Rehabilitation of Degraded Forests in Indonesia

by

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PART A
STATUS OF LAND USE AND FOREST (AND LAND) DEGRADATION

1. Forest Land Use and Land Use Change

Forests in Indonesia are sub-divided into three groups based on their function, namely (a) production forest, (b) conservation forest, and (c) protective forest. Seventy-five percent of Indonesia's total land area of 191 million hectares is classified as forest land, and the tropical rain forest component make up the vast majority of forest cover. This is particularly so in Kalimantan, Sumatra, and Irian Jaya. Under Indonesian law a forest is described as an eco-system which has biodiversity dominated by trees.

- The production forest is used for the production of timber and non-wood forest produce.
- The protection forest is an area earmarked for watershed management, erosion control as well as the conservation of wildlife.
- Conservation forests are areas which have been earmarked specifically for the protection of ecosystems including their biological diversity.

During the mid-1980s the estimated rate of deforestation varied from 700,000 to more than 1 million hectares per year. According to a critical evaluation of the Indonesian forestry sector, it was found that deforestation could not be blamed on a single major factor but was instead due to a complicated interplay among commercial logging, transmigration program activities and shifting cultivation that is still being practiced largely in Kalimantan. The most immediate threat to Indonesia's forests was the government promotion of domestic timber processing, while the transmigration programme is considered a long-term threat to the forests.

According to a report by FAO, the loss of forest land in Indonesia from 1982- 1990 showed that over the eight year period Java lost about 90.5 % of its forest cover, while the figures for Sumatra are 59 %, for Nusa Tenggara 74.4 %; Kalimantan 38.8 %, Sulawesi 49.6 % resulting in the Indonesia average forest loss of 54.4 % excluding Maluku and Papua (Soemarwoto, 2001).

The interest in planting oilpalm has become rampant and most of the Districts showed interest in converting forest land to oilpalm plantations. Rubber plantations in some areas have also become very important but oilpalm seems to be the most preferred species throughout the state.

Mining of coal, gold and other precious metals also posed a great risk to the protected forest areas. President Megawati for example released a President’s Decree to allow the operation of 13 companies in protected forest areas. At the same time another 100 companies submitted their applications for permission to carry out mining activities also in the protected forest areas.

According to Simon (2004) in Indonesia landuse can be sub-divided into seven groups based on eco-regions and some socio-economic parameters, as shown in Table 1:

Table 1. ***Land use characteristics in Indonesia by region***

Sumatra	
Total land area	482.393 km^2
Main natural vegetation types	Extensive lowland dipterocarp forests, peat swamps and mangrove forests in the East part; hill forests in the West.
Population	42 140 000 or about 85 persons per km^2
Dominant land use	80 % of the population are farmers practicing shifting cultivation, and managing rubber and oilpalm plantations.
Forest area	Total forest is 23 million or 47.1 % of total land area.
Forest management	Sustainable forest management not yet introduced on a large-scale; large tracts of land are unproductive grasslands and degraded secondary forests, particularly in South Sumatra and Lampung.

Java	
Total land area	127.499 km^2
Main natural soil or vegetation types	Mostly fertile soils and in some areas with volcanic parent material
Population	910 people per km^2
Dominant land use	65 % of the population are farmers with only 0.2 ha agricultural land per family; traditional home gardens developed over time represent an important element in integrated farming systems.
Forest area	3 million ha or 23 % of total land area, mostly protection forests in the highlands; about 1 million ha of teak plantations
Forest management	High social pressure on forests due to increasing population density

Kalimantan	
Total land area	547.891 km^2
Main natural soil or vegetation types	The soils are podzolic and not fertile in wet conditions
Population	Population about 11.5 million and about 20 people per km^2
Dominant land use	Forestry and increasingly oilpalm, rubber and timber plantations
Forest area	37 million ha or 66,9 % of the total land area dominated by dipterocarp forests
Forest management	Forest conditions rapidly deteriorate due to fire and land clearing; sustainable forest management not yet introduced on a large-scale; large tracts of land are unproductive grasslands and degraded secondary forests.

Sulawesi	
Total land area	191.800 km^2
Main natural soil or vegetation types	The soils are podzolic and not fertile in wet conditions.
Population	Population about 15 million and about 72 people per km^2.
Dominant land use	Farming area mostly rice cultivation in the South; however, several of those areas are hilly.
Forest area	Forest area about 12 million ha (62.7% of total land area). However, 8 million ha converted to other use and the rest also occupied and planted by cocoa and other crops.
Forest management	Ecosystem based forest management not yet defined.

Nusa Tenggara	
Total land area	87.744 km^2
Main natural soil or vegetation types	Climate influenced by monsoon and partly semi-arid. Only West Lombok considered as fertile area.
Population	Population about 11 million and about 125 people per km^2.
Dominant land use	Pasture management and agroforestry systems well developed.
Forest area	Forest area is about 3,4 million ha or 38,3 % of total land area.
Forest management	Ecosystem based forest management not yet defined.

Maluku	
Total land area	77.871 km^2
Main natural soil or vegetation types	
Population	Population about 2 million and about 26 people per $km^{2.}$
Dominant land use	
Forest area	Forest area is about 5 million ha or 62,8 % of total land area
Forest management	Ecosystem based forest management not yet defined.

Papua	
Total land area	421.981 km^2
Main natural soil or vegetation types	Mostly dominated by hilly land, swampy lowlands and also mangroves, especially in the South and West.
Population	Population about 2,2 million and only about 6 people per km^2
Dominant land use	Several large-scale mining projects for gold, oil and other minerals are also found in this area
Forest area	Total forest area about 28,8 million ha or 68,3 % of total land area.
Forest management	Ecosystem based forest management not yet defined.

2. Status of Forest (and Land) Degradation

Most of the degraded forests are still considered as forest production areas. However, it has been found that some of these areas have already been occupied legally or illegally and converted to gardens, oilpalm and rubber plantations. Cocoa is also planted in some protection areas, particularly in Southeast Sulawesi. In Lampung, South Sumatra, cocoa and coffee are produced in the forest production and protection areas. The people used these lands illegally and so far the government has been reluctant to remove them from these areas. This is partly due to the opportunities for income generation and development and at the same time to overcome socio-economic constraints.

Generally, after illegal logging and forest fires there is a significant rate of conversion of the production forest area into other land uses. The production forest area in 1983 was about 64.39 million ha while it has been reduced to about 58.25 million ha until 1999. According to the 1945 constitution, the government has the ownership rights to all natural forests in the country. However, this ownership could be temporarily reassigned in the form of timber concessions, known as Forest Exploitation Rights (Hak Pengusahaan Hutan), or permanently transferred, as in the case of land titles granted to transmigration families. The average concession size was 98,000 hectares, and the usual duration was twenty years. In the 1970s concessionaires were slowly phased out to conserve the forest resources foreign timber, and by 1980, of more than 500 active forest concessions, only 9 were operated by foreign firms.
In 1990, there were 564 forest concession holders with a total area of 59.62 million ha. By 1997 the number of forest concession holders decreased to only 450 with a total area of 52.8 million ha. The production was 23 million m^3/year or 0.45 m^3/ha/year. In 2006, there are only 289 forest concession holders covering an area of 28.27 million ha with a total productivity of about 8.2 million m^3/year or 0.29 m^3/ha/year.

Log production peaked at 25 million cubic meters in 1979, of which about 18 million cubic meters were exported as unprocessed logs. Restrictions on unprocessed exports in the early 1980s contributed to a decline in total log production, which fell to 13 million tons in 1982. However, increasing demand for sawn timber and plywood began to boost production again, bringing it up to 26 million cubic meters by 1987. In that year, about half of the total log production was exported in the form of sawn timber and plywood, the rest going into domestic consumption. Log production again dropped at the end of the 1980s, falling to 20 million cubic meters by 1989. The government attributed this decline to policies designed to ***preserve the natural forest***. One such policy was the increase in a levy imposed on loggers for reforestation, which was raised from USD 4 to USD 7 for every cubic meter of cut log.
Forest degradation data in Indonesia varies depending on the source from where the data is procured. The government reported that forest degradation was about 1.8 million ha per year from 1997- 2000 while Forest Watch reported that this degradation amounted to about 4.1 million ha from 2001- 2003. The recent data of forest degradation released by the government (2005) reported about 2.8 million ha per year.

3. Causes of Forest (and Land) Degradation

Each day, some 600 hectares of Indonesia's forests are cleared by logging alone. According to data from the World Resources Institute (WRI), only 28% or 40 million ha of Indonesia's forests preserve was left in 1997. Longgena told visitors at the 2001 Environment Expo, "If the government doesn't impose the moratorium now, I would call it a national suicide." The forum proposed a gradual moratorium over a two to three year period, with the first phase being a stop in the

issuance of new licenses as well as the extension of existing logging licenses. A ban on log exports should also be imposed. The next step would be to terminate forest concessions of troubled companies, especially companies riddled with debts (Anonymous, 2001).

Other main causes of forest degradation are forest fire. Forest fire in fact causes great problems not only in several areas in Indonesia like West Kalimantan, East Kalimantan, Central Kalimantan, South Sumatra, Jambi, and Pekanbaru where most of the land clearing for oilpalm shifting cultivation using fire is practiced .The haze created by these fires concerns also Malaysia, Singapore the Phillipines causing great problems to human health and the safety of the transportation sector.

Gonner (1999) reported that the forest and land fires in 1997/1998 affected more than 5.2 million ha in Kalimantan alone. Fires are likely to occur again due to the large amount of remaining debris in the forest.

The other causes of forest degradation are coal mining which is practiced extensively in the country due to the need for income of both the local and national governments. Despite the fact that rehabilitation costs of ex-mining areas are not very high, efforts to rehabilitate such areas is minimal.

Illegal logging is also another important cause of forest degradation. About 2.9 million ha are logged illegally every year. The domestic and export requirements for timber are much higher than the wood supply. This has resulted in heavy degradation of forests. Wood consumption for the industry in Indonesia is about 72 million m^3/year. The volume supplied accounts for 30 million m^3/year of sawn timber, 18 million m^3/year of plywood and 24 million m^3/year as pulp and paper.

Sustained yield level of wood production is only about 17 million to 25 million m^3/year. The Government in 2002 decided to limit production of timber to 6 million m^3/year, but then on 2004 this was increased to 20 million m^3/year. Thus, there is a shortfall of wood supply of about 47 to 55 million m^3/year.

4. Impact of Forest Degradation

Owing to degradation several areas lost their biodiversity and water resources became scarce. This resulted in loss of food production in some areas. In 2002, about 46,906 citizens in Samarinda were living below the poverty level and this number increased to 48,137 in 2004 or about 10% the population in Samarinda. In East Kalimantan out of the 2.7 million people, 328,597 were found to be living below the poverty line. The poor population in Kutai Kertanegara increased from 69,100 in 2002 to 75,404 in 2003 of a total population of 480,499 (Jakarta Post June 18, 2005). In the past East Kalimantan was the biggest dipterocarp timber producer and the richest forest state in the country. Now this state has became degraded and in recent years problems related to the environment health and poverty have significantly increased.
There are also other examples in several regions where forest degradation has caused damage to the water resources. One example is the Manisrenggo Klaten District known for its high rice production. The success of this production was due to the weekly supply of irrigation water. Today this area is irrigated only once every month.
In the Gunung Kidul area (Kompas, 2006) the 282 sources of water have now been reduced to 217. Likewise, in NTB in the East of Indonesia only 223 sources of water are available compared to 600 water resources available in the past.

The impact of forest degradation has also significantly affected the wood supply to the local wood industries all over Indonesia.

PART B
IMPLEMENTATION OF FOREST RESTORATION/REHABILITATION

1. History of Restoration/Rehabilitation

According to Simon (2004) timber extraction especially in Java started as early as the 8th century applying several methods i.e. conventional method by the Kingdom of Java until 1650, and the modern method by the East Indian Company (VOC) from 1650 to 1800, and by the Government of "Netherlands Indie", from 1808 to 1849. This was followed by the establishment and management of timber plantations based on plans by the Mollier team from 1849 to 1890 and its implementation by Djatibedrijfs from 1890 to 1942. In that period a new forest law for Java and Madura was created replacing the existing one of 1865. The period between1942-50 was rather chaotic without a systematic approach to forest exploitation. However, the situation improved through the work of the Forestry Department in the period 1950-1963. The management of forests was then taken over by PN Perhutani (1963-1972), and Perum Perhutani from 1972 until now. Simon (2004) also states that due to social problems after 1998, the problem of illegal logging became a very significant phenolmenon. The social forestry approach has been tested from 1974-1980, followed by the methods of PMDH and Perhutanan Sosial between 1976 and 2000, and community based forest management from 2000 until today (i.e.PHJO and PHBM Pengelolaan Hutan Bersama Masyarakat).

In the forest areas outside Java significant exploitation began in 1967 after the Forestry Act No. 5 had been established. Uncontrolled timber extraction and uncertain legal circumstances have caused Indonesian forest degradation within only 20 years with an estimated total area of 64 million ha left severely damaged. This is much greater than the damages caused by the VOC on Java's forests leading to a total area of 650.000 ha of degraded forests within 200 years (Simon, 2004).

After large-scale timber extraction especially outside Java from 1970 to 1980 the Indonesian Government started to reduce timber exploitation and launched the Presidential Regulation No. 35 1980 declaring that forest concession holders have to pay into a reforestation fund (DJR Dana Jaminan Reboisasi), a fee for each cubic meter timber extracted. The intention was that if the forest concession company replants or regenerates the over-logged forest area, the DJR will be paid back to the respective forest concession company. Later in 1989, a new Presidential Regulation No 31 was launched establishing a reforestation fund (DR: Dana Reboisasi). Under this regulation the forest concession company must pay the DR for each cubic meter timber extracted and is also responsible for the rehabilitation of the logged forest area, while the Government is responsible for the rehabilitation of areas outside the forest concession company such as industrial tree plantations (HTI: Hutan Tanaman Industri) through a loan without interest and a governmental fund sharing arrangement. The DR funds are to be deposited with the Ministry of Forestry. The use of the funds for any purpose needs to be coordinated by the Ministry of Forestry and the Ministry of Finance and requires approval by the President.

In 2001 the government initiated a program called "Gerakan Penanaman Pohon", which encourages individuals or groups of people to voluntary plant trees, for example before a marriage.

Under the same programme planting trees is compulsory for those who enter elementary and high schools or universities. In 2002, the government started a new program called “Gerakan Rehabilitasi Hutan dan Lahan” that continues until today and concentrates on the rehabilitation of watershed areas (Daerah Aliran Sungai).

2. Current Policies Governing Land Use and Restoration/Rehabilitation

The National Movement of Forest and Land Rehabilitation (Gerakan Nasional Rehabilitasi Hutan dan Lahan) has been promoted in 2003 by the Indonesian Government during President Megawati’s reign and planned for at least 5 years involving several ministries i.e. Ministry of Forestry, Ministry of Agriculture, Ministry of Social Welfare, and Ministry of Education. About 300,000 ha of forest areas have been rehabilitated in the first year (2003) and increased to 500,000 ha in 2004.

In 2003, an area of 163.114 ha of state forests and 136.856 ha of other land outside the state forests were rehabilitated through this program covering 29 watershed areas prioritized in 15 provinces and 145 districts. In 2004, the project increased the rehabilitation area to 500.000 ha consisting of 226.957 ha state forest area and 273.043 ha outside state forests in 141 watershed areas, 31 provinces and 372 districts (Anonymous, 2006).

With regard to stakeholder involvement in rehabilitation activities the government decided to better coordinate the participation of several ministries, such as the Ministry of Forestry, the Ministry of Environment, the Ministry of Community Welfare, the Ministry of Infrastructure, the Ministry of Internal Affair and also the Ministry of Education. Stakeholder participation also takes place at the operational level, for example, by communities working in the nurseries for seedling production and also through project control and evaluation by universities. However, the program is not so easy to implement since the enforcement of laws and evaluation procedures are still not strong enough to accelerate the program.

3. Forest Restoration/Rehabilitation Initiatives

Forest rehabilitation in Indonesia takes place mainly on state forest land following degradation by forest concessions, illegal logging, and fire. These activities aim at reparation of the ecosystem for productivity and environmental services.

Sumatra

In Sumatra restoration initiatives began with the rehabilitation of grass land (i.e., imperata cylindrica) using mostly fast yielding species. This project was supported by JICA in South Sumatra in the early 1980s at Binakat followed by investments through Musi Hutan Persada which planted *Acacia mangium* for pulp production on a larger scale. Other companies followed this example. The Kansai Engineering Company started cooperation with the Gadjah Mada University in 1992 to plant dipterocarps with mycorrhiza in Muara Tebo Jambi. The project was terminated in 2005. Several methods of rehabilitation using dipterocarps were developed and tested and the plot today can be used for demonstration purposes of successful rehabilitation of dipterocarp forests. BIOTROP also developed a model of rehabilitation and conservation of tropical forests in the Muara Tebo area of Jambi.

Java

After deforestation by VOC in the 17th century the Dutch Government of Indonesia in the 18th century succeeded to rehabilitate some areas (Simon, 2004). *Pinus merkusii* sp. was planted in mostly in the high lands and produced terpentine as well as gum. Paraserianthes falcataria was planted not only in forest areas but more successfully as mixed crops in homegardens and agro-forestry systems. Several restoration/rehabilitation initiatives such as Wanagama I in Gadjah Mada University Yogyakarta, (about 600 ha) started in 1966 as rehabilitation of karst or dry land areas for education, training and also ecotourism.

Coastal rehabilitation was also conducted from 1995 onwards by the University Gadjah Mada Team as RUT Project (Integrated Competitive Research Fund) sponsored by the Ministry of Research and Technology and LIPI (The Indonesian Institute of Science). The project is a successful model for the protection from extreme winds and also reduces the impact by tsunamis. Until today, implementation has reached 9 km of rehabilitated coastal area. The initiative is not only pursued by the university but also by farmers who are aware of the important role and economic value of coastal forests particularly for protection and increase in productivity of wood and non-wood forest produce. Private companies such as PT Indokor also succeeded in rehabilitating their coast lines and were able to widen their production area. IPB (Bogor Agriculture Institute) in Kadipaten also initiated to promote Paraserianthes falcataria to increase the income of farmers.

Bali

The ongoing cooperation between JICA and the Directorat of Forest Rehabilitation and Social Forestry and the Department of Forestry promotes the establishment of a model for mangrove rehabilitation. A larger plot was established at Denpasar with additional project activities in order to promote also the conservation of mangroves in other areas.

Kalimantan

Planting of *Acacia mangium* began with the involvement of the Finnish Government in projects in South Kalimantan and West Kalimantan. The aim of the projects was to replant deforested area covered by imperata cylindrical created through illegal logging and shifting cultivation.

JICA, in cooperation with the Higher Education Department, initiated the rehabilitation of tropical rain forests and established a model of rehabilitation in Bukit Suharto, East Kalimantan. JICA also assisted the Mulawarman University, IPB, and University Gadjah Mada in forestry research and education. German Technical Assistance through GTZ also concentrated on research, education and training of forest scientists. PT Sumitomo of Japan also promoted the establishment of a model for tropical forests in Sebulu, East Kalimantan, and produced several publications on this experiment.

Sulawesi

Planting of gmelina for pulp production after deforestation was quite successful. However, the best results were obtained by the planting of 27,000 ha of teak (muna) in Konawe (Southeast Sulawesi). Long-term sustainability is at risk because of illegal cocoa plantations established within the forest plantation area.

Nusa Tenggara

There are only few rehabilitation activities, one of them by Perhutani, which has successfully planted teak on more than 20,000 ha. After the contract was completed, however, problems arose in the management and also with security of the area.

Maluku

For a long time the Maluku region has been an area of conflict and therefore the forest rehabilitation programme is not well established. The total forest area of 5 million ha will be targeted for conservation and should be rehabilitated mainly with indigenous species.

Papua

Mangroves in Papua are a very important group of tree species for the industry. Several companies such as PT Freeport and PT Bintuni try to conserve and develop forest areas and conduct different types of research using various mangrove species.

Numerous examples of past and ongoing forest rehabilitation initiatives exist in various localities in Indonesia. A wide range of stakeholders such as government agencies, universities, private companies, and local communities are involved in these initiatives. The selected case studies are briefly described using the following aspects:

- Driving factors
- Project success evaluation
- Factors contributory to success/failure
- Lessons learned

Case Study 1: *Fast Yieding Species (Acacia mangium):*

More than 100,000 ha in South Sumatra; oldest age class is 20 years

Driving factors	The rehabilitation effort was primarily driven by the desire to commercially produce short rotation timber from bare land areas.
Project success and impacts	In terms of production the project is successful. The whole area is now fully stocked with the planted *Acacia mangium* and bigger companies operating for pulp production. The major impacts of the project include employment for the people living in the surrounding areas. The project also contributed to skills development and assisted graduate students to experience practical work in plantation management and industry.
Reasons for success/failure	The plantation company could use funding from the HTI project released by the government. The debt was successfully returned to the government.
Lessons learned	During the establishment of the plantation there were conflicts with local people living in the surrounding areas because of ownership issues. By pursuing a social approach to satisfy local needs such as vegetable growing, cattle rearing and other social development projects such conflicts could be avoided.

Case Study 2: *Tropical Rain Forest Rehabilitation*

About 1,000 ha in Jambi established 13 years ago by KEEC & UGM

Driving factors	The rehabilitation efforts were primarily driven by the desire to do research on mycorrhiza suitable for dipterocarp forest rehabilitation. The secondary purpose of this project is to find other useful models for the rehabilitation of tropical rain forest areas.
Project success and impact	In terms of biophysical accomplishments the project is successful on at least 1,000 ha of test sites and also produced more than 200 scientific papers presented in national and international seminars and journals. The major impacts of the project are: • Model of rehabilitation of the tropical rain forest has been tested; • Wildlife species tend to return to the area; • Since the approach combines rubber trees with dipterocarps, short term income can be generated to support sustainable production in the long term; • Private companies are increasingly interested in cooperating with Gadjah Mada University on sustainable forest management.
Reasons for success/failure	Gadjah Mada University was able to obtain funding from KEEC/Kansai Osaka, Japan, with an average allocation of 500 million Rupees annually, excluding equipment and vehicles. Researchers from both Japan and Gadjah Mada University produced at least 16 topical papers per annum.
Lessons learned	A major lesson learned is the threat through illegal logging and monoculture plantation development such as oilpalm and *Acacia mangium* by big private companies in the surroundings. In additional also local people tried to encroach into the area. The pressure for additional land might endanger the sustainable management of multi-species natural forests.

Case Study 3: *BIOTROP on Tropical Rain Forest Rehabilitation*

Implemented in Jambi Province

Driving factors	The rehabilitation efforts were implemented primarily to develop research on tropical rain forest ecosystems.
Project success and impact	The project is unsuccessful and will not be continued because of logistic reasons (i.e.the great distance to the field sites and high operational costs to maintain the project).
Reasons for success/failure	Limited budget from the BIOTROP research programme which should have involved more domestic and international agencies.
Lessons learned	Illegal logging and land occupation need to be minimized and requires sufficient funding to ensure security.

Case Study 4: *Sengonisasi*

Implemented in Java over a period of more than 20 years

Driving factors	This rehabilitation effort primarily aims to produce short-rotation timber in order to satisfy the increasing demand for timber in highly populated regions such as Java.
Project success and impact	The project is successful in promoting *Paraserianthes falcataria* plantings in home gardens belonging to farmers and big companies such as Perhutani. Many companies followed this example and established timber plantations of P. falcataria for exporting light wood products to Japan and other countries. This species is not so allelophatic and can also be combined with other species such as durian, jack fruit, and several kinds of vegetables generating income for people.
Reasons for success/failure	The promotion by the Government and an increasing demand for light timber in local and regional markets.
Lessons learned	Planting of *P.falcataria* can easily be managed by farmers and does not need high investments and labour input. When planting is carried out in cooperation with private companies, farmers further benefit due to reduced harvesting and transportation costs. Marketing is not a problem since many companies buying the raw material exist in different locations.

Case Study 5: *Forest Education Project*

Implemented in Yogyakarta and several provinces throughout the country over 40 years

Driving factors	The rehabilitation efforts were primarily driven by the need of the University of Gadjah Mada to develop research models for rehabilitation of marginal lands, especially in dry areas. Providing opportunities for practical work for students and training for extension workers.
Project success and impact	In terms of biophysical accomplishments the project is successful with the establishment of 600 ha of rehabilitated forests using several species such as *Santalum album, Swietenia mahagony, Tectona grandis, eucalyptus sp, acacia mangium, A. auriculiformis, dyospyros celebica.* The project was successful in (a) training of more than thousand students and extension workers; (b) promotion of the area for ecotourism and attraction of students and colleagues from Singapore for more than 5 years to stay and study environment in the center. Most of the ministries and at least two presidents of Indonesia have visited the area. Several organizations used this area for general meetings or recreation, movies, TV programme and camping.
Reasons for success/failure	There was sufficient funding from the government, communities and also from local schools and universities from Singapore.

Lessons learned	One major problem is illegal logging of *Santalum album* for cosmetic products, timber of mahagony and also leaves of *Santalum album* and *Swietenia mahagony* for cattle feeding especially in the dry season.

Case Study 6: *Coastal Rehabilitation*

Implemented in South of Yogyakarta Province over 10 years; 450 ha

Driving factors	The rehabilitation efforts were primarily driven by the importance of wind breakers for the protection and development of the agriculture area in coastal zones.
Project success and impact	In terms of bio-physical achievements the project is successful. The agriculture area could significantly be improved with many areas becoming productive. Shrimp production e.g. by companies like PT Indokor could be enhanced. The protection function was also improved and lead to a reduced tsunami effect in June 2006.
Reasons for success/failure	Sufficient funds were supplied through the RUT fund and the Department of Forestry's budget for Gerhan (Movement of Rehabilitation of Forest and Land) in the coastal area.
Lessons learned	The major problems are related to illegal cutting and overhauling for bonsai. However, since the people are interested in planting, the tree planting area could be expanded to also cover home gardens, road sides, and park areas.

Case Study 7: *Mangrove Rehabilitation*

Implemented near Denpasar, Bali, over more than 5 years

Driving factors	The primary objective of the mangrove rehabilitation project in Denpasar is to reduce abration of the airport of Ngurah Rai Denpasar and to develop a model for rehabilitation of mangrove areas in Indonesia.
Project success and impact	The project is successful in terms of biophysical improvement of mangrove areas with newly established mangrove trees showing excellent growth. Training and an action programme of mangrove rehabilitation by communities and a student's movement became popular.
Reasons for success/failure	JICA supported the project through funding and facilities such as expertise and scientist's involvement. The government also provided support through local facilities and organization of seminars and workshops on mangrove management.
Lessons learned	The project is limited and has not yet been implemented on a larger scale.

Case Study 8: *Acacia Afforestation (Finnish Project)*

Implemented in South Kalimantan for more than 15 years.

Driving factors	The rehabilitation effort was primarily driven by the desire to commercially produce short rotation timber to supply the demand of wood and pulp for paper production. *Acacia mangium* and eucalyptus are the main species used in this project.
Project success and impact	A devastating fire after plantation establishment occurred and made this programme unsuccessful.
Reasons for success/failure	The project was funded by the Finnish Government in cooperation with the Indonesian Government.
Lessons learned	Frequent fire events inflicted great damage to the *Acacia mangium* plantation and the entire ecosystem and biodiversity of the region. The regrowth of *Acacia mangium* was very poor with extraordinary high mortality rates. In addition, homegardens of the local farming community were invaded by *Acacia mangium* regeneration.

Case Study 9: *Tropical Rainforest Rehabilitation*

Implemented in Bukit Suharto, East Kalimantan for more than 10 years.

Driving factors	The rehabilitation effort was primarily driven by the objecttives to restore the natural vegetation of indigenous trees in Bukit Suharto, East Kalimantan. Secondly, to develop a model for the rehabilitation of tropical rain forests.
Project success and impact	The project is considered successful and provided scholarships for PhD and MSc studies in Japan.
Reasons for success/failure	JICA funded the project and provided laboratory facilities, expertise and scientists. The support also included scholarships for cooperation with several universities in Indonesia, such as IPB, UGM and UNMUL. GTZ of Germany also provided support through scholarships for several PhD and MSc studies on ecology.
Lessons learned	The major constraint in running the project after external support had been terminated was the lack of local expertise to manage the sophisticated laboratories. Project knowledge on rainforest rehabilitation was also insufficiently transferred to the field.

Case Study 10: *Teak Rehabilitation*

Implemented in Konawe, South East Sulawesi; 27,000 ha

Driving factors	The rehabilitation effort was directed towards the production of high quality timber.Teak is ecologically suitable for the project area. Another objective was to generate employment for rural communities in this area.
Project success and impact	This project is considered successful. The establishment of the plantation generated employment and in addition, produced local food cultivated under the teak forests such as ginger and yam (*Dioscorea hispida* POIR).
Reasons for success/failure	The government supported the project through the Department of Forestry.
Lessons learned	After several years, however, the plantation area was affected by illegal logging and insufficient management control.

Case Study 11: *Mangrove Rehabilitation (Gesang et al., 2006)*

Implemented in Papua (PT Freeport Indonesia Contract of Work) over 8 years; 59,5 ha

Driving factors	The primary objective is to rehabilitate the mangrove area in Papua after mining, particularly to accelerate mangrove colonization and succession in the Ajkwa estuary; • Identify the most suitable species to be used for Colonizing of newly formed area by sedimentation; • Investigate the best planting methods; • Assess the success of assisted colonization by measuring the effectiveness of colonization/planting, the rate of recruitment of flora and fauna, and the performance of basic ecological processes.
Project success and impact	Survival rate of plantings is about 2.4 % to 31.2 % for *Avicenia marina, and Rhizophoa mucronata*. 15 news species of crabs were identified during five years of monitoring (2000-2005). The number and species of crustaceans and mollusks recovered to levels comparable with the natural ecosystem.
Reasons for success/failure	The willingness and dedication of the PT Freeport Indonesia Contract of Work.
Lessons learned	Many scientists were engaged to carry out studies and surveys of the mangrove ecosystem.

PART C
FUTURE ACTION FOR ENHANCING RESTORATION/REHABILITATION

1. Improving and Revising Existing Policies

A number of changes have been brought about to existing policies, for example, the Presidential Decree No.35, 1980, revised and issued as Presidential Decree No 31, 1989 as well as the Government Decree No.35, 1999 on non taxable national revenue known as PNPB or Penerimaan Negara Bukan Pajak (Government Decree No 35 2002). However, in spite of these revisions, there still continued to be many problems and weaknesses because of loopholes in these revised regulations. These loopholes became tools for individuals to benefit. For example the revised Government Decree No. 35, 2002 encouraged District Heads (Bupaties) to use the allocated funds not only for rehabilitation but other purposes such as putting it in a bank as fixed deposit to attract interest.

In order to make rehabilitation work move more rapidly, the Government established a programme on “Revitalising agriculture, forestry and plantations” (Revitalisasi Pertanian, Kehutanan dan Perkebunan). In addition, a new law was also instituted to increase the effectiveness of extension (Penyuluhan) work. Simon (2004) suggested that the rehabilitation work should follow five strategies:

1. Social forestry should be given priority based on the resolutions taken at th VIII World Forestry Congress held in Jakarta in 1978;

2. Poverty eradication among rural communities should be the prime objective to be pursued;

3. Sustainable forest management should be the governing principle in managing all forests;

4. Ecosystem-based forest management should be adopted; *and*

5. Autonomous principle should be ensured.

Simon (2004) further suggested that planning of forest rehabilitation programs in the various regions of Indonesia should be based on the following guidelines:

Sumatra

- Using indigenous species for productive areas;

- Forest timber plantation establishment on unproductive areas and in young secondary forests;

- Agroforestry models should be adopted (Examples: rubber with dipterocarps; oil palm with dipterocarps as demonstrated by the Gadjah Mada University and by London Sumatra Private Limited (PT Lonsum));

- Conservation activities in protection forests and restoration in the National Park to restore the forest to its original structure;

- Mangroves and swamp rehabilitation especially in Northern parts of Aceh and the Eastern parts of Sumatra Island;

- Develop downstream wood industries to supply timber for both export and domestic use;

- Involvement of many organizations and stakeholders such as the National Forestry Department, Provincial Forestry Department, District Forestry Department, National Companies, and also NGOs; *and*

- Strengthening of the organization, planning and also professionalism.

Java

- Increase teak production in order to attain at least 6 m^3/ha/year so that teak production at national level can attain 4.8 million m^3/ha/year;

- Promotion of teak as national wood for construction and export;

- Production of non-teak timber should reach at least 5 m^3/ha/year. Harvesting from productive forest should not exceed 0.2 m^3/ha/year for construction wood;

- Production of fuel wood should be about 5.2 m^3/ha/year;

- About 85,000 ha/year of forest land should be utilized for agroforestry using several models such as mixed food crops and teak;

- Develop cattle feed production, protect water resources, erosion control, flora and fauna conservation, and ecotourism;

- Production area to be managed by the sustainable forest resources management approach and the non-productive areas to be managed by the forest ecosystem management approach;

- Develop forest communities, introduce forest tree planting along the streets in urban areas, along the rivers, drainage areas and also in residential areas;

- Better forest management will assist at least 2 million families and will benefit more than 4 million people;

- Some other requirements for the success of forest management in Java should involve:

    - Train professional workers especially for sustainable forest management to be organized by the state companies under the supervision of the Forestry Department;

    - Introduce social forestry paradigm to reduce socio-economic pressure.

Kalimantan

Simon (2004) suggested that for Kalimantan, which has 36,7 million ha land area, and of which about 25,6 million ha is production area with low population, the utilization of its forest could be managed as follows:

- 5 million ha could be used for timber plantation, 5 million ha for community forests and estates and the remaining 15.6 million ha should be restored and maintained as natural forests;

- Kalimantan should be managed using the forest ecosystem based management system for about 11.1 million ha. As most of these areas would be returned to and maintained as tropical rain forest. The restored state of this ecosystem will be beneficial and important for Malaysia and Singapore to avoid any haze issues in future;

- Indigenous species such as Dipterocarp, Ramin, *Eusideroxylon zwageri* and also several kinds of food and fruit species should be introduced into the forest;

- Forest timber plantation should be introduced into unproductive areas and secondary forests;

- Forest and estate communities should be established both in the forest and also outside the forest;

- Agroforestry could be established especially using not only several important timber and estate species but also food crops under a forest canopy;

- Establishment of a National Park and Protection forest through the forest ecosystem management approach;

- Rehabilitation of watershed areas such as Mahakam, Barito and Kapuas;

- Promote the development of wood industries for domestic use and export;

- Involve a majority of the stakeholders such as, state and private companies, forestry departments, local people and their local institutions;

- Mangrove rehabilitation along the coastal areas;

- Reclamation of mining areas using the forest ecosystem management approach; *and*

- Rehabilitation of conservation and protection forests by returning them to a close-to primary state.

Sulawesi

In 1997, data showed that Sulawesi had about 12 million ha of forests consisting of 6,188,000 ha production area and 5,870,000 ha conservation area. Ebony (*Dyospiros celebica*) should be one of the very important timbers to be replanted. The reforestation activities should be concentrated in Central Sulawesi where the population is lowest. Simon (2004) then suggested that rehabilitation of Sulawesi should be based on the following principles:

- Rehabilitation with indigenous species such as *Dyospiros celebica*;
- About 1.5 million hectares should be under short rotation forest timber plantations;
- Another 1.5 million hectares under agroforestry management systems;
- Manage conservation forest by the forest ecosystem management approach;
- Mangrove rehabilitation to be reverted to their natural state;
- Promote the wood industry for domestic and export purposes;
- Involve several stakeholders such as national and district forestry departments, state and private companies, and local communities; *and*
- Develop conservation and protection forests.

Nusa Tenggara

The total area of these islands is about 2.7 million ha. About 1.134.000 ha are production areas while 1.533.000 ha is conservation and protection forests. The rehabilitation strategies suggested for Nusa Tenggara are as follows:

- Agroforestry should be the first priority for these islands;
- Planting of indigenous species such as duabanga, durian, kenari etc. should be carried out;
- The islands of Sumbawa and Flores as the main areas for timber production for domestic and export markets;
- Replanting to enrich the natural habitat of mangroves;
- Planting of economic timber trees that are suitable for semi arid areas such as teak, mahagony, *Dalbergia latifolia* should be carried out. Planting of local species is preferred especially due to their pest and disease resistance and their adaptation to water deficient areas;
- Planting along the road sides with species such as kenari is very beneficial not only for urban forest but their fruits can also be utilized as food;

- Involve more local communities, state and private companies, forestry department in forest ecosystem management; *and*

- Manage conservation and protection forests for water resources conservation.

Maluku

The total forest area in Maluku is about 7.2 million ha or about 65 % of the total land of Maluku. The regions of Halmahera, Ceram, Buru and the Southeast of Maluku should be designated for wood production.

- Rehabilitate the area back to its natural ecosystem state;

- Rehabilitation should be carried out based on local wisdom;

- Promote industries for export and domestic wood;

- Involve the organization of department of forestry, private and state companies and local communities; *and*

- Restoration of conservation and protection forests.

2. Building Research and Education Capacities

In 1970 a Research and Development Unit (Litbang Kehutanan) was formed within the Forestry Department to provide technical support related to suitable species for planting and other silvicultural practices needed for the success of the rehabilitation programs. At about the same time, the Government also created about 6000 vacancies for recruiting suitable extension professionals to carry out the duties.

While research on forest rehabilitation was enhanced, however, the interest in rehabilitation decreased throughout the country. This resulted in a decrease in students enrolling in the faculty of forestry at the universities in the recent years. Furthermore, forestry and faculties of forestry also became unpopular especially after the financial crisis in 1997 that escalated the bankruptcy of many of the forest concession companies.

Research in forest rehabilitation also needs to be expanded as very little research has been done in this field. Education capacity also needs to be expanded since most of extension workers appointed in the early eighties have retired, and at the same time there are not many student candidates who would like to enter programs such as in the faculty of agriculture, the faculty of forestry, the faculty of animal sciences and into agriculture technology. Most qualified students are only interested in civil engineering, medicine and economics. To recreate back interest in these fields, the government is now creating a new act to put in place new bodies or to renew the commitments of the existing bodies to seriously get involved into the program of rehabilitation of the country. Efforts are also being made to commit sufficient funds for such programs.

3. Reconciling Global and National Policies

There are several programs under the national policies such as the National Movement on Forest and Land Rehabilitation (GNRHL-Gerakan Nasional Rehabilitasi Hutan dan Lahan) which will rehabilitate about 3 million ha within 5 years. However, the total degraded forest land is about 58 million ha so. Hence, the target of 3 million hectares over 5 years is still too small.

Indonesia has ratified the Kyoto Protocol but to date the availability of funds through the CDM program is still difficult to mobilise. Most of the rehabilitation work done by NGOs either locally or from abroad focus only on fast growing species. Not much has been done in using indigenous species for planting in both water and biodiversity conservation. The Government is serious in the protection of the environment and hence it is a party to several of the international agreements and protocols. These include the following: Biodiversity, Climate Change, Endangered Species, Hazardous Wastes, Law of the Sea, Nuclear Test Ban, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Wetlands; signed, but not ratified - Desertification, Marine Life Conservation, and Tropical Timber 94.

4. Partnership and Collaboration with Private Sectors

Industrial Plantations (HTI-Hutan Tanaman Industri) became one of the main programs, of the previous President Suharto, to rehabilitate large areas of degraded land. Several companies such as PT Barito Pacific in South Sumatra, PT WKS in Jambi Province, and PT Andalan Pulp in Riau have successfully carried out such industrial plantations but mostly for pulp and paper production.

At the level of the involvement of communities, the Government's program named as the National Movement for Forest Rehabilitation (Gerhan/GNRHL) has created facilities for small, medium and even large scale community involvement in the production of quality seedlings in cooperation with the government. This too resulted in problems because the communities were not experienced in the techniques of seedling production.

Several private companies have been working on rehabilitation especially using indigenous species. One such company is Sari Bumi Kusuma that decided to rehabilitate areas with Dipterocarpaceae using line planting (tebang jalur) in existing degraded areas with the support and advice of the Gajah Mada University team. This program showed good results. Now Inhutani I, II, III also IV, which are companies belonging to the Government, are teaming up with the Gadjah Mada University to also carry out forest rehabilitation using dipterocarps.

5. Creating Public Awareness and Support

In the early 1970s, a program called Greening (penghijauan) was initiated. To make this greening of the country a success, the Government recruited about 6000 extension officers (Petugas Penyuluh Pertanian). Unfortunately, following the reformation era, most of these extension officers lost their role of creating public awareness on greening; instead they became administrative assistants in the respective districts.

In the early 1980s President Suharto started a campaign of "Planting a Million Trees" (Penanaman Satu Juta Pohon) to create public awareness of the importance of greening through the Youth Movements. One of the shortcomings of all these greening programs was that in most cases fast

growing species which were mostly exotics were used at the expense of the indigenous species. During the period from 1980-1990, species like *Acacia* sp., *Leucaena* sp. and *Paraserianthes falcataria* were extensively planted. The program was, however, quite successful but from the biodiversity point of view, local species lost out to these exotics.

President Abdurrahaman Wahid during his term as President started a campaign “No Forest No Future”. During all his visits around the country, he made it a point to plant trees as a mark of his visit to a specific location.

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President Megawati during her era inaugurated a program termed as the National Movement for the Rehabilitation of Forest and Watershed areas (Gerakan Nasional Rehabilitasi Hutan dan Lahan). This was to be a 5 year program involving three ministries. The total area to be rehabilitated was 3 million ha. The program clearly outlined the rehabilitation of 300,000 ha in 2003; 500,000 ha in 2004, 600,000 ha in 2005; 700,000 ha in 2006; and 900,000 ha in 2007 (dirjen RLPS, 2004).

The new Indonesian Government under President Susilo Bambang Yudoyono also has initiated several campaigns through the mass media such as newspapers and televisions for getting the support of the people to become more involved in the forest and environment rehabilitation movements. The campaign on the use of dipterocarp species for rehabilitation has now taken roots and the people at large know of their importance. The new Government is using the participatory approach by the communities to produce planting material from community nurseries for the rehabilitation program. Furthermore the Government is able to cover more areas of planting through this approach. Areas of rehabilitation includes degraded forests, mangroves, urban areas, road side planting and in community forest areas.

6. Community Involvement

Real GDP growth in 1985-94 averaged an impressive growth of about 6%, but not sufficient to both reduce unemployment and to absorb the 2.3 million workers annually entering the labor force. Agriculture, including forestry and fishing, are important sectors accounting for 21% of GDP and over 50% of the employed labor force. The staple crop of the country is rice. Once the world's largest rice importer, Indonesia is now nearly self-sufficient. Plantation crops - rubber and palm oil - and textiles and plywood are being encouraged for both export and job generation. Industrial output now accounts for almost 40% of GDP and is based on a supply of diverse natural resources, including crude oil, natural gas, timber, metals, and coal. Foreign investment has also boosted manufacturing output and exports in recent years. Indeed, the economy's growth is highly dependent on the continuing expansion of non-oil exports. Japan remains Indonesia's most important customer and supplier of aid. Rapid growth in the money supply in 1989-90 prompted Jakarta to implement a tight monetary policy in 1991, forcing the private sector to go to foreign banks for financing their investments. Real interest rates remained above 10% and off-shore commercial debt grew. The growth in off-shore debt prompted Jakarta to limit foreign borrowing beginning in late 1991. Despite the continued problems in moving toward a more open financial system and the persistence of a fairly tight credit situation, GDP growth in 1992-94 has matched the government target of 6-7% annual growth.

In the year 2006, the government faced the problems of 10 million unemployed workers while in early 1990 the figure was only 2.3 million workers. With the serious environmental damage caused the capacity of making available job opportunities to the communities was also reduced. In the

early 1990s the deforestation was between 700,000 ha to 1 million ha annually, while in 2005 deforestation reached about 2.9 million ha per year. To combat this worrisome rate, the Government instituted the Social Forestry Program to increase agriculture productivity and at the same time combining such agricultural activities with the conservation of natural resources on land. To obtain more support from the communities and to allow for more involvement at the same time, the government introduced another regulation to empower the communities around and inside the social forestry program to ensure sustainable forest management of the areas.

7. Monitoring and Evaluation for More Effective Rehabilitation/Restoration

Monitoring and evaluation has been done in the past. Most of the projects have been reported as successful work. However, in some cases when ground inspection was done, the projects were not implemented correctly and hence must be considered as unsuccessful. There is a need to put in place a more stringent monitoring system to ensure that all the rehabilitation programs undertaken are successful. Monitoring is imperative to ensure that the efforts put in for rehabilitation are indeed successful. The need is urgent as currently the area recognized as degraded forest stands at 59 million ha. Some of the universities have been charged to oversee and monitor rehabilitation acti-vities in their vicinity.

8. Effective and Practical Applications

Indonesia has been ranked as the 3rd mega diverse rich centre in the world. In principle therefore, the country should be rich in resources that should provide for the basic needs of its citizens. However, it can be noted that today this country depends on imports for its food needs. The import includes items like rice, wheat, corn, meat, milk, fruits, vegetables etc. The reason for this is the land productivity; availability of good quality water has reduced drastically due to the deforestation activities. Data until 1995 showed that the annual deforestation was about 600,000 ha. However, from recently collected data it was noted that the annual destruction was about 2,900,000 ha. Some NGOs on the other hand claim that the annual destruction could reach as much as 3,500,000 ha.

The tropical forest, home gardens and estates ecologically and originally could produce in huge quantities food such as, arrow root, cassava, sweet potato, yam, sukun (*Artocarpus communis*). Such food is a good source of vitamins and has many calories, not only in its fruits, but also in its leaves. Indigenous knowledge about food diversification (or agroforestry) in fact has a long history and has supported the sustainability of Indonesian society for thousands of years. These traditional foods could be produced throughout the year not only in the wet season but also during dry seasons unlike for example rice which needs a lot of water to grow and hence only cultivated once during the rainy season.

If this old food diversification method (or agroforestry system) is continued in the forest under the forest canopy, in estates, in home gardens or in marginal land areas, a large quantity of food can be produced that could eliminate the food scarcity in the country. However, the increase in monoculture systems of the food production industry which is more beneficial from the business point of view may not be suitable for most of the Indonesian situation because such practices reduce land optimization, deplete the water resources, and can aggravate a water shortage situation in the country. Taking an agroforestry approach, which has been tested over thousands of years in the country, would be the best way for the country, thus ensuring food security for the country and at

the same time ensuring the conservation of the forest and the water resources. In addition, it will also reduce the hefty bill on food imports.

The media can play a significant role in promoting good agricultural practices and food diversification programs. Special programs can be drawn up to explain to the public about the importance of optimal land utilization for food production which will reduce the pressure to clear more land for food production using monoculture systems.

Education is another important means to effectively promote the concept of food diversification, the importance of locally produced food for consumption and importance of attaining self sufficiency in food production and locally made products. If this is adopted, Indonesia can enhance and advance the science at the local universities towards agriculture, livestock, forestry, agroforestry and food science.

9. Financing for Forest Restoration

Forest rehabilitation in Indonesia started in the early 1980s as “penghijauan” or afforestation. These programs involved planting of trees on areas outside of the forests. Under the “Proyek Penghijauan” (Regreening project) forest rehabilitation is financed through the fund for reforestation (DJR: Dana Jaminan Reboisasi). As explained in the section on rehabilitation history, this fund has been created by the Presidential Regulation No. 35 1980, obliging forest concession holders to pay into the fund a fee for each cubic meter timber extracted. Forest concession companies replant or regenerate the logged-over forest areas. Once the replanting has proven successful the companies will be compensated by the Government using DJR funds.

In 1989, a new Presidential Regulation No 31 1989 called Reforestation Fund (DR: Dana Reboisasi) was launched. Under this regulation the forest concession company had to pay the DR for each cubic meter timber extracted being also responsible for the rehabilitation of logged forest area. The Government was responsible for the rehabilitation of areas outside the forest concession company such as Industrial Plantation Forest (HTI: Hutan Tanaman Industri) through a loan without interest and a governmental fund share. The DR funds were to be deposited in the accounts of the Ministry of Forestry. The use of the money had to be coordinated by the Ministry of Forestry and the Ministry of Finance and was additionally approved by the President.
Later on, problems arose when most of the rehabilitation projects faced difficulties to meet the time requirements. Since the rehabilitation work depended on the rainy season, in many cases seedling production commenced late and thus produced seedlings of low quality. Frequently, seedlings were planted in the field outside the preferred rainy season. As a consequence, survival rates and growth performance was poor, thus the entire project lead failed.

After 1999, another President Decree called “Penerimaan Negara Bukan Pajak” was implemented. Under this regulation, funds for rehabilitation have to be deposited in the Ministry of Finance (as non tax national revenue). Later on, this budget was not only used for forest rehabilitation but also for other government projects. In 2002, the Government revised the reforestation fund (DR: Dana Reboisasi) and transformed it to a loan scheme with focus on forest rehabilitation outside the production areas.

10. Home Garden/Indigenous Systems

The home garden model in Indonesia is a model that has evolved over thousands of years especially in Java. This model emulates the structure of tropical rain forests in home gardens and supplies most of the basic needs of the farmer's family. Food is produced under a canopy of fruit and timber trees while at the same time cattle and goats are reared as well.

11. Enhancement of Human Well-being and Natural Environment

Forest restoration usually succeeds when it contributes to the increase of benefits, daily income, and cultural life of local people. It must also be compatible with the ecology of the area. Numerous examples show that successful rehabilitation building diverse forests with many different layers and species provides a wide array of benefits to society. A combined rubber tree and dipterocarp management provides cash income through gum and timber production and improved the water resources. Gum production in Lampung, South Sumatra, for example, could be increased by improved maintenance of the trees without cutting them.

Research conducted by Mutiara and Irfan (1999) compares the efficiency of several management models. The first model represents present land use by planting several crops in an open area. The second model is a mix of crops and tress in gardens and the third model is a conversion from pine forest to a ginger plantation. The results show that mix gardens is the best model to protect the area from soil erosion and the decrease of the farmer's income is only 0.5 %/year. The second model reduces erosion by about 26%, while using the open area increases soil erosion by 3 %. However, the income only increases by about 2.3 %. The first model causes 22.53 tons of soil erosion/year.

The second model on mixed gardens therefore is the best scenario because the farmer's income is not significantly reduced. Although soil erosion in the second model is still above the tolerable value it can be reduced by soil conservation practices, especially in steep areas. The model was tested in the area of the Toba Lake catchment with a total area of 259.594 ha (FAO, 1987). Forest cover is around 65.100 ha or 25% of the total area; the remaining land belongs to local people. Almost 93% the land of the local people has steep slope and it is used for seasonal agricultural production without any soil conservations practices. Therefore, soil erosion is above the tolerable value. If this condition continues, soil fertility will decrease rapidly.
Based on the above-described background, another study was conducted at one of the sub-catchments of the Toba Lake, in order to evaluate the effect of land use on soil erosion and farmer's income. This study is also seeking the best land use model that can by applied in the Program of Forest, Land and Water Sustainability, without loosing farmer's income.

PART D
MISCELLANEOUS

1. Forest Fires

Forest fires are caused by land clearing activities for oil palm plantations, arson linked to land tenure conflicts (e.g. financial compensation for forest gardens), other types of arson and accidental fires. Drought seasons and the effects of uncontrolled fires increase the pressure on the

local population through destroyed forest gardens, temporary loss of many plant resources, reduced protein and vitamin supply causing an increase in health problems.
One of the main factors effecting forest degradation is forest fires and uncontrolled burning. ASEAN countries especially Malaysia and Indonesia were most affected by forest fires during July-November, 1997. The worst haze occurred in Sarawak, Malaysia when an emergency was declared based on the Air Pollution Index (API) indicating a danger level of 800, 300 above the allowable danger level. Observations and studies based on data from the Meteorological Department Service showed that the haze was caused by fires and burning in large parts of Indonesia. This paper also assessed the burned forest area and the relationship between the number of "hot spots" and the severity of haze occurrence in affected areas, particularly Borneo. The causes of forest fires were highlighted and a management plan of forest fire control was proposed (Kamaruzaman and Aswarti, 1999).
Nyoman and Irwansyah (1999) describe the impact of forest fire on the biodiversity and water quality in Berbak National Park studied during March to October 1998. The study covered three swampy areas: Simpang Palas, Simpang Datuk and Air Hitam Dalam. The first two areas had been burnt twice (1994 and 1997) and the Air Hitam Dalam area only once (1997). The results include the impact of fire on the water quality, vegetation and fauna.

- *Impact on water quality:* The survey indicated that forest fire had caused acidification and increased ion concentration in the water of the areas studied. The pH of these areas was very low (3.3-3.5), with the acidity ranging from 120 to 760 ppm, compared to the adjacent area which received no direct impact from forest fire (i.e. the Batanghari river: pH 5.8-7.1, no acidity values detected). The acidification of these swampy areas is thought to have resulted from the release of sulfate (through drought and fire) from soils containing sulfides or free sulfur, which then oxidized in the presence of water to form sulfuric acid. The survey recorded that the sulfate (136-695 ppm) and iron (1.7-6.4 ppm) content of these swampy areas was very high compared to the Batanghari river (sulphate: 14-29 ppm, total iron 0.30-0.62 ppm). Physical degradation of organic matter during the forest fire in Berbak had also significantly increased the ion (Ca, Na, Mg, K, SO_4, CO_3) concentration in the water. This effect has been demonstrated in the laboratory using a simulation model.

- *Impact on vegetation:* Forest fire has destroyed 75-98% (24-48 species) of plant species in the study areas. The highest loss was recorded in Air Hitam Dalam (98% or 48sp from a total of 49 species found in unburned areas), followed by Simpang Palas (96 % or 25sp from total 26 species) and Simpang Datuk (75% or 8sp from total 32 species). Although significant numbers of plant species were destroyed during the fire, the loss of thick canopies has enabled several dormant plant species to emerge from the ex-forest fire floors.

- *Impact of fauna:* Forest fire has created many patches of open areas in Berbak. This implies loss of living habitat, feeding grounds and nesting habitat and certain creatures (e.g.: sun bear). During the October 1998 survey, crowds of predator birds (e.g. Lesser adjutant and Brahminy kite) were observed searching for food in these open areas and villagers' crops (e.g. coconut trees). Villagers reported finding many freshwater fishes dead in Berbak NP during the 1997 dry season, due to the disappearance of water from swamps, and also in the 1998 early rainy season. The 1998 fish death toll is suspected to be due to water acidification. A number of these fish species (e.g. the climbing perch *Anabas testudineus*),

snakeheads (*Channa striata*), sepat rawa (*Trichogaster leeri*) and seluang (*Rasbora agyrotaenia*)) have since reappeared in these ex-forest fire swampy areas. A minimum of between 20-21 adult individuals and 15 ducklings of WWD (White Winged Duck, *Cairina scutulata*) were found in Desa Sei Rambut and Air Hitam Dalam. (These areas have now become new records for WWD populations found in Sumatra). In the short term, forest fire has had no significant impact on the occurrence of WWD in these areas, but in the long term due to the loss of suitable habitats.

2. Regional Collaboration

Collaboration for forest rehabilitation has been developed with JICA of Japan, KEEC/Kanso Sumitomo Japan, the South Korea Government and privates companies, as well as with the European Union and other organizations such as ICRAF, ITTO, KOICA, IUFRO-SPDC, GTZ and CIDA.
JICA for example has developed a model for rehabilitation of tropical rain forest in cooperation with the University of Mulawarman and many other universities through the Indonesian Ministry of Education.
ICRAF also formed a network for agroforestry education (INAFE: Indonesian Network Agroforestry Education) and worked with 23 universities to promote education in agroforestry also as a means for ecosystem rehabilitation.

3. Pests and Diseases, Invasive Species, Exotics

The introduction of *Leucaena leucocephala* (lamtoro gung) in Indonesia has caused serious forest health problems, particularly the introduction of pests such as kutu loncat. In addition, the exotic leucaena species is a strong competitor to the local species of leucaena (lamtoro/kemlandingan) which is in danger to be eliminated. Exotic species, such as *Acacia mangium*, *Acacia pellita* etc., are preferably planted in fast-growing tree plantations for the production of pulp and paper causing great problems to Indonesia's rich biodiversity. Similarly, the conversion of tropical forests to oil-palm and rubber plantations has also a negative effect on biodiversity.

4. Biodiversity

Indonesia ranks number three of the list of biological diversity. Although its land area is only about 1.3 percent of the world, Indonesia has about 17 percent of all species. Due to past and ongoing land conversion to monocultures biodiversity faces a critical era in the years to come. According to Rivai (1993) there are about 28,000 plant species in Indonesia, but only about 6,000 have been utilized for various purposes such as:

- Ornaments about 1100 species;
- Medicinal plants about 940 species;
- Fruits about 400 species;

- Vegetables about 340 species;
- Tannin about 228 species;
- Timbers 267 species; *and*
- Spices about 54 species.

If marine diversity was also included Indonesia would be regarded as the most significant mega-diversity region in the world. The 47 ecosystem types in Indonesia can be divided into seven bio-geographic regions which are located on the major groups of island as follows:

- *Java and Bali*: rain forests, natural monsoon forests;montane forests, temperate herbaceous formation, limestone karst, fresh water swamp forests and mangroves;
- *Kalimantan including the Natuna and Anambas islands*: lowland evergreen forests; montane forest; extensive mangroves, peat and fresh water swamp forests and large heath forests;
- *Sumatra and offshore islands:* dipterocarp forest; peat swamp forests, mangroves, montane rain forests; natural pine forests;
- *Sulawesi and offshores islands including Sulu:* montane rain forests; lowland rain forests, karst lime stone, swamp forests and mangroves;
- *Nusa Tenggara:* monsoon forests and extensive grass lands, natural sandalwood forests and some montane rain forests;
- *Maluku:* low land and montane forests, mangroves and fresh water swamps;
- *Papua:* monsoon forests; savanna woodlands, tropical rain forest including lower mountain forests; mangrove forests; upper montane forests; alpine heath forests, fresh water swamp forests; limestone; grassland and beach forests.

Rapid deforestation mainly due to land conversion is the major cause of loss of biodiversity. Therefore, maintenance of biodiversity is one of the most demanding tasks for the new century (Gonner 1999). A good example of sustainable management and biodiversity conservation can be reported from Kalimantan. During at least 300-400 years of swidden agriculture and forest management, Dayak Benuaq farmers have created a mosaic of vegetation on an area of 9,200 ha, consisting of more than 1,700 forest gardens (rattan, fruit, rubber) and hundreds of swidden fallows in different succession stages (Gonner, 1999). More than 740 taxa are used by the locals, including at least 398 extracted plant species, 246 cultivated crop varieties and 99 hunted animal species. Out of this diversity about 10-15 species are regularly used as traded commodities. This example shows that only approaches to forest restoration will work that seek to balance human needs with those of biodiversity and aim to restore a range of forest functions and accepting and negotiating the trade-offs between them.

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