seven Forest Management Units (FMU) at peat-swamp forest and hill forest in Riau. They reported that at all FMUs, large areas of the natural forests were converted to *Acacia mangium* and *A. Crassicarpa* plantations which age were between 1-6 months old. These natural forests had very high diversities of both native trees and animals species. Based on the reconstruction of the log piles of the log yards from all FMUs, they found ramin tree (*Gonystylus bancanus*) with diameter more than 50 cm. This indicated that the natural forests were ramin habitat. They also found others endangered tree species, *Shorea uliginosa* (meranti bakau), *S. teysmaniana* (meranti lilin), *Shorea ovalis* ssp. *sericea* (meranti sabut), *Vatica stapfiana* (resak rawa), *Anisoptera marginata* (mersawa), dan *Crystotachys renda* (palm merah). They reported the ramin logs were piled up at the log yards of the FMUs. However, there was no any ramin stands in the natural forest at almost all FMUs, except at the natural forest of one FMU, it still had both trees and saplings of Ramin. Formerly these forest also habitat of climax tree species such as, *Kompassia malaccensis* (kempas), *Swintonia penangiana* (rengas), *Xylopa malayana* (pisang-pisang), *Durio* sp. (durian rawa), *Cratoxylum arborescens* (gerunggang), *Myristica iners* (mendarahan).

The log piles were also dominated by trees of rengas (*Swintonia penangiana*), kempas (*Kompassia malaccensis*), *Melanorrhoea* sp (rengas), *Myristica iners* (mendarahan), *Litsea paludosa* (medang), *Calophyllum pulcerrimum* (bintangur), *Palaquium burkii* (balam), *Alstonia pneumatophora* (pulai rawa), *Blumeodendron tokbrai* (timah-timah); *Madhuca montleyana* (balam durian), *Camnosperma auriculata* (terentang), *Garccinia sp* (kandis), *Horsfeldia grandis* (mendarahan), *Dialium induum* (kurangi), *Gonystylus bancanus* (ramin). The DBH of the biggest tree was 63 cm, and it belonged to *Shorea uliginosa*.

**Endangered animal species** – All the FMUs had the endangered animal species, such as *Panthera tigris sumatrae*, beruang madu (*Helarctos malayanus*), harimau dahan (*Neofelis nebulosa*), siamang (*Symphalangus syndactylus*), belibis (*Dendrocygna javanica*), bangau tong-tong (*Leptoptylos javanicus*), murai batu (*Saxicola torquata*), buaya katak (*Crocodylus sp.*), arwana (*Scleropages formosus*), tonuk (*Tapirus indicus*), siamang hitam (*Presbytes siamenses*), siamang merah (*Hylobates agilis*), and landak (*Hystix brachyuran*). Beside the endangered animal species the natural forests of FMUs were also
rich with other species. The indigenous people live here, and these people depend on the forest for their subsistence (Djohan et al., 2005). These peat-swamp forests were also breeding grounds and sources of fish for consumption and as source local subsistence (Chockkalingam et al., 2005).

**Regulation** — There are regulations from government, Keppres No.2 Tahun 1990, and SK Menhut No. 101/Kpts-II/2001, that when the peat depths more than 3 meters, the natural forest of the peat- tropical forest swamp should be protected. Similarly, when the natural forest has the potential wood stock more than 20 m$^3$, the forest should be protected. Along the canals of all the natural forest of FMUs had peat depths more than 3 - 9 meters. The natural forest had the potential standing stocks were between 31.90 - 40.00 m$^3$ per ha. Thus all the FMUs in the peat-swamp forest were legally protected forest based on the criteria of the peat depth and the wood standing stock (Djohan et al., 2005).

The peat tropical-swamp forest is a carbon sink by storing immense amount of carbon (Page et al., 2011). These swamps have the ecosystem services. They play key role in water conservation, and control the systems in regulating flow, and mitigating drought and flood. These swamps are also home of many endemic-endangered organisms (Djohan et al., 2005). Their present is also important for the implication of climate change. When their function was valued as no valued, one big project was developed in the Central Kalimantan. The tropical peat swamps were converted to mega-rice project with constructed 4533 km canals with 30 m width. As a result, the canals decreased the water level in the peat, and exposed the dry peat. This dry peat was a good source for occurring fires during dry seasons. Naturally, the forest in peat-swamp had peat depth up to 20 m, and the forest grew on the peat. Changing of the forest cover especially for the drainage and the forest clearing disturbed the peat-swamp forest stability. These conditions in large scale caused the peat forest prone to the fires (Page et al., 2002).

**A case study from Central Kalimantan** — It was reported that during the El-Nino year 1997, there was a big forest fire occurred in the tropical peat-swamp forest in central Kalimantan and Sumatra. Page et al. (2002) reported that 32% (0.79 Mha) of the forest cover was in fire, which consisted of 91.5 % (0.73 Mha) peat-swamp forest. Their estimated based on peat depth burnt. The CO$_2$ released to the atmosphere were between 0.19-0.23 gig-tons (Gt) from the peat swamp, and 0.05 Gt from natural forest stands. They stated that in the 1997 carbon was released to the atmosphere between 0.19-0.23 Gt. This emission equal to 13-40% average of global carbon from fossil fuel, and contributed to the increase of CO$_2$ atmosphere. The fire types were not only surface and crown fires, but also ground fires. Ground fires burn the peat down to the earth, and caused deep-ecological scars, because it takes along time to recovery. They also reported that this fire placed Indonesia as the third carbon emission country after USA and China. Even though, some Indonesian scientists are still questioning about this report.

**A case study from the mangrove swamp, central Java** – Segara Anakan mangrove is a brackish estuary ecosystem in south-western part central Java. Their mangrove forest and the estuary covered areas of 24,000 ha. This estuary has experienced heavy siltations, which received around 4.5 million tons of sediment per year from the Citanduy watershed. In the 1980 the prediction was made, if the siltation rate was persistence, the
Segara Anakan estuary will be filled up in 30 years (Napitupulu & Ramu 1982). The environmental stresses in the Segara Anakan mangrove beside the heavy siltation, was also from the mangrove-tree cutting, and conversion to failure shrimp-ponds. The mangrove of Segara Anakan is in the process of changing to freshwater-wetland ecosystem. These conditions change the mangrove ecosystem, and the Segara Anakan mangrove is a dying ecosystem. Thus their present in the future is in the question (Djohan, T. S. 2007; Djohan 2012).

**Mangrove forest degradation** – As mentioned before, beside the stress from heavy siltation, the degradation of mangrove in the Segara Anakan due the cutting down of the mangrove trees. People from out side the Segara Anakan cut the selective and economic tree species, such *Brugueira gymnorrhiza*, *Rhizophora apiculata*, *R. mucronata*, and *Avicennia* spp. When these trees were gone, they finally cut down the *Sonneratia* spp. The *Sonneratia* was the less economic-value tree compared to *Bruguiera* spp. and *Rhizophora* spp. These tree cutting created big gap areas in the mangrove forest. This forest gaps were colonized by shrub of *Acanthus ilicifolius* and liana *Derris heterophylla*. Both of these species have r and k strategies. It means once both of these species colonize the mangrove gap areas, they will reduce the mangrove tree seedlings to grow. Thus the present of mangrove trees species of *Bruguiera* spp. and *Rhizophora* spp was threatened. At present, even the *Sonneratia* spp. are gone. All the mangrove trees was cut-doen by the out-sider of Segara Anakan. Thus the huge area of mangrove forest has changed to the mangrove shrubs, *Achantus ilicifolius* and *Derrys heterophylla*. Recently, the government through the local community try again to rehabilitate this mangrove forest by planting the seedling of *Rhizophora* spp. and *Bruguiera* spp. using incentive based on the number of seedling survive (Djohan, T. S. 2007; Djohan 2012).

**Kamojang tropical mountain-rainforest** – The forest cover at the mountain forest of Kamojang geothermal area was recently is around 40%. The rest was colonized by invasive species of *Lantana camara* and *Eupatorium odoratum*. The present of these invasive species caused the tree seedling of the native tree out competed, and cannot established. The forest canopy is important, because Kamojang area is a geothermal area for geothermal energy. Geothermal energy is a renewable energy and environmental friendly. This energy depends heavily on water in the ground and the surface-water reservoir. Therefore the tree canopy plays very significant role in the water conservatory. Thus, to return the forest in the Kamojang area, the corporate has planted many seedlings of native trees through their program on reforestation (Djohan & Suhesthiningsih 2013). However, planting the tree seedling should be counted as a success if these tree seedlings grow and produce their new generation (Krebs 2009). In order to be succeeded in planting the tree, corporate has to be working together with the local people. The incentive should be given based on the number of the tree seedling growing and monitored until these trees reproduced their new generation (Suwido Limin 2007: Pers. Comm.). Mostly the reforestation by planting native tree-seedling failed, because after the planting, the seedling was leaved in the nature and lost to the invasive species such *Eupatorium odoratum* and *Lantana camara*.

**Forest land cover change and the climate change** – The lost of the tropical rainforest has caused the climate change. In few decades to come, the global ecology change will affect the ecology, social, economy, and community. The impact of ecology included the
biodiversity change, productivity, species migration, and the sustainable ecosystem. The climate change and the land use changes are two major causes in the global ecology change (Dale 1997).

**Government efforts** – In the case study of Segara Anakan mangrove, it is true that the government since 2001 has planted many seedlings of mangrove tree species. However, most of the plantings failed because of no efforts to take care the planted tree-seedlings. These planted tree seedlings were only based on how many the tree seedlings were planted, but did not act on how many the seedling planted grow. For example, the planted seedling areas were colonized by the mangrove shrub, *Acanthus ilicifolius*, and mangrove vine, *Derris heterophylla*. The failure was due to the planted tree seedlings lost-competed to the mangrove shrub and mangrove vine. The shrub and vine mangrove have a combination of r to spectrum K strategies. Selective r acts to maximize growth through rapid abundant of seeds, and selection K has life-span longer. In contrast the tree has K-selection with slower growth. It means that all the shrub and vine out-compete to the planted tree seedlings. Thus the mangrove tree seedling failed to grow (Djohan 2012).

To over-come the failure of the tree seedling planted, the approach of planting should be change as established by Suwido Limin (2007: Pers. Comm.). As mentioned before, success of the planted seedling counted based on the seedling grew up to sapling and reproduced. The care for the planted seedling took 3-4 years. The planting was conducted together with the people next to the forest. Therefore, the incentive for the people was paid based on the planted trees survive until 3-4 year old, and was not based on the number of seedling trees were planted. The incentive was paid every year on special occasion month, such as during the new school year or the religious holiday. Thus this approach must be granted success. Therefore, the success of challenge in seedling tree planting in attempt to return the ecological services of the degraded forest is the policy, which is the way and the approach how to grow the tree seedling planted and reproduced. Therefore, the incentive to the community is not based on how many the number of seedlings is planted, but the incentive should be based on the number of how many the planted tree seedlings grow and reproduce. Therefore, the way of the forest rehabilitation or reforestation the degraded lands should be established with a precautious approach.

**Hope to return the degraded forest** – Corporate Social Responsibility (CSR) — Recently, through one of the CSR program, the reforestation program has been established. One of the CSR program is to return the forest ecosystems on the degraded land. Thus, the Corporate has the responsibility to return the degraded lands. As mentioned before, however, the success of the planted tree seedlings is not depended on: 1. How many the tree seedlings are planted, but how many the planted seedlings survive and grow to sapling and reproduce their new regeneration; 2. The planted tree seedlings should be the indigenous species, because the indigenous species, as an ecotype species, which has capability to adapt to their environment very well.

As mentioned before, Kamojang Area is a geothermal area with the tropical-mountain rainforest setting. Therefore, the present of forest-tree canopy is important, because they play significant role in water conservation. However, the forest cover is around 40% left. In attempt to return the forest cover, the corporate has established the efforts to return the forest
by planting the tree seedlings. In the past, these efforts did not succeed due to the invasive species, *Eupatorium odoratum*, *Lantana camara*, and *Saccharum* sp. (rumput tebu). Thus, the planted tree seedling lost-compete to the invasive shrubs and grass. Since the planting of the tree seedling should be counted as a success if these tree seedlings grow and produce their generation.

At present, the Corporate has a nursery native-tree garden, and has a plan to return the native forest. They will establish the native-tree-seedling species and will work together with the Kamojang community village in planting the seedling of the native tree. The incentive will be paid based on the number of tree seedling survive, and they will take care the tree seedling planted until became sapling or tree and reproduce a new generation or flowering (Djohan & Suhesthiningsih 2013).

**CONCLUSIONS**

In conclusion the deforestation in Indonesia was occurred at alarming rate. Many forest have gone with their diversity, thus the tropical biodiversities are threatened. Furthermore, the ecosystem cannot give their ecological services anymore. The CSR is a new hope in returning the natural forest through one of their programs. But this program should be approached with precautious and established together with the people next to the forest. The incentive should be given based on the number of planted tree seedlings survive and reproduce a new generation, and is not based on the number of seedlings were planted.

**ACKNOWLEDGEMENTS**

I would like to express my thanks to many people, students, colleagues, the communities, who works with me in studying the ecosystems in the landscape ecology from mountain forest to mangrove swamp. I would like to extend my thanks also to Krisni Suhesthiningsih for her valuable comments on the manuscript.

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